NEPA COVER SHEET

TITLE: Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington

RESPONSIBLE AGENCIES: Lead Federal Agency: U.S. Department of Energy (DOE), Richland Operations Office; Lead State Agency: Washington State Department of Ecology (Ecology).

ABSTRACT: This document analyzes the potential environmental consequences related to the Hanford Site Tank Waste Remediation System (TWRS) alternatives for management and disposal of radioactive, hazardous, and mixed waste, and the management and disposal of approximately 1,930 cesium and strontium capsules located at the Hanford Site. This waste is currently or projected to be stored in 177 underground storage tanks and approximately 60 miscellaneous underground storage tanks. This document analyzes the following alternatives for remediating the tank waste: No Action, Long-Term Management, In Situ Fill and Cap, In Situ Vitrification, Ex Situ Intermediate Separations, Ex Situ No Separations, Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1, and Ex Situ/ In Situ Combination 2 . This document also addresses a Phased Implementation alternative (the DOE and Ecology preferred alternative for remediation of tank waste). Alternatives analyzed for the cesium and strontium capsules include: No Action, Onsite Disposal, Overpack and Ship, and Vitrify with Tank Waste. The DOE and Ecology preferred alternative for the cesium and strontium capsules is the No Action alternative.

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PUBLIC COMMENT: Public meetings on the TWRS Draft Environmental Impact Statement were held at five locations during the comment period . Written and oral comments on the TWRS Draft Environmental Impact Statement were accepted from April 12, 1996 until May 28, 1996. DOE and Ecology consider ed all public comments in preparing the TWRS Final Environmental Impact Statement.

SEPA FACT SHEET

DOCUMENT TITLE AND LOCATION OF PROJECT: Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington

PROPONENT: U.S. Department of Energy

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POTENTIAL PERMITS REQUIRED:

Activity and Waste Type	Regulatory Action Required	Regulation	Regulatory Agency
Air emissions	Radiation Air Emissions Program (Approval)	Washington Administrative Code 246-247	Washington State Department of Health
Air emissions	Controls for New Sources of Toxic Air Pollutants (Approval)	Washington Administrative Code 173-460 and 40 Code of Federal Regulations (CFR) 61	Ecology and EPA
Air emissions	Notice of Construction and possible modification to the Sitewide permit (Approval)	Washington Administrative Code 173-400 and 173-460	Ecology and Benton County Clean Air Authority
Air emissions	Ambient Air Quality Standards and Emissions Limits for Radionuclides (Approvals)	Washington Administrative Code 173-480	Ecology
Soil column waste water disposal	State Waste Discharge Permit (Permit)	Washington Administrative Code 173-216	Ecology
Effluent, spills	Groundwater Quality Standards (Approval and possible permit)	Washington Administrative Code 173-200	Ecology
Effluent	Water Quality Standards for Surface Waters (Permit)	Washington Administrative Code 173-201A	Ecology
Effluent	National Pollutant Discharge Elimination System Permit Program (Permit)	Washington Administrative Code 173-226-100	Ecology
Dangerous (including mixed) waste generation, storage, treatment, and disposal	Dangerous Waste Permit, RCRA Permit (Permit)	Washington Administrative Code 173-303 and 40 CFR 260-270	Ecology and EPA
All media	Cultural Resource Review Clearance	36 CFR 800	DOE and Washington State Historic Preservation Officer
All media	Endangered Species Review	50 CFR 402.6	U.S. Fish and Wildlife Service
Onsite management and disposal of high-level and transuranic waste	Waste Disposal Review and Standards (Approval)	40 CFR 191	EPA

DATES FOR FINAL ACTIONS: The TWRS Record of Decision is anticipated in October 1996. The Record of Decision will be published in the Federal Register.

RELATED DOCUMENTS: Environmental Impact Statement technical reports, background data, materials incorporated by reference, and other related documents are available either through the contacts listed in the Contact

Section, or at:

DOE Freedom of Information Reading Room Forrestal Building 1000 Independence Ave. S.W. Washington, D.C.	DOE Public Reading Room Washington State University Tri-Cities Branch 100 Sprout Road Richland, WA

and at the following U.S. Department of Energy information repositories:

University of Washington Suzzallo Library Government Publication Room Seattle, WA	Gonzaga University Foley Center E. 502 Boone Spokane, WA

Portland State University
Bradford Price Millar Library
SW Harrison and Park
Portland, OR

Copies of the Environmental Impact Statement are available free of charge to the interested public through the contacts listed in the Contact Section.

1.0 INTRODUCTION

The U.S. Department of Energy (DOE), in cooperation with the Washington State Department of Ecology (Ecology), must make decisions on how to manage and dispose of Hanford Site tank waste and encapsulated cesium and strontium to reduce existing and potential future risk to the public, Site workers, and the environment. The waste includes radioactive, hazardous, and mixed waste currently stored in 177 underground storage tanks, approximately 60 other smaller active and inactive miscellaneous underground storage tanks (MUSTs), and additional Site waste likely to be added to the tank waste, which is part of the tank farm system. In addition, DOE proposes to manage and dispose of approximately 1,930 cesium and strontium capsules that are by-products of tank waste. The tank waste and capsules are located in the 200 Areas of the Hanford Site near Richland, Washington (Figure 1.0.1).

The alternatives selected for the final management and disposal of this waste must comply with Federal and Washington State environmental laws and regulations, and be within the context of the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1994). Permanent solutions to tank waste risk are a major goal of the agreement. The Tri-Party Agreement was signed by DOE, Ecology, and the U.S. Environmental Protection Agency (EPA) to address waste management and cleanup of the Hanford Site.

Figure 1.0.1 Hanford Site Map

On January 28, 1994, in a Notice of Intent published in the Federal Register (FR), DOE announced its intent to prepare two Environmental Impact Statements (EISs): 1) an interim action EIS to resolve urgent tank safety issues; and 2) this Tank Waste Remediation System (TWRS) EIS (59 FR 4052).

The TWRS proposed action is subject to the Council on Environmental Quality's National Environmental Policy Act (NEPA) (10 Code of Federal Regulations [CFR] Parts 1500 to 1508) and the Washington State Environmental Policy Act (SEPA) (Revised Code of Washington [RCW] 43.21C). Both acts require analysis of potential environmental impacts in the decision-making process. DOE and Ecology signed a Memorandum of Understanding on February 15, 1994 to jointly prepare the EIS for the proposed TWRS action (MOU 1994). The co-preparation of the EIS streamlines the environmental review process while ensuring compliance with applicable Federal and State laws, regulations, and policies.

A 45-day scoping and public participation process began on January 28, 1994 and ended on March 15, 1994. During the scoping process, DOE and Ecology conducted five public meetings and accepted both verbal and written comments. The scoping process provided opportunities for the public to review information and comment on the proposed action. DOE and Ecology considered both verbal and written comments on the scope of the proposed action, alternatives, and environmental issues in preparing the TWRS EIS Implementation Plan (DOE 1995b) and the TWRS EIS.

On April 12, 1996, in a Notice of Availability published in the Federal Register (FR 16248), DOE announced the availability of the Draft EIS for review and comment. A 45-day public comment period began on April 12, 1996 and ended on May 28, 1996. During the public comment period, DOE and Ecology conducted five public meetings and accepted both verbal and written comments. Consultation meetings were also held with local, State, and Federal agencies, Tribal Nations, and DOE advisory boards. DOE and Ecology considered both verbal and written comments on the Draft EIS in preparing the Final EIS. Information on the public comment period is provided in Volume One, Section 7.0. Verbal and written comments and DOE and Ecology responses to comments are presented in Volume Six,

Appendix L.

NEPA and SEPA provide decision makers with an analysis of environmental impacts (both positive and negative) of proposed actions for consideration during decision making. This EIS presents the impacts of the proposed action and its reasonable alternatives for review and comment by the public and interested parties.

The decisions made by DOE will be discussed in a Record of Decision to be issued no earlier than 30 days after issuing the Final EIS. Also to be issued following the completion of the Final EIS is a Mitigation Action Plan, which will detail the commitments to mitigate impacts to the environment made in the Record of Decision.

In the following sections, an overview of the history of the tank waste and capsules is provided, along with an explanation of the policy and regulatory developments that require DOE to manage and dispose of the tank waste. This is followed by a review of technical and programmatic developments that have influenced DOE's tank waste remediation plans. The section concludes with a brief summary of the alternatives development process, an explanation of the contents of the EIS, and definitions of technical terms, data, and concepts used in the EIS.

1.1 POLICY BACKGROUND

The Federal government established the Hanford Site near Richland, Washington in 1943 to produce plutonium for national defense purposes. The Hanford Site occupies approximately 1,450 square kilometers (km^2) (560 square miles [mi^2]) of land north of the city of Richland. The production mission ended at the Hanford Site in 1988. The current Hanford Site mission is waste management and environmental restoration, which includes programs to manage and dispose of radioactive, hazardous, and mixed waste that exists at the Site. This TWRS EIS addresses tank waste, MUST waste, and cesium and strontium capsules located in the 200 Areas of the Site.

1.1.1 Hanford Site Tank Waste and Cesium and Strontium Capsules

At the Hanford Site, there are 149 single-shell tanks (SSTs) constructed between 1944 and 1964, which received waste until 1980. Waste in the SSTs consists of liquid, sludges, and saltcake (i.e., crusty solids made of crystallized salts). Over the years, much of the liquid stored in SSTs has been evaporated or pumped to double-shell tanks (DSTs). There are 28 DSTs at the Hanford Site that were constructed between 1968 and 1986. The DSTs are used to store liquid radioactive waste from the SSTs and various Hanford Site processes. The waste is partially segregated and stored in tanks based on composition, level of radioactivity, or origin.

In addition to the 177 underground storage tanks, there are approximately 40 inactive and 20 active MUSTs located in the 200 Areas. The MUSTs contain small quantities of radioactive, hazardous, and mixed waste similar in content and composition to the waste in the SSTs and DSTs. The MUSTs, which are part of the tank waste system, consist of buried steel tanks used for collecting spills and leaks during waste transfer and buried concrete vaults with carbon or stainless-steel tanks used for waste recovery (WHC 1994a).

Cesium and strontium are stored in approximately 1,930 double-walled capsules. In the 1960's and 1970's, radioactive cesium and strontium were extracted from waste in some SSTs to reduce the sources of heat in the tanks (WHC 1995h). The cesium and strontium were converted to salt forms and placed in capsules. Some capsules were shipped offsite to be used as heat or radiation sources. All the capsules will be returned to the Hanford Site for final disposal (DOE 1994c). All strontium capsules have been returned to the Site, and all cesium capsules are scheduled to be returned to the Site in 199 7 . The capsules at the Hanford Site are stored in the 200 Areas in the Waste Encapsulation and Storage Facility, which began operating as a capsule production facility in 1974. For the purpose of analysis in this EIS, it is assumed that all capsules will be returned to the Hanford Site and stored in the Waste Encapsulation and Storage Facility. The capsules currently are classified as waste by-product material, which means they could be put to productive uses if a need is identified and a user acceptable to DOE desires the material. For example, the strontium could be used as a source of heat and the cesium could be used to sterilize medical equipment or to irradiate food to extend its shelf life. DOE is attempting to find uses for these materials. If no future use can be found, the cesium and strontium capsules may be classified as high-level waste (HLW) for disposal purposes. The final determination as to whether the capsules are HLW will be made in consultation with the Nuclear Regulatory Commission. The number of capsules requiring treatment and disposal could increase slightly if capsule contents, previously removed during research and development programs, are reencapsulated. The volume of tank waste and number of capsules are summarized in Figure 1.1.1.

1.1.2 Regulatory Developments

From the 1943 to 1989, the Hanford Site's principal mission was the production of weapons-grade plutonium. To produce plutonium, uranium metal was irradiated in a plutonium production reactor. The irradiated uranium metal, also known as spent fuel, was cooled and then treated in a chemical separations or reprocessing plant. At the reprocessing plant, the spent fuel was dissolved in acid and the plutonium was separated from uranium and many radioactive by-products. The plutonium then was used for nuclear weapons production. Several tons of spent fuel were produced to generate enough plutonium to make a nuclear weapon. The process resulted in a large volume of radioactive waste.

The Hanford Site processed more than 100,000 metric tons (mt) (110,000 tons) of irradiated uranium and generated several hundred thousand metric tons of chemical and radioactive waste. The waste included HLW, transuranic waste, low-activity waste (LAW), hazardous waste, and mixed waste (radioactive and hazardous waste).

For many years, the waste produced at the Hanford Site was managed in a manner that complied with standards at that time. For the HLW generated by the chemical reprocessing plants, waste management initially involved making the waste caustic with sodium hydroxide and calcium carbonate and storing the waste in large underground tanks until a long-term solution could be found for disposal of HLW. In the 1940's through the early 1960's, 149 SSTs were built to store HLW in the 200 Areas of the Hanford Site.

Figure 1.1.1 Hanford Site Tank and Capsule Overview

During the 1950's, uranium was extracted from some of the SSTs, an action that introduced new chemicals to the tanks. Also, to free up tank space for the large volume of new waste being generated by fuel reprocessing, chemicals were added to the tanks to cause many of the radionuclides to settle to the bottom of the tanks (Gephart-Lundgren 1995) . The remaining liquid contained a low concentration of radioactivity that did not require tank storage. Large volumes of the liquid waste could be siphoned off and disposed of as LAW. As waste flowed from one tank to another, much of the solids were separated off from the waste along the way, and the LAW liquid that resulted was sent to unlined cribs where it percolated into the soil. This process resulted in increasing the concentration of the cesium-137 and strontium-90, which concentrated the heat being generated enough that waste in some tanks began to boil and the heat threatened the integrity of the tanks. To address this problem, chemicals were added to the tanks in the 1960's to separate cesium and strontium from the waste and waste was recovered from the tanks . Cesium and strontium then were extracted from the waste in B Plant , placed in capsules, and stored in a separate facility.

In the mid-1950's, leaks were detected in SSTs. By the late 1980's, 67 of the SSTs were known or suspected leakers, and an estimated 3.8 million liters (L) (1 million gallons [gal]) of HLW had been released into the soil beneath the tanks. To address concerns with the design of SSTs, the Hanford Site adopted a new DST design. The DST design would allow leaks to be detected and remedial action taken before waste could reach soil surrounding the tanks. Between 1968 and 1986, 28 DSTs were constructed. Through the end of July 199 6 , 115 SSTs have been stabilized by removing pumpable liquids to minimize future leaks. The stabilization program will be completed in 2000. Newly generated waste and pumped interim SST stabilization waste is stored in the DSTs.

Throughout much of the history of plutonium production at the Hanford Site, there were few laws regulating waste management and environmental protection. In the 1970's and 1980's, new environmental laws were enacted regulating waste management, storage, disposal, and pollution emissions to the air and water. Because of national security concerns, nuclear production facilities like the Hanford Site were self-regulated. Under the provisions of the Atomic Energy Act, DOE was authorized to establish standards to protect health or minimize dangers to life or property for activities under DOE's jurisdiction. In the 1980's, much of DOE's authority to self-regulate facilities was eliminated, and other agencies became responsible for regulating many aspects of DOE's activities.

The Clean Air Act originally was passed in 1970 and has been amended several times, including extensive amendments in 1977 and 1990. This law requires DOE to meet national air quality standards, ensure hazardous air emissions from existing and new sources are controlled to the extent practical, and obtain an operating permit for all major emission sources. The Clean Water Act, which underwent major amendments in 1972, 1977, and 1987, and the Safe Drinking Water Act, originally passed in 1974 and amended in 1986, regulate discharges to surface water, set national drinking water standards, and regulate emissions of hazardous constituents to surface and groundwater.

In 1976, with the passage of the Resource Conservation and Recovery Act of 1976 (RCRA), the Federal government for the first time assumed a major role in the management of hazardous waste. Through RCRA, the 1984 amendment to RCRA (known as the Hazardous and Solid Waste Amendments of 1984), and as amended by the Federal Facility Compliance Act of 1992, the EPA and EPA-authorized states were authorized to regulate hazardous waste generation, treatment, storage, and disposal. RCRA's provisions excluded radioactive waste from regulation by EPA, and it was not until 1984 that EPA's jurisdiction over DOE's nonradioactive waste was firmly established. In 1987, mixed waste at DOE facilities was recognized under RCRA regulations. In November 1987, Ecology, the administrating agency for the state Hazardous Waste Management Act, was delegated RCRA enforcement authority. RCRA established regulations for newly generated hazardous waste but did not address past waste disposal practices. To clean up past hazardous and radioactive waste disposal sites, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980. CERCLA was significantly amended in 1986 by the Superfund Amendments and Reauthorization Act. The 1986 amendments required Federal agencies to investigate and remediate releases of hazardous substances, including radioactive contaminants, from their facilities.

Beginning in 1986, regulators from EPA, Ecology, and DOE's Richland Operations Office began to examine how best to bring the Hanford Site into compliance with RCRA and CERCLA. The regulators and DOE agreed to develop one compliance agreement that set agreed-upon milestones for cleaning up past disposal sites under CERCLA and bring operating facilities into compliance with RCRA. Negotiations concluded in late 1988, and the Tri-Party Agreement was signed by the three agencies on January 15, 1989. The Tri-Party Agreement is the primary framework for CERCLA and RCRA regulation of the Hanford Site, including the tank farms. The existing hazardous and mixed waste and new waste added to the tank farms is regulated through the Tri-Party Agreement's RCRA enforcement provisions. Hazardous, mixed, and radioactive waste from the tanks that was disposed of through the cribs to the soil is regulated through the Tri-Party Agreement's CERCLA enforcement provisions. Neither RCRA nor CERCLA provide the regulatory framework for the disposal of radioactive waste.

In response to the continued accumulation of spent nuclear fuel, high-level radioactive waste, other hazardous waste, and growing public awareness and concern for public health and safety, Congress has passed numerous laws including the Nuclear Waste Policy Act of 1982. The purpose of these laws was to establish a national policy and programs that would provide reasonable assurance that the public and the environment would be adequately protected from the hazards posed by these wastes. The action by Congress was influenced by a national consensus that the potential hazards of spent nuclear fuel and HLW needed to be permanently isolated from the human environment with minimal reliance on institutional controls. Permanent isolation consists of containment of the waste within engineered and natural barriers, which are likely to contain the material for a very long time. Minimal reliance on institutional controls means the isolation is not dependent on ongoing maintenance of facilities, human attention, or commitment by governments or other institutions. The national consensus has been reflected in the Northwest by strong support among DOE, Federal and State agencies, Tribal Nations, and citizens and stakeholders to clean up the Hanford Site.

In 1974, Congress passed the Energy Reorganization Act, which authorized the Nuclear Regulatory Commission to regulate and license DOE facilities constructed for the express purpose of long-term storage and disposal of high-level radioactive waste, which is not part of DOE's research and development program. The Nuclear Regulatory Commission has established regulations for radioactive waste that can be disposed of in land disposal sites (10 CFR

Part 61), as well as radioactive waste requiring geologic disposal (10 CFR Part 60). The EPA was authorized to establish standards for managing and disposing of spent nuclear fuel, HLW, and transuranic waste. These regulations are contained in 40 CFR Part 191 and would apply to HLW disposed of at the Hanford Site.

A number of evaluations and decisions regarding the disposal of commercial and defense HLW were completed in the late 1970's and early 1980's. These evaluations included NEPA analysis for management of commercial radioactive waste, the Waste Isolation Pilot Plant, and the Immobilization Research and Development program at Savannah River. For these evaluations, it was decided that HLW and transuranic waste should be disposed of in potential geologic repositories.

Congress then enacted the Nuclear Waste Policy Act, authorizing Federal agencies to develop geologic repositories for disposing of high-level radioactive waste and spent nuclear fuel from commercial reactors. In 1983, DOE submitted the Defense Waste Management Plan, which provided deep potential geologic repository disposal of HLW as the planning basis for all DOE HLW, and in 1985, the President approved a DOE recommendation to dispose of defense waste in a commercial repository. In 1987, Congress amended the Nuclear Waste Policy Act to focus potential geologic repository development activity at one site, the Yucca Mountain site in Nevada.

In addition to applicable laws and regulations, DOE has established a set of policies to guide DOE activities. In 1988, DOE issued DOE Order 5820.2A, which stated DOE's policy to process and dispose of HLW in a potential geologic repository. For planning purposes, DOE assumes that some or all of the defense HLW that satisfies the repository acceptance criteria could be placed in the first potential geologic repository developed under the Nuclear Waste Policy Act. By law, the first repository is limited to a total capacity of 70,000 mt (77,000 tons) of spent nuclear fuel or HLW, or a quantity of solidified HLW resulting from the reprocessing of such a quantity of spent fuel prior to operating a second repository. The allocated capacity for defense HLW in the first repository is 7,000 mt (7,700 tons). At this time, sufficient quality and quantity of information is not available to determine whether the Yucca Mountain site is a suitable candidate for geologic disposal of spent nuclear fuel and HLW. DOE will prepare a repository EIS to evaluate potential environmental impacts associated with the repository's construction and operation.

1.1.3 Hanford Defense Waste Environmental Impact Statement Record of Decision

In April 1988, after completing the Hanford Defense Waste EIS, DOE decided to proceed with preparing the DST waste for final disposal. Based on the Hanford Defense Waste EIS Record of Decision, the waste was to be processed in a pretreatment facility to separate DST waste into two waste streams (53 FR 12449). The larger waste stream would be LAW, and a smaller waste stream would be HLW. The LAW was to be mixed with a cement-like material to form grout. The grout was to be encased in large underground concrete vaults at the Hanford Site. The HLW portion was to be vitrified into a glass-like material and encased in stainless-steel canisters at the proposed Hanford Waste Vitrification Plant. The canisters were to be stored at the Hanford Site until a potential geologic repository was available to receive this waste. The Hanford Defense Waste EIS Record of Decision also called for the continued storage of cesium and strontium capsules until a potential geologic repository was ready to receive the capsules for disposal. Before shipment to the repository, the capsules would be packaged to meet the repository acceptance criteria.

In the Hanford Defense Waste EIS Record of Decision, DOE decided to perform additional development and characterization before making decisions on final disposal of SST waste. The SST waste would continue to be stored and monitored. The development and characterization effort was to focus on methods to retrieve and process SST waste for disposal and stabilize and isolate the waste near the surface. Before a decision would be made on the final disposal of the waste, alternative disposal methods were to be examined in a supplemental analysis to the Hanford Defense Waste EIS.

The Hanford Defense Waste EIS Record of Decision formed the planning basis for DOE programs to manage tank waste and cesium and strontium capsules at the Hanford Site. The TWRS program is responsible for tank farm routine operations, including tank farm management, regulatory compliance, reporting, surveillance, and operations and maintenance of facilities and equipment. Additional ongoing TWRS activities include: 1) characterizing waste to support safety, retrieval and transfer, processing, treatment, and disposal; 2) addressing tank safety issues; 3) isolating and removing pumpable liquid from SSTs to reduce the potential of future leakage; and 4) operating the 242-A

Evaporator to concentrate waste by reducing the amount of liquid. Other projects initiated under the 1988 Record of Decision included technology development, design, and construction of the facilities needed to implement the planned retrieval, pretreatment, immobilization, and storage and disposal of DST waste.

1.1.4 Developments Since the Hanford Defense Waste Record of Decision

The TWRS EIS satisfies the DOE commitment made in the Hanford Defense Waste EIS Record of Decision to prepare a supplemental NEPA analysis. The TWRS EIS also is being prepared in response to several important changes since the 1988 Hanford Defense Waste Record of Decision requiring DOE to prepare the TWRS EIS. The following changes affected the planned approach for managing the disposal of Hanford Site tank waste.

- B Plant, which was selected in the Hanford Defense Waste Record of Decision as the facility for pretreatment processes to comply with current environmental and safety requirements, was found not to be viable or cost-effective.
- The Tri-Party Agreement was signed by DOE, Ecology, and EPA in 1989, establishing an approach for achieving environmental compliance at the Hanford Site, including specific milestones for the retrieval, treatment, and disposal of tank waste.
- Safety issues were identified for about 50 DSTs and SSTs, which became classified as Watchlist tanks in response to the 1990 enactment of Public Law 101-510.
- The planned grout project was terminated, and a vitrified waste form was adopted as the proposed approach as a result of stakeholders' concerns with the long-term adequacy of near-surface disposal of grouted LAW in vaults.
- The construction of the Hanford Waste Vitrification Plant was delayed because of insufficient capacity to vitrify the HLW fraction of all DST and SST waste in the planned time frame.
- The planning basis for retrieval of the waste from underground storage tanks was changed to include the SSTs and treating the retrieved SST waste in combination with DST waste.

These changes resulted in an extensive reevaluation of the waste treatment and disposal plan that culminated in adopting a revised strategy to manage and dispose of tank waste and encapsulated cesium and strontium. The reevaluation of the waste treatment and disposal plan began following a December 1991 decision by the Secretary of Energy to reconsider the entire tank safety and treatment and disposal program and to accelerate the retrieval and disposal of SST waste (DOE 1995i) (Figure 1.1.2).

In March 1993, DOE submitted proposed changes to the Tri-Party Agreement to Ecology and EPA to reflect the new technical strategy. DOE, Ecology, and EPA agreed to negotiate changes to the agreement. As part of the reevaluation process and the renegotiation of the Tri-Party Agreement, DOE involved the public by conducting a series of 10 public meetings and forming the Tank Waste Task Force to receive stakeholder input on the revised technical strategy (HTWTF 1993) . In September 1993, formal negotiations ended, and the negotiated changes underwent a public comment period from October through December 1993. The changes to the Tri-Party Agreement were incorporated into an amended agreement signed by DOE, Ecology, and EPA in January 1994.

The agencies negotiated changes to the Tri-Party Agreement in 1996 . The proposed changes underwent a 45-day public comment period that ended on February 15, 1996 and were approved in July 1996 . Major changes to the tank waste system program contained in the amendment reflect the incorporation of DOE's proposed privatization (contracting with private companies) using one of two approaches.

The primary approach would involve two or more facilities that would be designed, owned, built, and operated by private contractors. The alternative approach, which would be implemented only if the primary approach was abandoned, would provide a fall back technical and regulatory approach to privatization. Under the primary approach, all LAW would be processed by 2024, which is 4 years earlier than under the alternative approach or the current Tri-Party Agreement schedule. The proposed changes also would result in the LAW pretreatment milestones being included with milestones for LAW vitrification. Under the alternative approach, DOE and Ecology have agreed to milestones that serve as a fall back technical and regulatory approach for privatization.

Figure 1.1.2 Hanford Site Tank Waste Remediation Timeline

The revised technical strategy embodied in the Tri-Party Agreement addressed the need to manage and dispose of tank waste because the waste has an unacceptable potential to release radioactive and hazardous waste to the environment and thereby poses risk to human health and the environment. The risk posed by tank waste includes urgent tank safety issues and long-term risk. Urgent tank safety issues include flammable gas generation, potential uncontrolled reaction of ferrocyanide-containing waste, potential uncontrolled reaction of organic-containing waste, high heat, tank vapor, and the potential for nuclear criticality. DOE is implementing corrective actions or mitigation measures to resolve urgent tank safety issues. As part of the technical strategy to address tank farm safety issues, DOE proposed implementing tank farm improvements to address near-term safety issues that required resolution before the completion of the TWRS EIS. These improvements included constructing new storage tanks (DSTs), a replacement cross-site transfer system between the 200 East Area and the 200 West Area, and associated tank waste retrieval systems.

In January 1994, the interim action Safe Interim Storage of Hanford Tank Waste EIS was initiated by DOE and Ecology to analyze the potential environmental impacts associated with the proposed interim actions and their reasonable alternatives (DOE 1995i). The Safe Interim Storage EIS dealt with only urgent tank waste safety concerns that require action before implementing decisions based on the TWRS EIS. The Final Safe Interim Storage of Hanford Tank Waste EIS was issued in October 1995, and a Record of Decision was issued in November 1995 (60 FR 61687).

In the Safe Interim Storage EIS and the Record of Decision, DOE and Ecology decided that existing mitigation measures and tank farm waste inventory management strategies had diminished the risk associated with Watchlist tanks. Therefore, DOE decided not to construct additional DSTs to store waste retrieved from Watchlist tanks. In the Record of Decision, DOE also stated that safe interim storage of tank waste required constructing a replacement cross-site transfer system between the 200 West Area and the 200 East Area. The transfer system will permit DOE to continue to stabilize SST waste in the 200 West Area. The waste transfer system also will provide operational flexibility should one or more tanks in the 200 West Area require retrieval before implementing the management and disposal decisions based on the TWRS EIS.

1.2 DEVELOPMENT OF EIS ALTERNATIVES

In this EIS, DOE and Ecology examine a range of reasonable alternative approaches, including no action, for implementing the technical strategy for retrieving, pretreating, and immobilizing tank waste. These approaches include either full implementation by DOE or phased implementation. The phased approach to implementing the TWRS technical strategy would have, as a first phase, constructing and operating demonstration-scale tank waste pretreatment and immobilization facilities at the Hanford Site. Following completion of the demonstration phase, a second phase would be implemented. The second phase would consist of full-scale waste separations and immobilization.

Managing and disposing of the tank waste and the encapsulated cesium and strontium involves a number of components including waste retrieval, pretreatment, immobilization, storage, and disposal. Numerous technologies are available to accomplish each component. For analysis in the EIS, DOE and Ecology developed alternatives that cover the full range of reasonable alternatives and reflect the results of the public scoping process for this EIS. Representative alternatives that incorporate the range of cost, human and ecological health risk, and technologies have been developed for analysis in the EIS. To provide a meaningful comparison of the alternative, a representative tank farm closure scenario was assumed for all tank waste alternatives. However, closure is beyond the scope of this EIS, and the EIS does not provide sufficient analysis to support a closure decision.

The first step in developing the alternatives for analysis in the EIS was to identify the available components and associated technologies. The candidate technologies then were screened to identify technologies that would be incorporated into the representative alternatives analyzed in the EIS. The screening process resulted in three groups of alternatives: 1) representative alternatives analyzed in the EIS (Section 3.0 and Volume Two, Appendix B); 2) technologies that, though not directly included in the representative alternatives, are considered in the EIS and are therefore available for potential implementation by decision makers (Volume Two, Appendix B); and 3) alternatives that were considered but excluded from analysis and therefore would not be available for selection by the decision makers (Volume Two, Appendix C).This process resulted in the development of 10 tank waste alternatives and four cesium and strontium capsule alternatives.

1.3 DOE AND ECOLOGY PREFERRED ALTERNATIVE

DOE and Ecology have identified the Phased Implementation alternative as the preferred alternative for managing and disposing of tank waste. The Phased Implementation alternative analyzed in the EIS is based on the integrated technical strategy for tank waste outlined in the Tri-Party Agreement. The DOE and Ecology preferred alternative for managing and disposing of encapsulated cesium and strontium is the No Action alternative.

1.4 CONTENTS OF THE EIS

A separate summary provides an overview of the EIS. Volume One includes the text of the EIS and is organized into eight sections, including this introduction. The sections in Volume One are described as follows.

1.0 Introduction

This section provides background on the development of the TWRS EIS, the content of the EIS, and information to help the reader understand technical information and data presented in the EIS.

2.0 Purpose and Need for Action

The need for agency action is described in this section. The environmental conditions and the legal and regulatory requirements that the proposed action and alternatives address are summarized in this section.

3.0 Description and Comparison of Alternatives

This section explains the approach used for developing the alternatives and describes each of the alternatives in detail. Each alternative then is summarized, and the major features of the alternatives are compared. Other technologies available for inclusion in the alternatives are identified. Alternatives considered but dismissed from further analysis are identified, and the decisions to dismiss these alternatives are explained.

4.0 Affected Environment

This section describes the current environment (e.g., land, water, air, wildlife, and socioeconomics) that potentially would be affected by the proposed TWRS action and the alternatives addressed in the EIS. The description of the affected environment provides the basis for 1) analyzing the impacts of the proposed action and the alternatives; and 2) making comparisons among the potential impacts of the alternatives (Section 5.0).

5.0 Environmental Consequences

This section describes the potential environmental impacts of each alternative. The impacts analysis is presented in terms of the specific components of the natural and human environment (e.g., air, water, wildlife, and socioeconomics). For each component of the environment, the potential positive and negative impacts of each alternative are presented to provide a basis for comparing the environmental consequences of the proposed action and

alternatives.

Methods to mitigate adverse impacts are described in this section. The section also summarizes: 1) cumulative impacts of TWRS activities plus the impacts of other Federal and non-Federal activities; 2) short-term impacts and long-term environmental productivity and irretrievable resource commitments; and 3) potential conflicts among land-use plans of various agencies. Identified are energy and natural resource consumption and conservation and pollution prevention measures related to each alternative. Also identified are any adverse impacts and disproportionate impacts on minority communities and low-income communities.

6.0 Statutory and Regulatory Requirements

This section describes Federal and Washington State statutes, regulations, and policies applicable to each alternative and the ability of each alternative to meet these requirements.

7.0 Scoping, Public Participation, and Consultations

This section describes how the scope of the TWRS EIS was established and the public participation processes through the public comment period of the Draft EIS. A summary of interagency and intergovernmental consultations also is provided.

8.0 List of Preparers

The agencies responsible for preparing the EIS are identified, and the names and roles of the individuals primarily responsible for preparing the EIS are listed.

Volumes Two through Six consist of appendices to the EIS. The 12 appendices provide detailed technical materials and data to support the analyses summarized in the text of the EIS. Figure 1.4.1 illustrates the relationship between the major volumes and sections of the EIS.

1.5 READERS GUIDE AND HELPFUL INFORMATION

The following information is provided to help the reader understand the technical data and format of this EIS. Definitions of technical terms can be found in the Glossary at the end of this volume. Listings of acronyms, and abbreviations, radionuclides, and chemical compounds can be found following the Table of Contents.

Reference Citations

Throughout the text of this document, in-text reference citations are presented where information from the referenced document was used. These in-text reference citations are contained within parentheses and provide a brief identification of the referenced document. This brief identification corresponds to the complete reference citation located on the reference list at the end of Volume One and following each appendix in Volumes Two to Five. An example of an in-text reference citation is (DOE 1995b), which corresponds to the complete reference citation provided at the end of the volume or appendix. On the reference list, DOE 1995b is listed in the following manner.

DOE 1995b. Implementation Plan for the Tank Waste Remediation System Environmental Impact Statement. DOE/RL-94-88. U.S. Department of Energy and Washington State Department of Ecology. Richland, Washington. December 1995.

Figure 1.4.1 Relationship of the Contents of the TWRS EIS

Rounding

Throughout the text of this document, numbers were rounded to two significant figures (e.g., 212 would be rounded to 210 and 0.126 would be rounded to 0.13). In many cases, rounding is done to reflect the degree of uncertainty inherent in the analysis or to simplify the relative differences among alternatives. In certain cases, numbers were not rounded to two significant digits to preserve the differences in impacts between alternatives.

Scientific Notation

Scientific notation is used in this document to express very large or very small numbers. For example, the number one million could be written in scientific notation as 1.0E+06 or in traditional form as 1,000,000. Translating from scientific notation to the traditional number requires moving the decimal point either right or left from the number being multiplied by 10 to some power depending on the sign of the power (negative power move left or positive power move right).

Chemical Elements and Radioactive Isotopes

Many chemical elements and radioactive isotopes are referenced in this document. Examples of the chemical elements are cesium-137, strontium-90, plutonium-239, and uranium-235. For the most part, these elements are spelled out; however, these elements may be presented in tables and figures in this format: Cs-137 or cesium-137, Sr-90 or strontium-90. The most common chemical elements and radioactive isotopes used in this EIS are listed following the Table of Contents.

Units of Measure

The primary units of measure used in this EIS are metric. However, the approximate equivalent in the U.S. Customary System of units is shown in parentheses directly following the use of a metric unit. For example, a distance presented as 10 meters (m) is followed by 33 feet [ft]. This example would be presented in the text of the document as follows: 10 m (33 ft).

Radioactivity Units

Radioactivity is presented in radioactivity units. The curie (Ci) is the basic unit used to describe an amount of radioactivity. Concentrations of radioactivity generally are expressed in terms of curies or fractions of curies per unit mass, volume, and area. One curie is equivalent to 37 billion disintegrations per second, and is the quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second. Disintegrations generally produce emissions of alpha or beta particles, gamma radiation, or combinations of these. An explanation of radiation is contained in Section 4.11.

Radiation Dose Units

The amount of energy deposited by radiation in a living organism is the radiation dose. For humans, the radiation dose usually is reported as effective dose equivalent, expressed in terms of rem. For example, the average dose rate from natural sources (cosmic radiation, natural radioactivity in the earth, and other natural sources) is approximately 0.3 rem/year. This document reports radiation dose in millirems (mrem). One millirem is equal to one-thousandth of a rem. Therefore, 0.3 rem per year could be restated as 300 mrem/year or 3.0E-01 rem/year.

2.0 PURPOSE AND NEED FOR ACTION

The U.S. Department of Energy (DOE), in cooperation with the Washington State Department of Ecology (Ecology), must make decisions on how to manage and dispose of Hanford Site tank waste and encapsulated cesium and strontium to reduce existing and potential future risk to the public, Site workers, and the environment. The waste, which is classified as radioactive high-level and low-activity, hazardous, and mixed waste (radioactive and hazardous waste), is stored in 177 underground storage tanks and approximately 60 other smaller active and inactive miscellaneous underground storage tanks in the tank farm system. DOE also must manage and dispose of waste that may be added to the tanks from current and planned cleanup operations at the Hanford Site. DOE also must address the management and disposal of the approximately 1,930 cesium and strontium capsules, which are either stored in the Waste Encapsulation and Storage Facility in water basins at the Hanford Site or are being returned to the Hanford Site.

The Hanford Site defense activities created a wide variety of waste. Because the tank waste and associated inactive miscellaneous underground storage tank waste contain by-products of reactor fuel processing, they are classified by the Nuclear Regulatory Commission as high-level radioactive waste (10 Code of Federal Regulations [CFR] Part 60). The high-level waste presently stored in 28 double-shell tanks (DSTs), 149 single-shell tanks (SSTs), and approximately 60 miscellaneous underground storage tanks came from a variety of operations and includes a variety of waste types. This waste has been processed and transferred between tanks, which has caused the chemical and physical characteristics of the waste to vary greatly among and within individual tanks. In addition, the tank waste contains chemicals or characteristics classified as hazardous waste under the Resource Conservation and Recovery Act regulations (40 CFR Parts 260 to 268 and 270 to 272) and as dangerous waste under the Washington Administrative Code (WAC) Dangerous Waste Regulations (WAC 173-303). Planned future waste to be stored in the tanks includes radioactive high-level and low-activity, hazardous, and mixed waste that will be transferred to the DSTs during deactivation and cleanout of Hanford Site facilities.

In April 1988, the Hanford Defense Waste Record of Decision was published in the Federal Register (53 FR 12449). In this Record of Decision, DOE decided to proceed with preparing DST waste for final disposal and develop additional information before making a final decision on disposal of SST waste. However, several important changes have occurred since the 1988 Hanford Defense Waste Record of Decision. Because of these changes, DOE and Ecology must examine alternative ways to manage and dispose of tank waste and encapsulated cesium and strontium. The changes include the following:

- Upgrading B Plant, which the Hanford Defense Waste Record of Decision proposed as the facility for pretreatment processes to comply with current environmental and safety requirements, was found not to be viable or cost-effective; consequently, B Plant was eliminated from consideration as a waste pretreatment facility.
- Signing the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) by DOE, Ecology, and EPA in 1989, which established an agreed-upon approach for achieving environmental compliance at the Hanford Site, and included specific milestones for the retrieval, treatment, and disposal of tank waste.
- Identifying tank safety issues for about 50 DSTs and SSTs, which became classified as Watchlist tanks in response to the 1990 enactment of Public Law 101-510.

- Terminating the planned grout project and adopting a vitrified waste form as the proposed approach as a result of stakeholders' concerns with the long-term adequacy of near-surface disposal of grouted low-activity waste in vaults.
- Delaying the construction of the Hanford Waste Vitrification Plant because of insufficient capacity to vitrify the high-level waste fraction of all DST and SST waste in the planned time frame.
- Changing the planning basis for addressing retrieval of the waste from underground storage tanks by DOE to include the SSTs and treating the retrieved SST waste in combination with DST waste.

DOE is addressing the immediate and near-term safety and environmental issues posed by this waste to minimize short-term potential risks to human health and the environment through ongoing safety programs. DOE also must implement long-term actions to safely manage and dispose of the tank waste, associated inactive miscellaneous underground storage tanks, and the cesium and strontium capsules to permanently reduce potential risk to human health and the environment. These long-term actions also are needed to ensure compliance with Federal and Washington State laws regulating the management and disposal of radioactive, hazardous, and mixed waste. Federal and State laws and regulations require DOE to safely manage the tank waste and encapsulated cesium and strontium and to dispose of high-level and low-activity waste.

3.0 DESCRIPTION AND COMPARISON OF ALTERNATIVES

3.1 INTRODUCTION

This section provides background information on the Tank Waste Remediation System (TWRS) and describes each of the alternatives addressed in this Environmental Impact Statement (EIS). This section summarizes the waste to be remediated and the remediation alternatives. Estimates of cost, schedules, and the technical feasibility of each alternative are also discussed. Additional information concerning the waste inventory, alternatives addressed, and alternatives considered but rejected from detailed evaluation is provided in Volume Two, Appendices A, B, and C, respectively.

The TWRS program involves a wide variety of both ongoing and planned activities that may extend over the next several decades. Some of these activities are interrelated with, but not directly a part of, the remediation of the tank waste or cesium and strontium capsules. The activities analyzed in the TWRS EIS and their relationship with other TWRS program activities are addressed in the following sections.

3.2 SITE AND WASTE DESCRIPTION

3.2.1 Tank Waste

3.2.1.1 History

Tank waste is the by-product of producing plutonium and other defense-related materials. From 1944 through 1990, chemical processing facilities at the Hanford Site processed irradiated or spent nuclear fuel from defense reactors to separate and recover plutonium for weapons production. As new, improved processing operations have been developed over the last 50 years, processing efficiency has improved and the waste compositions sent to the tanks for storage have changed both chemically and radiologically. T and B Plants were the first separations facilities built at the Site. The separations processes carried out at these plants recovered only plutonium; consequently, all remaining components of the dissolved fuel elements, including uranium, were sent to the waste tanks.

Later, processes were developed to recover uranium, which was recycled back into the reactor fuel cycle. Many of the chemical processes associated with plutonium recovery from spent nuclear fuel involved dissolving the material in nitric acid. The resulting acidic waste streams were made alkaline by adding sodium hydroxide or calcium carbonate before being transferred to the tanks. These processing steps produced large volumes of sodium nitrate salts in the tanks. Table 3.2.1 shows the major processing facilities that served as sources of tank waste (see Figure 3.2.3 for location s).

Table 3.2.1 Waste Generating Facilities

Chemical processing generated approximately 1.5E+09 liters (L) (4.0E+08 gallons [gal]) of waste. More than 1.1E+09 L (3.0E+08 gal) of waste was sent to underground storage tanks throughout the production period. Volume reduction practices were followed to maintain waste volumes within available tank space. The tanks were single-shell tanks (SSTs) or double-shell tanks (DSTs).

Through evaporation, concentration, and the past practice of discharging dilute waste to the ground, the waste volume has been reduced to approximately 2.1E+08 L (5.6E+07 gal) (Hanlon 199 6). Discharging SST liquid to the ground was stopped in 1966, and since then, no waste from SSTs or DSTs has been discharged to the ground intentionally.

3.2.1.2 Tank Farm Description

The first 149 waste storage tanks constructed were SSTs. An SST is an underground storage tank with carbon-steel sides and bottom surrounded by a reinforced concrete shell (Figure 3.2.1). The tops of the tanks are buried approximately 2.5 meters (m) (8 feet [ft]) belowground for radiation shielding. The larger tanks have multiple risers (shielded openings) that provide tank access from the surface. These risers provide access points for monitoring instrumentation, camera observation, tank ventilation systems, and sampling. Sixty-seven of the SSTs are known or assumed to have leaked 2.3 million to 3.4 million liters (600,000 to 900,000 gallons) of liquids (Hanlon 1996).

An ongoing vadose zone characterization program that was initiated in April 1995 (DOE 1995t) is providing new baseline characterization data on the potential contaminant distribution in the vadose zone beneath and in the vicinity of the SSTs. This has resulted in additional information for the SX Tank Farm. The characterization effort relies on geophysical logging of existing drywells using a spectral gamma logging system with a high-purity intrinsic germanium detection device to provide assays of gamma-emitting radionuclides near the drywells (Brodeur 1996).

Figure 3.2.1 Single-Shell Tank Configuration

Ten of the 15 tanks in the SX Tank Farm are assumed or verified as leaking, as discussed in Volume Five, Appendix K. Ninety-five drywells ranging in depth from 23 m (75 ft) to 38 m (125 ft) from ground surface were logged with the

Spectral gama logging system in the SX Tank Farm. The most abundant and highest concentration radionuclide detected was cesium-137, which was detected in virtually every borehole (Brodeur 1996). Cesium-137 was detected at the following depths in several drywells: 23 m (75 ft) in drywells 41-09-03 and 41-08-07, 32 m (105 ft) in 41-09-04, 27 m (90 ft) in 41-11-10, and 38 m (125 ft) in 41-12-02.

Other gamma-emitting radionuclides detected include cobalt-60, europium-152, and europium-154, which were generally found near the surface and are believed to be the result of spills (Brodeur 1996). Cobalt-60 was found in drywell 41-14-06 only and was detected at a depth of 17 to 23 m (55 to 76 ft) below ground surface. The data are unclear as to whether relatively immobile contaminants such as cesium-137 would be found dispersed laterally within the vadose zone (i.e., at observed concentrations laterally several meters from the drywells) at the depths of over 30 m (100 ft) based on ambient conditions and vadose zone contaminant transport via advective flow in interstitial pore spaces. There may be other transport mechanism(s) occurring. The viability of any other potential transport mechanism has not yet been demonstrated but is one of the objectives of the ongoing investigations.

The last 28 tanks constructed were DSTs, which have two carbon-steel tanks inside a reinforced concrete shell (Figure 3.2.2). This design provides improved leak detection and containment of the waste. To the present time, no leaks have been detected in the annulus, the space between the inner and outer tanks. The space between the tanks houses equipment to detect and recover waste in the event that the inner tank develops a leak. Like the SSTs, the DSTs are buried belowground and have risers for tank monitoring and access.

The tanks are arranged in groups, referred to as tank farms, with each tank farm containing 2 to 18 tanks. The SST farms typically were interconnected in a series or cascade that allowed the waste to be pumped into the first tank, overflow into the next tank, and so on throughout the cascade series. This process allowed solid particles to settle into the first few tanks of a cascade and allowed the liquid in the last tank to be discharged into a crib (subsurface drain system). The practice of discharging tank waste to cribs no longer occurs. A summary of the number and size of SSTs and DSTs and their locations is shown in Table 3.2.2 and Figure 3.2.3.

Also included in the tank farm system are approximately 40 inactive and 20 active miscellaneous underground storage tanks (MUSTs). The inactive MUSTs, which are smaller than the SSTs and DSTs, were used for settling solids out of liquid waste before decanting the liquid to cribs, reducing the acidity of process waste, uranium recovery operations, collecting waste transfer leakage, and waste handling and experimentation. The active MUSTs still are used as receiver tanks during waste transfer activities or as catch tanks to collect potential spills and leaks. The volume of waste in all the MUSTs combined is less than one-half of 1 percent of the total tank inventory (WHC 1995n).

Figure 3.2.2 Double-Shell General Configuration

Figure 3.2.3 Tank Farm Locations in 200 East and 200 West Areas

Table 3.2.2 Size and Number of Tanks by Type

3.2.1.3 Waste Characterization

Tank waste characterization is the process of determining the physical, radiological, and chemical properties of the waste. Considerable historical data are available and have been used to estimate the contents of the storage tanks. Historical data provide a basis for an overall tank waste inventory and are compiled from invoices of chemical purchases and records of waste transfers and processing.

Historical-based data for SSTs and laboratory data and characterization reports for DSTs provide the basis for radioactive and mixed waste inventory estimates used in this EIS. These inventory estimates, as provided in Volume Two, Appendix A, are adequate for a detailed evaluation of impacts (WHC 1995d).

A considerable amount of inventory information is available from process records and past sampling activities. However, this information is not considered adequate to characterize the waste in individual tanks in support of safety issues and final design activities for remediation. There is an ongoing waste characterization program to better determine the contents of each tank through analyzing samples to help resolve safety issues and support design decisions for implementing the remediation alternative.

The tank waste is categorized as liquid, sludge, or saltcake. Liquid is made up of water and organic compounds that contain dissolved salts. The organics in liquid form, depending on the type, either are dissolved in the water or exist in separate phases. Liquid is present in the tanks as either free standing, where the liquid volume is relatively free of solid particles, or as interstitial liquid, where the liquid volume is contained within the void spaces surrounding the sludge and saltcake particles. Sludge is a mixture of insoluble (i.e., will not dissolve in tank liquid) metal salt compounds that have precipitated and settled out of solution after the waste was made alkaline. Saltcake is primarily sodium and aluminum salt that crystallizes out of solution following evaporation.

These three types of waste exist in the tanks in numerous combinations and proportions, which results in complex combinations of waste with varied physical and chemical properties. Sludge has been found with consistencies from mud to hardened clay. Layers of organic compounds have been found in some tanks floating on top of solid waste. Crusts have formed in some tanks where a layer of solid has formed on top of the liquid. Table 3.2.3 is a summary of the waste forms in both the SSTs and DSTs (Hanlon 1995). The percentages shown may change as additional data become available.

Table 3.2.3 Waste Form Summary

3.2.1.4 Ongoing Activities

All U.S. Department of Energy (DOE) facilities that store hazardous or radioactive materials require documented authorization bases that establish a range of operating parameters (e.g., temperature, pressure, concentration) within which routine operations are conducted. These authorization bases also evaluate the effects of potential accidents, abnormal events, and natural disasters.

Watchlist Tanks

The identification of tank safety issues and the concern for the potential of an uncontrolled release of high-level radioactive waste to the environment resulted in the passing of Public Law 101-510, Section 313, Safety Measures for Waste Tanks at the Hanford Nuclear Reservation (also known as the Wyden Amendment) in 1990. In response to this law, a program was created to identify tanks with potential safety problems. Many of the tank safety issues that became Watchlist tank categories were already known to DOE, and the maintenance and operations for these tanks were being reviewed and managed. The enactment of the public law and the establishment of the Watchlist provided a more formalized and rigorous basis for addressing specific tank safety issues. Safety issues associated with the tanks were grouped into four categories: flammable gas, ferrocyanide, high organic content, and high heat generation. Tanks having any of these characteristics, referred to as Watchlist tanks, are categorized as shown in Table 3.2.4 (Hanlon 1996 , Cowan 1996). There currently are 50 Watchlist tanks with several tanks listed in more than one category.

Table 3.2.4 Watchlist Tanks

Unreviewed Safety Questions

DOE has a formal administrative program to identify, communicate, and establish corrective actions for known or suspected operating conditions that have not been analyzed or that fall outside of the established authorization bases as an Unreviewed Safety Question. Following the identification of an Unreviewed Safety Question, a review is conducted, and corrective action is taken if applicable. Following the review process, the Unreviewed Safety Questions may be closed from an administrative standpoint, which means that conditions surrounding the safety issue have been analyzed. However, the conditions on which the safety issue is based still may exist and may require mitigation, controls, or corrective action. In this way, safety issues and Unreviewed Safety Questions are related. The safety issues that were identified under the Watchlist program also were analyzed as Unreviewed Safety Questions. Those issues that had not been addressed in the documented authorization bases were established as Unreviewed Safety Questions. Following the review processes, the Unreviewed Safety Question can be closed while the tank remains on the

Watchlist. The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) requires the resolution of all existing Unreviewed Safety Questions by September 1998 (Ecology et al. 1994).

Technical evaluation has resulted in closing the following Unreviewed Safety Questions identified for the tanks: ferrocyanide (closed in March 1994); floating organic layer in tank 241-C-103 (closed in May 1994); and criticality (closed in March 1994). Criticality was addressed on a tank farm basis and did not result in identifying any individual tanks to be added as Watchlist tanks. Criticality, which would be an issue during tank waste retrieval and transfer, would be evaluated on a tank-by-tank basis during final design. Closure of the Unreviewed Safety Questions was accomplished by defining the parameters (e.g., concentrations and temperature) of potential reactions that could lead to an uncontrolled release, collecting physical and chemical data on the waste, and establishing safe operating specifications.

The remaining Unreviewed Safety Questions are undergoing resolution. Mitigative action has been implemented for tank 241-SY-101 (commonly known as 101-SY), the most widely known flammable-gas-generating tank. This mitigative action involved installing a mixer pump to control the periodic release of flammable hydrogen gas and provide a more frequent and gradual release of hydrogen. This mitigative action reduced the maximum concentration of flammable gas that can exist in the tank and greatly reduced the potential for an uncontrolled gas burn.

There is a safety screening and characterization program ongoing to determine if any additional tanks should be placed under special controls. Recently, all 177 tanks (Watchlist and non-Watchlist) were placed under flammable gas controls, which means that flammable gas may exist in all 177 tanks and special safety measures will be taken during maintenance, monitoring, and waste transfer activities. Until the necessary characterization data are obtained, the tank farm system will continue to operate under these special waste management requirements to maintain a safe operating envelope. Additional data may allow for relaxed operating procedures, where appropriate. Volume Four, Appendix E contains a more detailed description of the tank safety issues.

Continued Operations of Tank Farm System

Numerous tank waste activities are ongoing to provide continued safe storage of the tank waste until remediation measures are implemented. These activities consist of a number of routine activities as well as a number of additional activities required for safe storage.

Routine operations include management oversight, regulatory compliance and reporting activities, and operations and maintenance of facilities and equipment. Tank monitoring activities support waste management by gathering information on waste temperature, liquid levels, solid levels, and tank status. Leak detection activities involve in-tank liquid level monitoring, leak detection monitoring of the annulus for the DSTs, drywell monitoring around tanks for increases in radioactivity levels, and groundwater monitoring. Other routine operations include:

- Calculating operational waste volume projections by comparing projected waste volumes against tank capacity. The projections also provide for identification and management of risk that could negatively impact available tank storage space;
- Combining compatible waste types. Transferring tank waste between tanks and tank farms through the existing cross-site transfer system to provide the required tank space and to address safety issues;
- Implementing a waste minimization program to reduce the generation of new waste requiring storage in the tanks. This program includes job preplanning and identification of new technologies such as low-volume hazardous waste decontamination practices to limit the generation of new waste. The waste minimization program also includes a support program for other onsite organizations (non-TWRS) that generate waste to encourage waste minimization practices;
- Screening and characterizing the waste on a tank-by-tank basis to gather data in support of safety and remedial action design activities;
- Isolating and removing pumpable liquid from SSTs to reduce the potential for future leakage (interim stabilization by saltwell pumping);
- Operating the 242-A Evaporator to concentrate waste; and
- Treat ing the evaporator effluents at the Effluent Treatment Facility to remove the contaminants prior to

discharge.

These activities are not within the scope of this EIS because they were addressed in previous National Environmental Policy Act (NEPA) documents: the Safe Interim Storage of Hanford Tank Waste EIS (Safe Interim Storage EIS) (DOE 1995i), the Waste Tank Safety Program Environmental Assessment (DOE 1993h), and the Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes at the Hanford Site (DOE 1987).

3.2.1.5 Planned Activities

Several tank waste activities are planned for implementation in the near future. These activities would address urgent safety or regulatory compliance issues.

Safe Interim Storage

One issue that requires action is the safe storage of tank waste in the interim period before implementing actions for the permanent remediation of tank waste. To address this issue, the Safe Interim Storage EIS was prepared to consider alternatives for maintaining safe storage of Hanford Site tank waste (DOE 1995i). The actions considered in the Safe Interim Storage EIS include interim actions to 1) mitigate the generation of high concentrations of flammable gases in tank 241-SY-101 ; and 2) contribute to the interim stabilization of older SSTs, many of which have leaked.

The most pressing interim need identified by DOE and the Washington State Department of Ecology (Ecology) was for a safe, reliable, and regulatorily compliant replacement cross-site transfer capability to move waste between the 200 West and 200 East Area tank farms. This transfer capability is needed because the 200 West Area has far less useable DST capacity than there is waste in SSTs. The replacement waste transfer capability would provide a safe, reliable, and regulatory compliant means to move waste from the 200 West Area to the available DST capacity located in the 200 East Area.

Based on tank waste management and operation activities when the Safe Interim Storage EIS was prepared, the following needs were addressed:

- Removing saltwell liquid from older SSTs to reduce the likelihood of liquid waste escaping from corroded tanks into the environment. Many of these tanks have leaked, and historically, new leaks, either known or assumed, have developed at a rate of more than one per year;
- Providing the ability to transfer the tank waste via a regulatorily compliant system to mitigate any future safety concerns and use current or future tank space allocations;
- Providing adequate tank waste storage capacity for future waste volumes associated with tank farm operations and other Hanford Site facility operations; and
- Mitigating the flammable gas safety issue in tank 241-SY-101.
- The alternatives evaluated in the Safe Interim Storage EIS provided DOE with the ability to continue safe storage of high-level tank waste and upgrade the regulatory compliance status with regard to the Resource Conservation and Recovery Act (RCRA) (40 Code of Federal Regulations [CFR] 260) and the Washington Administrative Code (WAC) Dangerous Waste Regulations (WAC 173-303).
- On December 1, 1995, DOE published the Record of Decision in the Federal Register (FR) (60 FR 61687). The decision was to implement most of the actions of the preferred alternative, including the following.
- Construct and operate a replacement cross-site transfer pipeline system.
- Continue operating the existing cross-site transfer pipeline system until the replacement system is operational.
- Continue operating the mixer pump in tank 241-SY-101 to mitigate the unacceptable accumulation of hydrogen and other flammable gases.
- Perform activities to mitigate the loss of shrub-steppe habitat.

The existing cross-site transfer system has been used to transfer waste from the 200 West Area to the 200 East Area for 40 years. This underground pipeline system is at the end of its original design life. Currently, four of six lines are out of service and unavailable to perform transfers because of plugging. The two useable lines do not meet current engineering standards such as double containment and leak detection, which are required for waste management facilities. The design and operation of the replacement cross-site transfer system will meet the requirements of RCRA and WAC for secondary containment and Tri-Party Agreement Milestone M-43-07, which required construction of the replacement cross-site transfer system to commence by November 1995. Construction of the replacement cross-site transfer system has begun and the system is scheduled to be operational in 1998.

DOE will continue to use the existing cross-site transfer system until the replacement cross-site transfer system is operational to provide access to 200 East Area DSTs for storage of 200 West Area facility waste and retrieved liquid waste from SSTs. Saltwell liquid retrieval will continue to reduce the risk to the environment from leaking SSTs. Operational procedures will ensure the integrity of the existing cross-site transfer system before any waste transfers. The current planning base estimates that the existing cross-site transfer system will operate for approximately 625 hours during 5 transfers before the replacement cross-site transfer system is operational in 1998.

The mixer pump in tank 241-SY-101 was proven to be effective in mitigating flammable gas as a safety issue in that tank during more than 1 year of operation. DOE and Ecology revised their preferred alternative between release of the Draft and Final Safe Interim Storage EIS, based on the demonstrated success of the mixer pump, and determined that the construction of new DSTs to resolve safety concerns was not necessary.

Based on new information available to DOE regarding nuclear criticality safety concerns during retrieval, transfer, and storage actions since the issuance of the Final Safe Interim Storage EIS, DOE has decided to defer a decision on the construction and operation of a retrieval system in tank 241-SY-102. Through an ongoing safety evaluation process, DOE recently revisited its operational assumptions regarding the potential for the occurrence of a nuclear criticality event during waste storage and transfers. Changes to the Tank Farm Authorization Basis for Criticality approved in September 1995 were rescinded by DOE in October 1995, pending the outcome of a criticality safety evaluation process outlined for the Defense Nuclear Facility Safety Board on November 8, 1995. Until these criticality safety evaluations are completed, the Site will operate under historic limits, which maintain reasonable assurance of subcritical conditions during tank farm storage and transfer operations.

Of the actions evaluated in the Final Safe Interim Storage EIS, only the retrieval of solids from tank 241-SY-102 was affected by the technical uncertainties regarding criticality. Based on the quantities of plutonium in tank 241-SY-102 sludge, retrieval of the solids falls within the scope of the criticality safety issues that will be evaluated over the next few months. As a result, a decision on retrieval of solids from tank 241-SY-102 was deferred in the Safe Interim Storage EIS Record of Decision (60 FR 61687). Pending the outcome of the technical initiative to resolve the tank waste criticality safety issue, waste transfers (primarily saltwell liquid) through tank 241-SY-102 will be limited to noncomplexed waste. Tank 241-SY-101 mixer pump operations, existing cross-site transfer system interim operations, replacement cross-site transfer system operations, saltwell liquid retrievals, and 200 West Area facility waste generation would occur within applicable criticality limits and be subcritical.

Privatization of Tank Farm Activities

Currently, DOE is considering contracting with private companies for waste remediation services for the tank waste. DOE is interested in encouraging industry to use innovative approaches and in using competition within the private marketplace to bring new ideas and concepts to tank waste remediation. The goal of the privatization effort is to streamline the TWRS mission, transfer a share of the responsibility, accountability, and liability for successful performance to industry, improve performance, and reduce cost without sacrificing worker and public safety or environmental protection. DOE issued a TWRS Privatization Request for Proposal in mid-February 1996 and has received two bids to treat tank waste (Briggs 1996). DOE plans to issue contracts to perform the first phase of the work in late summer 1996. As currently envisioned, DOE would select contractors to construct and operate commercial demonstration facilities for two tank waste separations and low-activity waste (LAW) immobilization facilities, one of which may include a high-level waste (HLW) vitrification facility. If these commercial demonstrations are successful, DOE may use the lessons learned from those demonstration facilities and proceed with contracting for full-scale facilities to remediate additional tank waste. The planning process for these privatization activities is not complete and is subject to the final decision concerning remediation of the tank waste, which is the subject of this EIS.

The potential environmental impacts associated with the activities included in the contracting strategy are analyzed in the EIS. The DOE plan is to require potential contractors to propose technologies that meet specified performance criteria for the waste product, as established by DOE. DOE will require potential offerers to submit environmental information and analyses reasonably available to them as a discrete part of their proposals. DOE will independently evaluate and verify the accuracy of the environmental data and analyses and, as appropriate, use the information to help ensure the consideration of environmental factors in the selection process in accordance with 10 CFR 1021.216.

DOE has received two proposals under the privatization initiative for constructing and operating demonstration-scale facilities for separating selected portions of the tanks waste into LAW and HLW fractions and immobilizing the separated waste. The two proposals would follow the same general approach described in the EIS for Phase 1 of the Phased Implementation alternative including; separating the waste into LAW and HLW streams, immobilizing the HLW by forming a borosilicate glass, and using high-temperature processes to generate immobilized LAW. Evaluation of the two proposals has shown that they would have similar overall environmental impacts and that the impacts would be less than or approximately the same as the impacts described in Phase 1 of the Phased Implementation alternative assessed in this EIS.

One proposal has the potential to substantially reduce the volume of LAW requiring disposal and would result in less disposal-related land disturbance. However, the total amount of radioactivity in the LAW would be approximately the same for both proposals, and the associated impacts on groundwater would be the same (i.e., small). This proposal also offers the potential for recycling a portion of the LAW, and some of the raw material used in LAW processing might be suitable for other beneficial uses within DOE or the nuclear industry. There is uncertainty about whether markets for these materials will be available. If such markets were not available then the potential benefits of LAW volume reduction would not occur and these materials would need to be disposed of. Differences between the proposals in environmental impacts associated with the use of resources such as fuel and from air emissions such as nitrogen oxides would be small.

DOE will also require selected offerers to submit further environmental information and analyses, and will use the additional information, as appropriate, to assist in the NEPA compliance process, including a determination under 10 CFR 1021.314 of the potential need for a supplemental EIS.

Tank Farm Upgrades

Upgrades to the tank farms are planned to improve the reliability of safety-related systems, minimize onsite health and safety hazards, upgrade the regulatory compliance status of the tank farms, and place the tank farms in a controlled, stable condition until disposal is complete. Upgrades planned include: 1) instrumentation including the automatic tank data gathering and management control system and the closed-circuit television monitoring to minimize personnel exposure; 2) tank ventilation to replace outdated ventilation systems; and 3) an electrical system to provide electrical power service with sufficient capacity and in compliance with current electrical codes. These three components of the tank farm upgrades are not addressed in the TWRS EIS but will be the subject of other analyses. Upgrades to the existing waste transfer system that would be used in conjunction with the replacement cross-site transfer system also are planned. Waste transfer system upgrades are included in the TWRS EIS and are discussed in Section 3.4.1.1.

Initial Tank Retrieval System

This project would provide systems for retrieving waste from up to 10 DSTs. Initial tank retrieval capabilities also would allow consolidation of compatible tank waste to create additional DST storage capacity and support passive mitigation such as diluting hydrogen-gas-generating Watchlist tanks, should that become necessary. Retrieval and transfer of waste from all tanks is addressed in this EIS, so the Initial Tank Retrieval System project is a subset of the actions included in this EIS and not addressed separately.

Hanford Tanks Initiative

Under this program, several waste retrieval activities discussed in the TWRS EIS would be demonstrated in support of the ex situ alternatives. This program would reduce the uncertainties associated with waste retrieval by developing and demonstrating the technologies required to meet retrieval requirements. The Hanford Tanks Initiative includes activities associated with waste retrieval and tank closure. Those activities associated with waste retrieval are covered under this EIS while activities associated with the closure would be the subject of future NEPA analysis.

This program would demonstrate equipment and systems for removal of tank residuals from tank 241-C-106 that are expected to remain following initial retrieval by sluicing. The objective would be to retrieve sufficient waste to meet waste retrieval requirements. This program also would attempt to develop technologies and criteria to retrieve waste from known or assumed leaking SSTs.

3.2.2 Cesium and Strontium Capsules

3.2.2.1 History

The cesium and strontium capsule program was initiated in the early 1970's to remove heat-generating cesium and strontium isotopes from the waste for safer storage. The waste used for this purpose either was existing waste retrieved from tanks or waste from the processing facilities enroute to the tanks. Removing cesium and strontium from the waste reduced the heat generation in the tanks and provided for safer storage of the waste remaining in the tanks.

The capsule fabrication program took place between 1974 and 1985 at the Waste Encapsulation and Storage Facility (WESF), which adjoins B Plant in the 200 East Area (Figure 3.2.4). Capsules were fabricated to hold the stabilized cesium chloride and strontium fluoride salts in an effort to provide a physical form for the cesium and strontium suitable for long-term storage.

3.2.2.2 Capsule Description

The capsules are double-walled, high-temperature metal alloy tubes that contain cesium and strontium (Figure 3.2.5). The capsules are stored in water-filled basins at WESF and are approximately 6. 7 centimeters (cm) (2.6 inches [in.]) in diameter and 51 cm (20 in.) in length. The decay reactions taking place within the capsules generate approximately 200 to 300 watts (W) of heat continuously from each capsule. Storing the capsules underwater provides radiation protection for workers as well as cooling for the capsules. Basins or pool cells are filled with water to a depth of 4 m (13 ft) and house metal storage racks to control capsule storage within the cells. WESF has a total of eight pools: five are active and used for capsule storage, one is used for temporary storage, and two are not used. The size and number of capsules are presented in Table 3.2.5. The capsules currently are classified as waste by-product, which means that they are available for productive uses if uses can be found.

Figure 3.2.4 Waste Encapsulation and Storage Facility

Figure 3.2.5 Typical Cesium and Strontium Capsule Configuration

The final classification of the cesium and the strontium would be made in correlation with the Nuclear Regulatory Commission (NRC) if and when the capsules are classified as waste.

3.2.2.3 Capsule Characterization

The chemical form of the cesium in the capsules is cesium chloride and the chemical form of the strontium in the capsules is strontium fluoride. The combined total capsule volume is approximately 2 cubic meters (m^3) (70 cubic feet [ft^3]) (WHC 1995h).

The cesium content of the capsules is primarily cesium-137, which has a half-life of 30.17 years. Cesium-137 decays to the stable isotope barium-137, either directly or through a two-step process, first into metastable barium-137m, and then to stable barium-137. Strontium capsules contain mainly strontium-90, which has a half-life of 28.6 years. Strontium-90 decays to yttrium-90 and then to the stable isotope zirconium-90. The quantities, heat loading, and radioactivity levels for the cesium and strontium capsules are presented in Table 3.2.6. Reduction in the number of curies, heat load, and concentration over time is due to radioactive decay of cesium and strontium into stable decay products.

Table 3.2.5 Cesium and Strontium Capsules

Table 3.2.6 Characteristics of Existing Capsules

3.2.2.4 Current and Planned Activities

The only ongoing and planned activities for the capsules are the continued storage of the capsules in WESF, return of the remaining cesium capsules to WESF, and attempts to find productive uses for the cesium and strontium capsules. Continued operations include monitoring capsule integrity and maintaining support facilities (ventilation, monitoring, radiation alarms, and waste handling systems).

DOE is in the early planning stages of considering whether the capsules should remain in WESF or be placed in alternative locations for storage. Among the possible alternatives are placing the capsules in the proposed Canister Storage Building originally planned to store HLW. DOE is currently upgrading WESF to operate independently of B Plant. No decisions have been made to proceed with any alternative storage options. For purposes of analyzing impacts in the TWRS EIS, it is assumed that the capsules will remain in WESF until ready for final disposition . If DOE proposes to change the method or location for the interim storage of the capsules, an appropriate NEPA review will be performed.

A cesium and strontium capsule management program will provide for management of the capsules until final disposition has been implemented.

Strontium capsules previously were used as heat sources, and the cesium capsules were used at commercial facilities for strengthening wood products, sterilizing medical products, and sterilizing saline solutions. Cesium and strontium capsules also have been used by DOE programs for research activities at Pacific Northwest National Laboratory, Sandia National Laboratory, and Oak Ridge National Laboratory. DOE has requested that all capsules be returned to the Hanford Site for storage at WESF (DOE). Some cesium capsules have not yet been returned, but plans call for all capsules to be returned to the Hanford Site by the end of 199 7. There are four strontium capsules located offsite that will not be returned to the Hanford Site.

DOE is pursuing alternative uses for the cesium and strontium capsules. If no future uses for these capsules are found, the capsules eventually would be managed and disposed of consistent with the Tri-Party Agreement (Ecology et al. 1994) and the TWRS EIS alternative selected for implementation.

3.3 DEVELOPMENT OF ALTERNATIVES

This section explains the process followed to develop and select alternatives for remediating the tank waste, alternatives for implementing the remediation of the tank waste, and remediating the cesium and strontium capsules. This section also discusses TWRS activities that are beyond the scope of this EIS.

3.3.1 Tank Waste

3.3.1.1 TWRS Elements

Final remediation of TWRS involves three distinct activities: remediation of the tank waste, disposition of the tanks and all associated equipment (a process called closure), and decontamination and decommissioning of any new facilities constructed to remediate the tank waste. These activities are described in this section.

Remediating Tank Waste

Remediating tank waste in the 177 underground tanks and approximately 60 MUSTs is the subject of this EIS and is discussed in detail in Section 3.3.1.2.

Disposition of the Tank Farms (Closure)

The final disposition of the tanks and associated equipment and the remediation of contaminated soil and groundwater associated with leaks from the tanks is a process called closure. Closure is not within the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. The amount and type of waste that ultimately remains in the tanks after remediation may also affect closure decisions. The Notice of Intent to prepare the TWRS EIS stated that: "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS to support tank closure, in the future" (59 FR 4052).

In response to emerging technical information and the need to support DOE's integrated approach to remediating the Central Plateau and the Hanford Site as a whole, DOE will prepare a future NEPA analysis to address tank farm closure and other issues associated with TWRS remediation. The analysis will address alternatives for closing the tank farms including disposition of the tanks and associated equipment, residual waste remaining after retrieval, and contaminated soils; resolution of emerging information concerning contamination of the vadose zone; and the integration of tank farm closure with the remediation of other Central Plateau areas. To support this analysis, DOE is implementing the Hanford Tanks Initiative to obtain operational experience on a number of important factors, which will provide data to support decisions on closure of the tank farms. Data that will be obtained include information on waste retrieval methods and waste volume sampling and characterization of residual waste, as discussed in Section 3.2.1.4.

Some of the decisions to be made concerning how to treat and dispose of tank waste may impact future decisions on closure, so the tank waste alternatives provide information on how tank waste remediation and closure are interrelated. Under the Tri-Party Agreement, the tanks are classified as hazardous waste management units that eventually would be closed under the State Dangerous Waste Regulations (WAC 173-303) and the requirements of the Tri-Party Agreement.

Three options exist for closure of the tanks. The first option is clean closure, which would involve the removal of all contaminants from the tanks and associated equipment, soil, and groundwater until natural background levels or health-based standards are achieved.

The second option is modified closure, which would involve a variety of closure methods but require periodic (at least once after 5 years) assessments to determine if the modified closure requirements are met. If modified closure requirements were not being met, additional remediation would be performed. Modified closure is a method specific to the Hanford Site Permit under the State Dangerous Waste Regulations (WAC 173-303).

The third option is closure as a landfill, which would involve leaving some waste in place with corrective action taken for contaminated soil and groundwater performed under post-closure requirements. This type of closure usually involves the construction of a low permeability cover over the contaminated media to reduce water infiltration and prevent inadvertent human intrusion.

Although sufficient information is not available to make final decisions on closure, some of the alternatives affect future closure decisions, so information is provided to allow the public and decision makers to understand how the alternatives would be interrelated with future closure of the tank farm system. For example, some of the alternatives addressed in the EIS involve removing most of the waste from the tanks (the ex situ alternatives) and would not substantially affect options for future closure decisions. Conversely, some of the alternatives do not involve removing the waste from the tanks (the in situ alternatives) but rather, would treat and dispose of the waste in the tanks. These alternatives include placing a low permeability cover over the tank farms to reduce water infiltration and prevent inadvertent human intrusion (e.g., Hanford Barrier). This would be considered closure as a landfill.

DOE plans to implement a program, the Hanford Tanks Initiative, to gather information and reduce uncertainties associated with tank closure. This would include developing and demonstrating systems to determine the residual waste volumes remaining in a tank following retrieval. The residual waste would be analyzed by developing systems for sampling and characterization. Site specific information on tank leaks would be obtained by developing systems to sample and characterize contamination in the soils surrounding the tanks. The information that would be gathered through the Hanford Tanks Initiative would be used to establish processes and criteria for future closure options.

Clean closure would be precluded by implementing the In Situ Fill and Cap and In Situ Vitrification alternatives because these alternatives would involve leaving most of the waste in place and placing a low permeability cover over the tank farms. This would constitute closure as a landfill. Similarly, the Ex Situ/In Situ Combination 1 and 2 alternatives would preclude clean closure of the tanks that contain waste that is not retrieved; 107 tanks for the Ex Situ/In Situ Combination 1 alternative and 152 tanks for the Ex Situ/In Situ Combination 2 alternative. The tanks that contain waste that is retrieved could be clean closed. The ex situ alternatives would not preclude clean closure.

For purposes of comparing the alternatives, a single and consistent method of closure was assumed for all of the alternatives. Closure as a landfill was chosen as the representative closure method for purposes of analysis and is included in all of the alternatives (except the No Action and Long-Term Management alternatives). This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. It is included to allow a meaningful comparison of the in situ and ex situ alternatives and to provide information to the public and the decision makers of the total cost and impacts of final restoration of the Site.

Because decisions on closure cannot be made at this time, but are interrelated with decisions to be made on remediation of the tank waste, the EIS presents an analysis of impacts with and without closure in Section 5.0. In each applicable subsection of Section 5.0, the impacts of the activities associated with remediating the waste are presented first. This is followed by the presentation of the combined impacts of remediating the tank waste and closing the tank farms by closure as a landfill. This provides the public and the decision makers with information on the impacts of the issues that are ripe for decision making (remediation of the tank waste) and information on the total project impacts (remediation and closure) as well as how they may be interrelated with the decisions on remediation of the tank waste.

Decontamination and Decommissioning

Decontamination and decommissioning of new facilities constructed to implement any of the alternatives are not evaluated in detail in this EIS because decisions on the appropriate method would not be required until the treatment and disposal of waste is complete (which is up to 30 years in the future) and because insufficient information is available presently to provide a meaningful evaluation. However, decontamination and decommissioning of these facilities is foreseeable. Therefore, the cost, personnel requirements, and volume of contaminated and noncontaminated materials resulting from decontamination and decommissioning were developed and analyzed using general practice assumptions to show how tank waste remediation and decontamination and decommissioning are interrelated. This provides an assessment of the relative environmental impacts of future decontamination and decommissioning activities so that the alternatives can be meaningfully compared. DOE will conduct an appropriate NEPA review to support future decontamination and decommissioning decisions.

3.3.1.2 Alternatives for Remediating Tank Waste

A wide range of potentially applicable technologies exists for treating tank waste. One of the challenges for DOE and Ecology is to eliminate from consideration technologies that are not viable and develop a range of reasonable alternatives for detailed analysis and presentation in the TWRS EIS. This section describes how the alternatives were developed.

There is a distinction between technologies and alternatives. Technologies are specific processes (e.g., cesium ion exchange) that relate to a component (e.g., retrieval or treatment) of an alternative. Alternatives include a set of technologies, or building blocks, that have been engineered to work together, forming complete systems for accomplishing the purpose and need for action. Alternatives are made up of a number of technologies linked together.

The first step in developing alternatives was to screen out technologies that were not viable. The full range of available technologies for each component of the proposed action was evaluated, and technologies that were not viable were eliminated from further consideration. The technologies eliminated by this screening process are described in Section 3.8 and Volume Two, Appendix C.

After rejecting technologies that were not viable, a large number of potential technologies remained for inclusion in the EIS. It would not be practicable to develop alternatives that include all of the potential combinations of technologies. In accordance with NEPA, representative alternatives were developed for detailed analysis to bound the full range of reasonable alternatives. Upper, lower, and intermediate bounding alternatives were developed in terms of cost, risk, and technologies for the two primary decisions that affect environmental impacts: the amount of waste to be retrieved from the tanks and the degree of separations of retrieved waste into HLW and LAW. The full range of applicable technologies and alternatives therefore is included in the EIS.

Because representative alternatives were developed for detailed analysis in the EIS, there are many other viable technologies for individual components of the alternatives that could not be included. These technologies are included in Volume Two, Appendix B and could be substituted for one of the technologies that is included in an alternative without a substantial change in the impacts of that alternative. An evaluation was performed for each of the technologies identified in Appendix B. Where there would be changes in impacts, the changes are discussed in Volume Two, Appendix B. The level of analysis was dependent on the magnitude of the change on impacts.

The alternatives developed for presentation in the EIS were chosen to be representative of many of the possible variations of the alternative. The design information for all alternatives is at an early planning stage, and the details of the alternative that ultimately is selected and implemented may change as the design process matures. Therefore, the alternatives are intended to represent an overall plan for remediation at a level of detail sufficient for impact analysis and alternative comparisons.

NEPA requires that an EIS includes a No Action alternative, which addresses not taking the proposed action (i.e., not initiating the project). For the TWRS project, there is a management program in place to continue the safe management of the tank waste and the capsules; therefore, the No Action alternatives addressed in this EIS (continue the current waste management program), consist of the activities currently being conducted to safely manage the waste. Further, under the No Action alternatives , no new facilities would be constructed other than those for which decisions already have been made based on other NEPA reviews (e.g., the Safe Interim Storage EIS).

Since the late 1950's, there have been numerous studies analyzing alternatives for tank waste treatment and disposal. The technologies contributing to the alternatives presented in the EIS come from different sources. The initial set of technologies used in the report was obtained by reviewing literature for processing radioactive, hazardous, and mixed waste. The literature review was supplemented by several DOE-sponsored workshops on treatment technologies for Hanford Site tank waste. Objectives and technologies were also proposed for consideration in the EIS during the public scoping process.

Four general categories of response actions have emerged through the alternative identification process. These categories are: 1) continue waste storage in the tanks; 2) waste treatment and disposal in the tanks, referred to as in situ treatment, 3) waste treatment outside of the tanks in a processing facility, referred to as ex situ treatment, and 4) a combination of in situ and ex situ treatments. In situ waste treatment would not involve removing the waste from the tanks. Ex situ treatment would require that the waste be removed from the tanks for treatment and disposal.

Continued waste storage would not result in remediation of the waste but would postpone the impacts of the uncontrolled release of the waste. In situ alternatives eliminate the need for waste retrieval and would result in leaving all of the waste onsite following treatment. Ex situ alternatives require removing waste from the tanks for treatment and provide the opportunity to separate the waste into HLW and LAW components. The purpose of separating the waste is to meet onsite disposal requirements for LAW and minimize the volume of HLW requiring offsite disposal. Combination alternatives provide the opportunity to selectively retrieve waste for ex situ treatment based on waste type to achieve acceptable post remediation risk levels.

Ex situ alternatives provide for disposal of HLW at a potential geologic repository. Solely for the purpose of analysis, the potential geologic repository at Yucca Mountain, Nevada was assumed to be the final destination because it currently is being characterized to determine its suitability as a repository. It was assumed that the potential geologic repository would be operational and accept HLW generated by the ex situ alternatives (see Section 3.7 and Volume Two, Section B.10) .

New Technical Strategy

In January 1994, DOE, Ecology, and U.S. Environmental Protection Agency (EPA) renegotiated the Tri-Party Agreement, which led to a new proposed technical strategy for remediating the tank waste. This technical strategy provides the basis for the TWRS EIS Ex Situ Intermediate Separations alternative and includes the following activities:

- Retrieve present and future waste from all DSTs and SSTs;
- Separate the waste into HLW and LAW streams to the extent required to meet onsite disposal requirements for LAW and to maintain an acceptable volume of HLW for offsite disposal;
- Vitrify the LAW and dispose of it onsite in a near-surface disposal facility in a retrievable form;
- Vitrify the HLW and store it onsite at a designated storage facility for future disposal at the potential geologic repository; and

Implementation of Alternatives

There are many technical uncertainties associated with the alternatives for remediating the tank waste. These uncertainties involve the types of waste contained in the tanks and the effectiveness of the retrieval techniques, waste separations, waste immobilization, and cost of implementing the alternatives. These uncertainties exist because some of the technologies that may be implemented are first-of-a-kind technologies, have not previously been applied to the TWRS tank waste, or have not been applied on a scale as large as would be required for the TWRS tank waste.

Because of these uncertainties, DOE considered different approaches to implementing the alternatives to reduce the financial risk involved if one or more of the technical uncertainties could not be readily resolved. DOE identified two approaches to implementing the alternatives: full-scale implementation and phased implementation. Under full implementation, DOE would design, construct, and operate full-scale facilities to remediate the tank waste. Under phased implementation, either DOE or a private contractor would design, build, and operate demonstration-scale facilities to prove that the remediation concept would function adequately before constructing and operating full-scale facilities. All calculations performed for this EIS are based on DOE implementing the alternatives through the existing Management and Operations contractor system. This phased implementation approach has the potential to prove that the technologies work before committing large capital expenditures that could not be recovered.

A phased approach could be developed for any of the alternatives, but not all phased approaches would involve changes to environmental impacts from the full-scale approach. Therefore, not all phased approaches need to be addressed in the EIS. To decide which of the full-scale alternatives would need to have an associated phased implementation alternative addressed in this EIS, the following two criteria were used.

- Would the full-scale alternative involve large front-end expenditures of funds that could be lost if an unproven technology did not function adequately?
- Would the environmental impacts of the phased implementation approach be different than those of the full-scale alternative?

If either criterion were met, a phased approach would be included in the EIS.

Applying these criteria showed that most alternatives did not warrant a separate analysis of a phased implementation approach. A phased implementation approach to the No Action and Long-Term Management alternatives would not involve changes in environmental impacts, large front-end expenditures, or unproven technologies, so no phased approach was included in the EIS for these alternatives. A phased implementation approach to the In Situ Fill and Cap alternative would involve the simple process of filling several tanks as a demonstration, and therefore would not involve different environmental impacts or large front-end expenditures of funds that could be lost, so no phased approach was included in the EIS. Similarly, a phased approach to the In Situ Vitrification alternative would involve testing the in situ vitrification process first on MUSTs, then small tanks, and then large tanks. Although this technology previously has not been performed on the tank waste, it could be tested gradually without any differences in environmental impacts or large expenditures of funds that could be lost if the process did not function adequately. Therefore, the In Situ Vitrification alternative did not warrant a separate phased implementation alternative, and no phased approach was included in the EIS.

All of the ex situ alternatives involve the application of technologies that have not been applied to the tank waste and all would involve large front-end expenditures of funds to construct large, complex separations and immobilization facilities. The phased implementation approach for these alternatives would involve constructing and operating demonstration-scale facilities before constructing the full-scale facilities, and would result in environmental impacts substantially different than the full-scale implementation alternative. Therefore, a phased implementation alternative has been included in the EIS to bound the impacts for the ex situ alternatives.

The Phased Implementation alternative consists of two phases: a proof of concept or demonstration phase (Phase 1) and a full-scale treatment phase (Phase 2). Phase 1 would include the construction and operation of one combined separations and LAW vitrification facility and one combined separations, LAW vitrification, and HLW vitrification facility. A sufficient quantity of a variety of tank waste types would be processed to demonstrate the effectiveness of the process and provide the necessary data to design a full-scale treatment facility . Phase 2 would include completing tank waste remediation by constructing and operating new full-scale separations, LAW immobilization, and HLW vitrification facilities. The degree of separations into LAW and HLW was assumed to be similar to the Ex Situ Intermediate Separations alternative, and includes additional processes to separate out the strontium, technetium, and transuranic elements from the LAW.

The tank waste alternatives addressed in this EIS include:

- No Action;

Long-Term Management;
- In Situ Fill and Cap;
- In Situ Vitrification;
- Ex Situ Intermediate Separations;
- Ex Situ No Separations;
- Ex Situ Extensive Separations;
- Ex Situ/In Situ Combination 1 ;
- Ex Situ/In Situ Combination 2 ; and
- Phased Implementation (preferred alternative).

The alternatives developed for detailed analysis cover the full range of actions as well as the No Action alternative. The tank waste alternatives range from waste containment with the Long-Term Management alternative to extensive processing (separating HLW from LAW fractions) and immobilization using new technologies with the Ex Situ Extensive Separations alternative. the relationship among the alternatives is shown in Figure 3.3.1.

Figure 3.3.1 Relationship Among TWRS EIS Alternatives

3.3.2 Cesium and Strontium Capsules

The cesium and strontium capsules currently are classified as waste by-product, and this EIS is only addressing measures to remediate the capsules when and if they are determined to have no productive uses. The development of alternatives to remediate the cesium and strontium capsules is much less technically complicated than for the tank waste.

There are two distinct activities related to remediation of the capsules: the disposition of the capsules, which is analyzed in this EIS; and decontamination and decommissioning of WESF, the current capsule storage facility. WESF is part of B Plant and would be decontaminated and decommissioned in the future with B Plant. This is not within the scope of the EIS.

3.3.2.1 Alternatives for Remediating Capsules

The alternatives for remediation of the capsules include No Action, disposal on the Hanford Site, or disposal off the Hanford Site either with or separate from the tank waste. None of these alternatives involve unproven technologies or the construction of major process facilities. The following capsule alternatives are addressed in this EIS:

- No Action (preferred alternative);
- Onsite Disposal;
- Overpack and Ship; and
- Vitrify with Tank Waste.

3.4 TANK WASTE ALTERNATIVES

This section describes the alternatives for remediating the tank waste. Additional details may be found in Volume Two, Appendix B.

3.4.1 Elements Common to Tank Waste Alternatives

3.4.1.1 Current Operations

Included in each alternative are the operations necessary to maintain the tanks and associated facilities until they are no longer required for waste management. Routine operations include the following activities:

- Managing operations;
- Operating and maintaining facilities and equipment;
- Monitoring tanks to gather information including data on waste temperatures, liquid levels, and tank status;
- Monitoring leak detection equipment, including drywells around the tanks for increases in radioactivity, groundwater monitoring, and in-tank liquid level monitoring;
- Adhering to regulatory compliance and reporting;
- Conducting security and surveillance of facilities and grounds;
- Performing interim stabilization of SSTs by saltwell pumping;
- Operating the 242-A Evaporator to concentrate waste;
- Maintaining tank safety including diluting tank waste as necessary and maintaining adequate storage capacity; and
- Characterizing MUST waste associated with TWRS.

The 242-A Evaporator is an existing facility in the 200 East Area. This facility, which recently has been upgraded, is used for routine operations and would continue to be used (until approximately 2005) for waste management under all of the tank waste alternatives.

The functions and activities for routine operations are the same for each alternative but the cost, schedule, and staffing levels vary according to the schedule for completion of waste treatment and subsequent closure of the tank farms. The impacts of these routine operations are included in the calculations of the impacts for each alternative (Section 5.0).

Included in all of the alternatives (except No Action) are upgrades to the existing waste transfer system. Waste transfer system upgrades would involve constructing buried waste transfer pipelines in the 200 East Area. These upgrades would provide for safe, reliable, and compliant waste transfer between waste-generating facilities and the tank farms. Selected valve pits and diversion boxes would be upgraded by installing liners to provide secondary containment in the event of a leak or spill. Also included are new jumper and cover installations for selected valve pits and diversion boxes. The various flow path combinations would be indicated on the new cover blocks. The replaced buried lines would be abandoned in place, whereas the replacement items such as valve and diversion box jumpers and box covers would be removed and disposed of onsite (WHC 1996c). These waste transfer system upgrades do not include the replacement cross-site transfer system.

Future additions of waste to the tank farms would occur during routine operations. Some of these waste additions would involve loading the waste as liquid or slurry into a tank truck or rail car at the generating facility, transporting to the tank farms, and unloading and transferring the waste into existing DSTs for storage. This waste could be transferred using existing rail or specialized truck (LR-56[H]) systems. Volume Two, Appendix B contains a description of the LR-56(H) truck, which was specially designed for the transport of nuclear waste. Waste will be generated and require transport to the tank farms from the following:

- 300 Area laboratory facility cleanout;

- Plutonium-Uranium Extraction (PUREX) Plant, Plutonium Finishing Plant (PFP), and B Plant cleanout;
- T Plant decontamination waste;
- Routine laboratory waste; and
- K Basins cleanout.

Some f uture waste volume projections are provided in Volume Two, Appendix A.

In December 1995, all 177 tanks (Watchlist and non-Watchlist) were placed under flammable gas controls. Until the necessary characterization data are obtained, the tank farm systems will continue to operate under a conservative management program to maintain a safe operating envelope. These controls may slightly increase the cost of performing maintenance and monitoring activities on the tanks until the issue is resolved.

3.4.1.2 Multi-Purpose Canister

For comparison, it has been assumed that each of the ex situ alternatives would use a large multi-purpose canister for interim onsite storage and transportation to the potential geologic repository. This canister is designated the Hanford Multi-Purpose Canister. The Hanford Multi-Purpose Canister would be approximately 4.6 m (15 ft) long and 1.4 m (4.5 ft) in diameter and would be used as an overpack canister to house up to four individual HLW canisters depending on canister size. The sizing of the HLW canisters and the decision to use a multi-purpose overpack canister are in the conceptual stage and have not been finalized. There may be potential economic and handling benefits to using a multi-purpose canister for the TWRS program. There may be potential additional costs associated with using Hanford Multi-Purpose Canisters if future evaluations determine that the Hanford Multi-Purpose Canisters were not acceptable for disposal or if the Hanford Multi-Purpose Canisters would require costly changes in repository design and operations. Such a multi-purpose type canister has also been proposed as a waste package for commercial spent nuclear fuel. Additional information on canister sizing is presented in Volume Two, Appendix B.

3.4.1.3 Liquid Effluent Processing

Liquid effluent processing for all of the alternatives would be provided by the secondary radioactive liquid-waste processing system. This system, which has been constructed and currently is undergoing acceptance testing, is assumed to be permitted and operational in time to support each of the alternatives. The environmental impacts of this facility were analyzed in an environmental assessment (DOE 1992a). The secondary radioactive liquid-waste processing system consists of the Liquid Effluent Retention Facility, the Effluent Treatment Facility, and the State-approved land disposal site.

To be accepted into the effluent treatment facilities, waste must meet specific waste acceptance criteria. It is assumed that the liquid effluent streams generated at the waste processing facilities identified for the various alternatives would meet the waste acceptance criteria for the Liquid Effluent Retention Facility and the Effluent Treatment Facility.

The Liquid Effluent Retention Facility provides up to 49 million L (13 million gal) of temporary storage capacity for liquid waste. This storage capacity is provided by two 25 million-L (6.5 million-gal) lined and covered basins. An additional storage basin is provided for emergency backup. Waste accumulated in the Liquid Effluent Retention Facility basins would be sent to the nearby Effluent Treatment Facility for treatment.

The Effluent Treatment Facility provides the final processing step before disposal. This facility includes a treatment system to reduce the concentrations of radioactive and hazardous waste constituents in the effluent streams to acceptable levels. The treated effluent is held in storage tanks to allow for verification before being transferred to the State-approved land disposal site for discharge.

3.4.1.4 Major Assumptions and Uncertainties

To develop engineering data required to perform impact analyses for each of the alternatives discussed in the EIS, assumptions were made regarding the technologies that have been configured to create a remediation alternative.

These assumptions were based either on the best information available, applications of a similar technology, or engineering judgement. By definition when an assumption is made, there is some level of uncertainty associated with it that can be expressed as a range for the assumed value that reasonably could be expected. This section identifies the major assumptions used for the alternatives. Additional information on assumptions is provided in Volume Two, Appendix B, Section B.8.0 and uncertainties in Volume Five, Appendix K.

In Situ Alternatives

It was assumed that there would be no leaks to the soil from the SSTs or DSTs during the administrative control period for the No Action, Long-Term Management, or In Situ Fill and Cap alternatives. This assumption is based on ongoing SST interim stabilization to remove pumpable liquids, the ability to detect and recover leaks from the space between the inner and outer liners of the DSTs, and ongoing monitoring activities within the tank farms. The SSTs and DSTs were assumed to maintain their structural integrity throughout the administrative control period under the No Action and Long-Term Management alternatives.

The In Situ Vitrification, In Situ Fill and Cap, and the in situ portion of the Ex Situ/In Situ Combination 1 and 2 alternatives were assumed to require additional characterization data to evaluate the acceptability of in place disposal and address RCRA land disposal requirement considerations. This requirement would be in addition to the current characterization requirements for the ex situ alternatives. These additional characterization efforts could involve extensive laboratory analysis of additional tank samples and may require modifications to the tanks to install additional risers for sampling access.

In Situ Vitrification

The in situ vitrification system was assumed to be capable of vitrifying each of the tanks to the required depth resulting in a consistent waste form. It was also assumed that the variation in waste composition and inventory from tank to tank would not impact the ability to produce an acceptable waste form.

In Situ Fill and Cap

The concentrated liquid waste contained in the DSTs was assumed to be acceptable for gravel filling. Under this alternative, the DST liquids would be concentrated using the 242-A Evaporator to remove as much water from the waste as possible, but the waste would still contain substantial volumes of liquid. It has been estimated that concentration by the 242-A Evaporator would reduce the current liquid volumes contained in the tanks by approximately one-third (WHC 1995f).

Ex Situ Alternatives

The major assumptions used for the ex situ alternatives are outlined in the following paragraphs and summarized in Table 3.4.1.

Table 3.4.1 Ex Situ Alternatives Major Assumptions

Retrieval Efficiency

Retrieval efficiency is the assumed percentage of the tank waste that would be retrieved. The amount and type of waste that would remain in the tanks after retrieval is uncertain. The Tri-Party Agreement (Ecology et al. 1994) set a goal for the SSTs that no more than 1 percent of the tank inventory would remain as a residual following waste retrieval activities. The engineering data for the waste retrieval and transfer function common to all ex situ alternatives was developed using 99 percent retrieval as a goal.

The residual contaminants left in the tanks either would be insoluble and hardened on the tank walls or bottom or of a size that could not be broken up or removed from the tanks. In either case, the residual would have low solubility because the retrieval technologies proposed would use substantial quantities of liquid in an attempt to dissolve or suspend the waste during retrieval. Because of the uncertainties regarding the amount and type of residual waste that would remain in the tanks, a conservative assumption was made to bound the impacts of the residual waste. For purposes of the analysis, it was assumed that 99 percent recovery would be achieved for ex situ alternatives, and the residual waste left in the tanks would contain 1 percent of all the original tank inventory, including the water-soluble contaminants. The water-soluble contaminants provide the long-term potential human health risk because they would be transported into the groundwater and then could be consumed by humans.

The assumption that 1 percent of the water-soluble waste would remain in the tanks yields an upper bound on the impacts that would occur under the ex situ alternatives. The In Situ Fill and Cap and Ex Situ/In Situ Combination 1 and 2 alternatives leave more waste in the tanks for disposal and provide an upper bound on the impacts associated with the amount and type of waste that is disposed of onsite.

Releases During Retrieval

To provide a conservative estimate of the impacts that could occur following retrieval, the analysis performed for the EIS assumed that each of the 149 SSTs would leak an average of 15,000 L (4,000 gal) to the soils surrounding the tank during retrieval operations. No leakage was assumed to occur from the DSTs during retrieval operations because DSTs have provisions for leak containment and collection. The leakage volume estimate was based on current information from the retrieval program and the assumption that the average leakage volume from an SST would be one order of magnitude lower than the maximum release volume estimated for tank 241-C-106 during sluicing operations (DOE 1995d). The leakage estimated for tank 241-C-106 was based on a series of conservative assumptions that would not be applicable for developing an average lead estimate for all SSTs. It was also assumed that the contaminant concentrations in the liquids released would be at maximum predicted concentrations; therefore, dilution of the waste during retrieval was not taken into account.

DOE is currently working with Ecology to define the operating envelope for allowable leakage during retrieval systems would include measures to detect and control leakage.

Nominal Case

A nominal case retrieval release and residual tank inventory was developed to assess the impacts that would result from nominal, as compared to bounding, assumptions for tank releases during retrieval and the residual waste left in the tanks following retrieval. Additional information on the nominal case is in Volume Two, Section B.3.

The nominal retrieval release inventory was developed by assuming that the waste would be diluted by one-third through the addition of water during waste retrieval. The nominal case retrieval release volume was assumed to be 15,000 L (4,000 gal) from each SST, and the contaminant concentrations were assumed to be two-thirds of the bounding case.

The nominal tank residual inventory was developed by modifying the bounding tank residual inventory to reduce the mobile constituents of concern based on solubility. The mobile constituents of concern were evaluated because of their contribution to post-remediation risk. The isotopes of carbon, technetium, and iodine were reduced in the nominal case tank residual inventory to 10 percent of the bounding tank residual inventory.

The nominal case for operation accidents was analyzed by using average tank inventory for the potential releases during accidents. This nominal inventory was developed by estimating the inventory of radioactive materials contained in the fuel from the single-pass reactors and N Reactor and sent to the tank farms. Reduction factors were applied to account for extracted plutonium, uranium, cesium, and strontium. This nominal radiological inventory is shown in Appendix E, Section E.1.0.

Operating Efficiency

The operating efficiency is a combination of the online efficiency and the production efficiency of the treatment facilities. The assumed operating efficiency is used in combination with the operating schedule to determine the size of the treatment facilities required to treat the waste. The 60 percent operating efficiency assumption was selected as a reasonable value for facility sizing. This value is considerably lower than operating efficiencies obtained in the commercial chemical processing industry to account for regulatory and safety requirements associated with nuclear waste processing. The operating efficiency for Phase 2 of the Phased Implementation alternative was assumed to be higher than the other alternatives to account for the phased implementation approach. Once a treatment facility is designed and constructed, the inability to achieve the assumed operating efficiency would result in a longer operating schedule.

Waste Loading

Waste loading or waste oxide loading is the percentage of waste that is in the final vitrified waste form. The waste oxide loading is controlled by the amount of glass formers that are added during the vitrification process. The higher the waste loading, the more waste contained in the vitrified glass, and the lower the overall waste volume. Conservative waste loading factors have been assumed for the ex situ alternatives. Current development work may result in the selection of higher waste loading factors. The sensitivity of the HLW and LAW volume and the engineering data to the waste loading assumptions is provided in Volume Two , Section B.8.0.

Blending Factor

Blending is the mixing of the wastes from different tanks during retrieval to obtain an average waste feed stream for treatment. Because there are 177 tanks that contain waste and the waste composition varies from tank to tank, it would be difficult to achieve a completely uniform blending of the waste during retrieval. To account for the uncertainties associated with achieving a uniformly blended waste feed stream, blending factors have been assumed for the HLW vitrification processes.

One of the major uncertainties associated with the ex situ alternatives is the volume of HLW that would be produced. The largest uncertainty range would be for alternatives that rely on an intermediate level of separations. The estimated volume of HLW produced is a function of the inventory and assumptions made for separations efficiencies , waste loading, and blending.

The waste loading and blending factors assumed for the ex situ alternatives represent a reasonable and conservative technical basis for the EIS. This basis was developed through an independent technical review (Taylor-Lang 1996).

The assumptions made for waste loading and blending result in approximately 12,200 HLW canisters (1.17 m^3 [41 ft^3]) for the Ex Situ Intermediate Separations and Phased Implementation alternatives.

Assumption on Disposal of Hanford Site HLW in a Geologic Repository

For purposes of analysis, a geologic repository candidate site at Yucca Mountain, Nevada was assumed to be the final disposal site for all TWRS HLW sent offsite for disposal. Current legislation prohibits the placement, in the first repository, of spent fuel in excess of 70,000 mt (77,000 tons) of heavy metal or a quantity of solidified high-level radioactive waste from the reprocessing of such a quantity of spent fuel until a second repository is operating. DOE will evaluate the need for a second repository no sooner than year 2007.

Currently, Yucca Mountain is the only site being characterized as a geologic repository for HLW. If selected as the site for development, it would be ready to accept HLW no sooner than 2015. The potential environmental impacts that would occur at the geologic repository from the disposal of HLW from TWRS are not addressed in this EIS. Potential impacts at the repository will be addressed in an EIS that DOE will prepare in accordance with the Nuclear Waste Policy Act to analyze the site-specific environmental impacts from construction, operation, and eventual closure of a potential geologic repository for spent nuclear fuel and HLW at Yucca Mountain. Detailed evaluations to support decisions on the disposal of HLW from the Hanford Site would be made following completion of the repository EIS. The repository EIS will also asses the impacts of transporting spent nuclear fuel and HLW from various storage locations to the potential geologic repository.

Each of the ex situ alternatives addressed in this EIS include sufficient interim onsite storage facilities to store all of the immobilized HLW produced while awaiting offsite transport and disposal at the potential geologic repository. This would allow each of the alternatives to operate independent of the acceptance schedule for the potential geologic repository.

Safety Issues

Because of the uncertainty involved with the tank waste inventory and the application of some first of a kind technologies, there are uncertainties involved with the estimates of accidents. Therefore, a bounding approach was taken for the calculation of consequences from accidents. A full safety review of all aspects of the alternative selected would be performed during the final design phase, and changes could be made to the selected alternative to provide engineering or administrative controls to mitigate accidents unforeseen at the current time. This is a standard design procedure.

The possibility of driving heavy equipment over an unstabilized tank during construction or operations that could potentially result in a tank dome collapse was considered. To reduce the potential for this accident, engineered features would be installed and administrative controls would be used to prevent large vehicles from driving on top of the domes. These engineered barriers would be mechanical barriers such as closely spaced posts installed around the tanks or tank farms.

3.4.1.5 Waste Compositions

Vitrification, or glassmaking, is a waste stabilization and solidification technology that incorporates radioactive and hazardous waste into a glass matrix. This process involves blending the waste material with glass formers or additives and heating the mixture to glass-forming temperatures. The types of glass formers added to the waste define the resulting glass type.

Borosilicate glass is based on a composition of silicon dioxide, boron trioxide, sodium oxide, and lithium oxide. Borosilicate glass is the standard final waste form for treating high-level radioactive waste because of its durability and ability to accommodate a varied range of waste feeds (DOE 1990). Additionally, borosilicate glass is currently identified as the only standard HLW form that will be accepted at the potential geologic repository (DOE 1994g).

Other types of glass could be selected for the vitrification of HLW or LAW; however, they would have to meet the repository or performance assessment criteria. One example is the soda-lime glass that would be produced by the Ex Situ No Separations (Vitrification) alternative. Soda-lime glass consists of mainly silicon dioxide, sodium oxide, and calcium oxide.

Two types of vitrified waste forms described in the alternatives are monoliths and cullet. Monoliths would be produced by casting the molten glass into a canister, resulting in a single piece of glass. The cullet would be produced by quenching the molten glass in water following vitrification, resulting in gravel-sized pieces of glass.

Cullet would provide processing and material handling advantages for the high-capacity processing facilities. The disadvantage of cullet as a waste form is its high surface area-to-volume ratio, which results in lower long-term performance. Matrices or coating material can be used in conjunction with the cullet to improve the waste-form performance.

All of the ex situ alternatives that produce vitrified LAW for onsite disposal have assumed cullet in a matrix material as the waste form for onsite LAW disposal. This provides a conservative analysis of the long-term impacts resulting from onsite disposal of LAW.

Grouting the retrieved tank waste is a technology that could be applied to any of the ex situ alternatives in place of vitrifying the waste. Grout is a common solidification and stabilization technology employed in the management of hazardous and radioactive waste. Grout is a general term that refers to a waste form obtained by mixing waste with chemical additives to stabilize and immobilize the hazardous constituents.

The grouting process applied to the ex situ treatment of the tank waste would involve waste retrieval and transfer to a grout facility where the waste would be mixed with appropriate mixtures of grout formers. After the grout is mixed, it could be placed into containers or pumped into large vaults for solidification and disposal.

Grouting tank waste has been studied extensively at the Hanford Site as a technology for LAW disposal. Grouting of the LAW was selected as the treatment method in the Hanford Defense Waste EIS (DOE 1987). The LAW described in the Hanford Defense Waste EIS included liquid waste from the tanks (after separation of HLW components) and secondary waste from the HLW vitrification facility, which would consist of waste from canister decontamination, drying feed material, and recovered liquid from off-gas treatment.

Each of the alternatives that involve treating the waste would involve collecting small sample quantities (up to about 2.5 L [0.65 gal] per sample) of tank waste and shipping the samples to offsite locations for bench-scale waste treatment and immobilization performance demonstration and testing purposes. The general approach would include collecting grab and/or core samples from the tanks, verifying that the samples and sample contents meet appropriate specifications (using existing onsite laboratory facilities, including necessary laboratory preparatory work [e.g., preparing composite samples]), and appropriately packaging and transporting the samples to other DOE facilities or to private contractor facilities. Initially, collecting and transferring small quantities of such samples would be to support contractor selection for DOEs TWRS privatization initiative.

3.4.1.6 Waste Minimization

Each alternative would involve waste minimization practices for primary, secondary, and tertiary waste. Primary waste is the treated tank waste and capsule contents requiring disposal. Primary waste minimization practices would be used to control the volume of HLW and LAW requiring disposal.

Secondary waste is generated during handling and processing of the waste and includes off-gases, contaminated filters, spent ion-exchange resins, and liquid effluents. Secondary waste minimization would involve practices such as using metal high-efficiency particulate air filters that could be washed in place and reused. In some process configurations, spent ion-exchange resin would be fed into the waste treatment process to reduce the volume of secondary waste.

Tertiary waste generation primarily would be a function of the number of operating personnel and includes such things as personal protective equipment and other incidental waste. Secondary and tertiary waste would be divided into low-level waste and transuranic waste based on characterization. Secondary low-level waste would be disposed of at the onsite low-level waste burial grounds. Secondary transuranic waste would be retrievably stored for future packaging at the Waste Receiving and Processing Facility. Current plans are for disposal of transuranic waste at the Waste Isolation Pilot Plant. Liquid effluent from all alternatives would be treated at the Effluent Treatment Facility in the 200 East Area before release.

Each of the tank waste alternatives that use high-temperature processing (vitrification or calcination) would make extensive use of recycle streams to recycle volatile radionuclide and chemical constituents, which are captured in the off-gas systems, back into the treatment process. These recycle streams would be used to minimize the generation of secondary waste. It has been determined that a bleed stream would be required for each alternative to avoid a continuous buildup of certain volatile radionuclide and chemical constituents (e.g., technetium-99 and mercury) in these recycle streams. For comparison purposes, it has been assumed for each alternative that the bleed stream percentage would be 1 percent of the recycle stream and that this secondary waste stream would be stabilized by some low-temperature process.

Hanford Site waste minimization would involve the use of chemicals and materials from other Hanford Site facilities where appropriate. One example would be the conversion of the sodium from the Fast-Flux Test Facility cooling system to sodium hydroxide for use during enhanced sludge washing for the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives, or other alternatives using waste stream separation processing. The conversion facility, with its process-inherent safety issues, would require a cost and safety analysis.

3.4.1.7 Cost Estimates

Cost estimates are presented for each alternative. These estimates are based on conceptual designs and have an associated level of uncertainty. This uncertainty is accounted for in the cost uncertainty analysis and results in a cost range that is estimated for each alternative. Additional information on the cost uncertainty is provided in Volume Two, Section B.8.0.

Capital cost is included in the cost for the alternatives and includes the direct cost (i.e., materials, labor, and equipment for facility construction), construction management, project management, engineering, and contingency. The contingency is obtained by multiplying the sum of the capital cost components by a contingency factor. Each of the estimates includes a value for current operations, which is the estimated cost associated with routine operations identified in Section 3.4.1.1.

Research and development cost is included in the cost estimates for each alternative. This cost is assumed to provide for development of the technologies required to implement an alternative. The resolution of implementability issues identified for each alternative would be part of the development work; thus the research and development cost partially reflects the implementation uncertainties.

Repository fees for alternatives that include shipment of HLW to the potential geologic repository are discussed in Section 3.7.

The cost estimates for each of the alternatives were prepared using the same methodology and estimating practices to ensure comparability among the alternatives. Additional detail on the cost estimates is provided in Volume Two, Appendix B.

3.4.1.8 Facility Sizing

The design capacities for the full-scale ex situ processing facilities were developed using a consistent approach. Each facility was sized to treat the projected volume of waste within the schedule outlined in the Tri-Party Agreement using a consistent set of assumptions for total operating efficiency. The total operating efficiency for the ex situ vitrification facilities was assumed to be 60 percent. The operating efficiency for the Phased Implementation alternative during Phase 2 was assumed to be higher to account for the advantages of the phased implementation approach.

3.4.1.9 Facility Siting

A site evaluation process was conducted and four potential sites were identified as suitable locations for the onsite treatment and disposal activities for the ex situ treatment and disposal alternatives. A suitable site, which would accommodate all of the full-scale ex situ alternatives, is a combination of Sites B and C shown in Figure 3.4.1. This representative site is for ex situ tank waste remediation activities for the purpose of alternative evaluation in the EIS and does not preclude the other sites from ultimately being selected. Prior to selecting the representative site, one of the other sites, or a combination of sites, appropriate NEPA analysis would be completed. All of the full-scale ex situ alternatives are assessed as if they were located on this representative site.

The representative site is located close to a potential support facility for the 200 East Area infrastructure on vacant land, which has been disturbed partially by past actions. The location of the Phase 1 facilities for the Phased Implementation alternative is assumed to be Site B, maintaining Site C for Phase 2 facilities (WHC 1996).

3.4.1.10 Hanford Barrier

The Hanford Barrier would be a horizontal, abovegrade, engineered soil structure used to isolate the waste site from the environment by preventing or reducing the likelihood of wind erosion, water infiltration, and plant, animal, and human intrusion. It would be composed of 10 layers with a combined thickness of 4.5 m (15 ft), and placed over the top of the stabilized tanks and the LAW disposal sites. Each Hanford Barrier would extend 9 m (30 ft) beyond the perimeter of the area to be protected. For additional information on the Hanford Barrier, see Volume Two, Section B.6.0.

Figure 3.4.1 Potential Site Location

For purposes of analysis only, the earthen borrow material was assumed to be obtained from three potential borrow sites on the Hanford Site. The use of these sites to allow the potential impacts to be calculated does not mean that these sites would be used. The evaluation and selection of borrow sites for closure activities will be addressed in a future NEPA analysis.

3.4.1.11 Interim HLW Storage

Each of the ex situ alternatives would include sufficient interim onsite storage capacity to store all of the immobilized HLW produced while awaiting shipment to the potential geologic repository. Interim HLW storage would consist of placing Hanford Multi-Purpose Canisters on a concrete storage pad and placing a concrete shielding cover over each Hanford Multi-Purpose Canister. This method of interim

storage would be used for all ex situ alternatives except for Phase 1 of Phased Implementation. During Phase 1 HLW canisters would be placed in the Canister Storage Building for interim storage. The Canister Storage Building is a facility that is being constructed in the 200 East Area for storage of DOE spent fuel.

3.4.2 No Action Alternative (Tank Waste)

3.4.2.1 Overview

The No Action alternative would provide for continued storage and monitoring of tank waste. For purposes of assessing impacts, it is assumed that administrative controls (e.g., site security and management) would be maintained for 100 years. However, DOE and Ecology currently have no policies or plans that would permit the loss of administrative control for radioactive and hazardous material.

The SST waste would have minimal free liquid remaining and would be left in place and monitored. Existing DSTs and MUSTs would be left in place and monitored, similar to the SSTs. No construction activities would be involved with the No Action alternative.

The information used in describing this alternative was obtained from the No Disposal Action Engineering Data Package for the TWRS EIS (WHC 1995g and Jacobs 1996).

3.4.2.2 Process Description

For the SSTs, it is assumed that current operations to remove pumpable liquid (interim stabilization) from the tanks would be completed. This would result in SST waste that primarily is solid but contains some interstitial liquid (the interstitial liquid is held within the void spaces of the sludge and saltcake). The SSTs would be monitored for releases and indications of tank dome settling or collapse. The SSTs showing signs of deterioration would be filled with grout or gravel as a corrective action or emergency response.

The DST waste mainly is liquid; consequently, a tank leak from a DST would represent a greater threat to the environment than a tank leak from a SST because of the potential volume and migration of contaminants to the groundwater. The DSTs were put into service between 1971 and 1987, and all DSTs would exceed their 50-year design life during the No Action alternative. Monitoring and maintenance activities would continue to ensure safe storage of waste in the DSTs. This would include maintaining spare DST capacity and leak recovery from the annulus of a tank if a leak were detected. Spare DST capacity would be maintained within the existing DSTs through periodic operation of the 242-A Evaporator and waste minimization practices. If a DST were to fail, its waste would be transferred to other DSTs as an emergency response. Administrative controls would be maintained for items such as monitoring, routine maintenance, fire protection, and security throughout the 100-year administrative control period.

3.4.2.3 Construction

No construction activities would take place for this alternative.

3.4.2.4 Operations

Operations would involve continued monitoring and maintenance of the tank farms.

3.4.2.5 Post Remediation

There would be no post-remediation activities associated with the No Action alternative. It is assumed for purpose of analyses that administrative control of the area would be discontinued after 100 years, and human intrusion could occur.

3.4.2.6 Schedule, Sequence, Cost

The No Action alternative schedule is shown in Table 3.4.2. The cost for the No Action alternative is shown in Table 3.4.3.

Table 3.4.2 Schedule - No Action Alternative (Tank Waste)

Table 3.4.3 Cost - No Action Alternative (Tank Waste) [1]

3.4.2.7 Implementability

The objective of the No Action alternative would be to provide continued management of the tank waste. This alternative would not provide remedial action for the tank waste. This alternative would provide for the continuation of current operations and, as such, does not present specific process uncertainties. There is some uncertainty in estimating the functional life of the DSTs. Current design life of the DSTs is approximately 50 years.

Extensive additional characterization would be required to address RCRA land disposal requirements if waste was left in place.

One implementability issue that would require additional analysis is the potential for interim stabilized SSTs to develop leaks. Following interim stabilization, an SST could contain as much as 190,000 L (50,000 gal) of interstitial liquid.

This alternative would not comply with Federal and State requirements for storing hazardous waste. When administrative control is assumed to be discontinued after 100 years, the waste left in place would not comply with State and Federal (including DOE Order 5820.2A) requirements for disposal of hazardous, radioactive, or mixed waste (Section 6.2).

3.4.3 Long-Term Management Alternative

3.4.3.1 Overview

The Long-Term Management alternative would provide continued storage and monitoring of tank waste and is similar to the No Action alternative except that the DSTs would be replaced twice during the 100-year administrative control period to prevent the release of DST liquid. For purposes of assessing impacts, it is assumed that administrative controls (e.g., site security and management) would be maintained for 100 years. However, DOE and Ecology currently have no policies or plans that would permit the loss of administrative control for radioactive and hazardous material.

The SST waste would have minimal free liquid remaining and would be left in place and monitored. The DST waste, which is currently 77 percent liquid, would be monitored, retrieved, and placed into new DSTs at 50-year intervals corresponding to the design life of the DSTs (Figure 3.4.2) . Existing MUSTs would be left in place and monitored similarly to the SSTs. Construction activities for the Long-Term Management alternative involve building new DSTs along with the retrieval, transfer, and evaporator facilities to accommodate two retanking campaigns for the DST waste during the 100-year administrative control period.

The information used in describing this alternative was obtained from the No Disposal Action Engineering Data Package for the TWRS EIS (WHC 1995g and Jacobs 1996).

3.4.3.2 Process Description

For the SSTs, it is assumed that current operations to remove pumpable liquid (interim stabilization) from the tanks would be completed. This would result in SST waste that is primarily solid but that contains some interstitial liquid (the interstitial liquid is held within the void spaces of the sludge and saltcake). The SSTs would be monitored for releases and indications of tank dome settling or collapse. The SSTs showing signs of deterioration would be filled with grout or gravel as a corrective action or emergency response.

The DST waste is mainly liquid, and consequently, a tank leak to the ground from a DST (both shells failing) would represent a greater threat to the environment than a tank leak from a SST because of the potential volume and migration of contaminants to the groundwater. The DST waste would be removed and transferred into new DSTs at two intervals corresponding to the 50-year design life of the tanks. The design life corresponds to a minimum length of service time that a tank would be expected to remain functional, though the DSTs may remain functional for more than 50 years. The DSTs were

put into service between 1971 and 1987, and the first retanking campaign would correspond to using the full 50-year service life of the newest DSTs, which were placed into service in 1987. The first retanking campaign for the 28 DSTs would begin in the year 2037. It is recognized that some DSTs would exceed their design life prior to the first retanking campaign; however, it is assumed that these tanks would be safely managed. Monitoring and maintenance activities would continue to ensure safe storage of waste in those DSTs that would exceed the 50-year design life. This would include maintaining additional DST capacity and leak recovery from the annulus of the DSTs.

Based on waste volume projections, each retanking campaign would require 26 new 3.8-million-L (1-million-gal) tanks to replace the existing DSTs. This estimate includes maintaining a spare tank for contingency. A total of two retanking campaigns would be required during the 100-year administrative control period.

Figure 3.4.2 Long-Term Management Alternative

Following retrieval, the empty DSTs would contain waste residuals and would be managed in the same manner as the SSTs. Administrative controls would be maintained for monitoring, routine maintenance, fire protection, and security throughout the 100-year administrative control period.

3.4.3.3 Construction

Construction activities for this alternative would consist of building 26 new DSTs along with the required retrieval and transfer systems for each DST retanking campaign. The 242-A Evaporator was assumed to be obsolete by the time the first retanking operation would take place, and a new evaporator would be constructed in the vicinity of the new DSTs for each retanking. A total of 52 new DSTs and 2 new evaporators would be built under this alternative.

3.4.3.4 Operations

Operations would involve continued monitoring and maintenance of the tank farms as well as retrieving and transferring the DST waste during the retanking campaigns.

- Waste retrieval would be accomplished during a DST retanking campaign as follows.
- Pump tank liquid (supernate) from existing to new DSTs.
- Add water to existing tanks and use mixer pumps to suspend solid and sludge into a slurry.
- Pump the slurry to the evaporator for water removal and volume reduction.
- Pump concentrated slurry to new DSTs.
- Send evaporator condensate and excess retrieval water to the Effluent Treatment Facility for treatment and discharge.

3.4.3.5 Post Remediation

There would be no post-remediation activities associated with the Long-Term Management alternative. The evaporator facility constructed with each set of new tanks would be decontaminated and decommissioned after each retanking campaign. It was assumed that administrative control of the area would be discontinued after 100 years, and human intrusion could occur.

3.4.3.6 Schedule, Sequence, Cost

The Long-Term Management alternative schedule is shown in Table 3.4.4. The two separate time periods shown correspond to building and transferring the DST waste to new tanks during the 100-year administrative control period. The overall cost for the Long-Term Management alternative is shown in Table 3.4.5.

Table 3.4.4 Schedule - Long-Term Management Alternative

3.4.3.7 Implementability

The objective of the Long-Term Management alternative would be to provide continued storage of the tank waste. This alternative would not provide remedial action for the tank waste. This alternative would provide for the continuation of current operations and, as such, does not present any process uncertainties. There is some uncertainty in estimating the functional life of the DSTs. Design life of the current DSTs is approximately 50 years. Many tanks are expected to exceed their design life; however, a structural integrity assessment has not been completed to date. One implementability issue that would require additional analysis would be the potential for interim stabilized SSTs to develop leaks. Following interim stabilization, an SST could contain as much as 190,000 L (50,000 gal) of interstitial liquid.

Table 3.4.5 Cost - Long-Term Management Alternative [1]

Extensive additional characterization would be required to address RCRA land disposal requirements if waste was left in place.

This alternative would not comply with Federal and State requirements for storing hazardous waste. When administrative control is assumed to be discontinued after 100 years, the waste left in place would not comply with State and Federal (including DOE Order 5820.2A) requirements for disposal of hazardous, radioactive, or mixed waste (Section 6.2).

3.4.4 In Situ Fill and Cap Alternative

3.4.4.1 Overview

The In Situ Fill and Cap alternative would leave the tank waste in place for disposal. This alternative would involve containing the waste by evaporating excess water from the DST waste using the 242-A Evaporator; filling the tanks with gravel to prevent subsidence; and installing a Hanford Barrier over each tank farm. These actions would slow the migration of contaminants from the waste by removing water from the waste and using the Hanford Barrier to limit the amount of rainwater that would infiltrate through the waste to the water table. The current barrier design is composed of 10 layers of material with a combined thickness of approximately 4.5 m (15 ft) (WHC 1995i). Additional information on the Hanford Barrier is contained in Volume Two, Appendix B. Information used in describing this alternative is from the In Situ and Closure engineering data packages (WHC 1995f, i, and Jacobs 1996).

3.4.4.2 Process Description

The 242-A Evaporator would be used to remove most of the liquid in the DSTs. The tanks would be filled with basalt gravel using commercially available equipment. Gravel filling the tanks would prevent future tank dome collapse and loss of integrity of the Hanford Barrier.

3.4.4.3 Construction

Construction for this alternative would include activities to fill the tanks with gravel: installing gravel handling equipment required to convey the gravel from a stock pile to individual tanks and distribute the gravel evenly into the tank; modifying tank openings to accommodate gravel handling equipment, and constructing four gravel stockpile storage sites.

3.4.4.4 Operations

Operations would take place during a 9-year period between 2000 and 2009. Major activities during operations would include evaporating DST liquid in the 242-A Evaporator to remove as much water from the liquid waste as practical, and filling SSTs and DSTs with gravel.

3.4.4.5 Post Remediation

After all tanks were filled, the equipment used for gravel filling would be decontaminated and decommissioned. The MUSTs (both active and inactive) and ancillary equipment in the tank farms would be filled with grout, and a Hanford Barrier would be constructed over each tank farm. The regulatory aspects of closure are discussed in Section 6.2.

3.4.4.6 Schedule, Sequence, and Cost

The schedule of major activities associated with this alternative is presented in Table 3.4.6. These estimates include the cost necessary to fill each of the tanks with gravel and cover each tank farm with a Hanford Barrier. The estimated cost for this alternative is shown in Table 3.4.7.

Table 3.4.6 Schedule - In Situ Fill and Cap Alternative

3.4.4.7 Implementability

The primary issue associated with implementing this alternative would be the possibility of spontaneous or radiolytic decomposition reactions occurring in the tanks following the gravel fill operations. Following gravel filling operations, oxidizing chemicals would be in contact with organics and safely disposing of these waste combinations would require further investigation. The regulatory issues associated with this alternative are discussed in Section 6.2.

Table 3.4.7 Cost - In Situ Fill and Cap Alternative [1]

This alternative would not meet the land disposal requirements of RCRA for hazardous waste. Near-surface disposal of HLW would not meet DOE policy to dispose of readily retrievable HLW in a potential geologic repository (Section 6.2).

3.4.5 In Situ Vitrification Alternative

3.4.5.1 Overview

The In Situ Vitrification alternative would immobilize all of the tank waste by vitrifying the tanks and their contents in place (Figure 3.4.3) .

This process would require the use of electrical resistance heating, referred to as joule heating, to create a high-temperature region of molten soil and waste that would solidify when cooled into a stable, glass-like form. During this process, various components of the waste either would be incorporated into the glass, destroyed, or vaporized into the off-gas treatment stream. A confinement facility would be constructed over each tank farm or smaller group of tanks to provide containment and collect the off-gases generated during vitrification for subsequent treatment. Each facility would span an entire tank farm or a smaller group of tanks and would be supported around the perimeter. Information and data used throughout this section to describe this alternative are from the Site Management and Operations contractor (WHC 1995f, i) and the TWRS EIS contractor (Jacobs 1996).

Operations for this alternative would involve preparing the tanks for vitrification, operating the vitrification equipment, and treating the off-gases. At least two vitrification systems would be in operation at all times during the operational phase.

Figure 3.4.3 In Situ Vitrification Alternative

Following remediation, the vitrified waste would be left in place for disposal. A Hanford Barrier would be constructed over each of the tank farms to reduce infiltration of precipitation, penetration by plant roots and burrowing animals, and to prevent inadvertent human intrusion.

3.4.5.2 Process Description

In situ vitrification is a thermal treatment process in which electricity would be used to generate a high-temperature region in the range of 1,450 to 1,600 degrees centigrade (C) (2,600 to 2,900 degrees Fahrenheit [F]). This would be accomplished by placing electrodes in a pattern at the surface of the soil. After the electrodes were energized and a current path established, the soil surrounding the electrodes would begin to melt. As the process continued, the electrodes would be fed down into the melt and the molten region would spread down and out, melting waste, tank, and soil. The process would be controlled by varying the amount of electricity flowing to the electrodes to maintain the temperature and rate at which the melt progressed. The melt would be continued until an entire tank and its waste contents were vitrified (converted to glass).

As the waste heated to the vitrification temperatures, some of the waste would decompose into gases and be released. The remainder of the waste would be incorporated into the glass that formed during cooling and solidification of the molten material. The gases generated during the operation would be vented from the top of or from around the molten region and collected for treatment before atmospheric release. A Hanford Barrier then would be constructed over each of the tank farms.

This alternative would involve the following major steps:

- Remove the maximum amount of water practicable from the DST waste by processing through the 242-A Evaporator;
- Construct the Tank Farm Confinement Facilities;
- Isolate the tanks electrically by disconnecting all support systems connections such as piping, instrumentation, and ventilation systems;
- Fill the tanks with sand, which would function as a glass former and eliminate all empty space within the tanks;
- Place electrodes and supply electrical current to melt waste;
- Collect and treat the off-gases;
- Decontaminate and decommission the Tank Farm Confinement Facilities;
- Grout fill MUSTs and ancillary equipment that is not vitrified; and
- Construct Hanford Barriers.

Removing liquid from the DSTs by pumping prior to vitrification would provide a more efficient operation and reduce the amount of vapor in the off-gas system. The liquid would be pumped to the 242-A Evaporator for evaporation. The concentrated waste would be returned to the tanks and the evaporator condensate would be treated at the Effluent Treatment Facility and discharged.

The Tank Farm Confinement Facility would be a free-span structure providing confinement to an entire tank farm. The Tank Farm Confinement Facility would consist of two main components: 1) the truss structure that would sit on a concrete foundation running around the perimeter of the tank farm; and 2) the confinement facility that would be suspended from the trusses. This would allow the entire tank farm to be enclosed without putting additional weight loads on the tank domes. The confinement facility would consist of an operating floor with removable panels to provide access to the tanks.

The confinement facility would also provide multi-zone ventilation to collect and treat the off-gases and maintain the operating zones (Figure 3.4.4).

Before beginning the vitrification operation, each tank would be electrically isolated from all support systems. This would include disconnecting and removing piping, instrumentation wiring, and ventilation systems shared with other tanks. This would prevent potential accidents and damage resulting from stray electrical current. Piping and equipment removed to electrically isolate the tanks would be decontaminated as necessary for onsite burial or placed in the tank and vitrified with the waste.

Because the vitrification process would rely on electrical resistance heating to create the melt zone, two important parameters in the process would be the resistance (which would affect melt temperature) and maintaining a continuous electrical path through the material being heated. All of the tanks have a void

Figure 3.4.4 In Situ Vitrification Arrangement and Features

space between the surface of the waste and the dome of the tank. Those tanks with the least volume of waste have the largest void spaces. These void spaces would be filled with Hanford Site sand to act as a filler and a glass former. This would require a total of 540,000 m^3 (714,000 cubic yards [yd^3]) of sand compared to 230,000 m^3 (304,000 yd^3) of waste currently stored in the tanks.

After filling the tanks with sand, the electrodes would be placed at the surface of the existing soil. An estimated 19 electrodes, each approximately 30 cm (12 in.) in diameter, would be used for a standard 23-m (75-ft)-diameter tank. An off-gas hood would be placed over the area to be melted to collect the

off-gases for cooling and treatment. A conductive material such as graphite then would be placed between the electrodes to help start the melt. An electrical potential would be applied to the electrodes starting the melt. As the melt progressed down, the individual electrodes would be fed through the off-gas collection system and down into the melt zone.

Each vitrification system would be configured to melt approximately 225 metric tons (mt) (248 tons) per hour consuming 160 MW, which would be required to vitrify the tank waste and the material between the tanks during a 5-year period. This rate of power consumption is about 14 percent of the output from a 1,100-MW power plant (e.g., Washington Public Power Supply System No. 2 Nuclear Power Plant). The electrical power required to vitrify a tank would be approximately 25,000 MW-hours (about 1 day's output from the Washington Public Power Supply System No. 2 Nuclear Power Plant). Four vitrification units would be built with at least two units in continuous operation.

The off-gas system would collect and treat gases from the melt before releasing them to the atmosphere. The off-gases would contain the reaction products resulting from the thermal destruction of the nitrates, nitrites, organic compounds, and some of the more volatile radionuclides contained in the waste. The off-gases would undergo substantial treatment before being released to the atmosphere. Specific control equipment used in the treatment of the off-gases would quench and cool the off-gases, remove radionuclide particulates, and remove nitrogen oxides and sulfur oxides.

Following vitrification operations, each of the Tank Farm Confinement Facilities would be taken down and decontaminated and decommissioned. The MUSTs and ancillary equipment located outside of the vitrified area (limited by the Tank Farm Confinement Facilities) would be filled with grout. Decontamination and decommissioning of a Tank Farm Confinement Facility would require a substantial level of effort because of the amount of surface area that would be contaminated during the vitrification process.

A Hanford Barrier would be constructed over each of the tank farms as well as those MUSTs that fall outside of the tank farm boundaries.

3.4.5.3 Construction

The main construction activity for this alternative would be building 18 Tank Farm Confinement Facilities to cover all of the tanks. The confinement facilities would be constructed in one of five configurations. The smallest configuration would cover a 2 by 2 tank farm (i.e., a tank farm that is two tanks wide by two tanks deep) and the largest would cover a 4 by 5 tank farm. The smaller Tank Farm Confinement Facility would be used for tank farms with two to four tanks.

Systems that would be constructed for the In Situ Vitrification alternative include the following:

- Tank Farm Confinement Facilities to provide confinement and ventilation control, (18 facilities total);
- Off-gas treatment systems to collect, treat, and filter process off-gases before discharge;
- Handling system to fill tank domes with sand by transporting sand from stock pile and uniformly filling the tank dome spaces;
- Electrical power distribution system to supply high-voltage power to the vitrification system;
- New electrical substation to connect the power distribution system to the existing electrical grid;
- Approximately 8 kilometers (km) (5 miles [mi]) of 115-kilovolt (kV) transmission line; and
- Temporary 115-kV lines from transmission lines to individual tank farms in the 200 Areas.

3.4.5.4 Operation

Operations for this alternative would take place during an 11-year period between 2005 and 2016. This would include 3 years to start up the project, 3 years to shut down the project, and an additional 5 years until the vitrification process would take place. Activities that would take place during the operations phase include the following:

- Remove and treat DST liquid in the 242-A Evaporator (treated slurry would be returned to tank);
- Disconnect and remove piping, instrumentation, and ventilation system connections;
- Fill tank void spaces with sand to provide an uninterrupted electrical path;
- Install electrodes in the electrode feed system that would lower the electrodes into the molten region as it progressed down consuming the tank and waste;
- Vitrify waste by starting the melt and controlling the applied power;
- Operate an off-gas treatment system to collect, treat, and filter process off-gases before discharge; and
- Treat liquid condensed in the off-gas system by evaporating to reduce the volume followed by low-temperature treatment or transporting to the Effluent Treatment Facility;

3.4.5.5 Post Remediation

When in situ vitrification was complete, the vitrified waste and the tank farms would be closed, and all facilities constructed for vitrifying the waste would be decontaminated and decommissioned. Activities that would take place include grout filling tank farm ancillary equipment (e.g., pump pits, diversion boxes, valve boxes) that would not be vitrified; constructing a Hanford Barrier over each tank farm; and decontaminating and decommissioning Tank Farm Confinement Facilities and equipment.

3.4.5.6 Schedule, Sequence, Cost

The schedule of major activities associated with this alternative is presented in Table 3.4.8.

The estimated cost for this alternative is shown in Table 3.4.9.

Table 3.4.8 Schedule - In Situ Vitrification Alternative

Table 3.4.9 Cost - In Situ Vitrification Alternative [1]

3.4.5.7 Implementability

Implementability of a remedial alternative will be a function of two factors: the history of the demonstrated performance of a technology; and the ability to construct and operate the technology given the existing conditions at the Site. The primary issues applicable to the implementability of the In Situ Vitrification alternative include the following.

- This alternative is more conceptual in design and development than the ex situ alternatives and thus has a higher degree of uncertainty associated with the supporting data.
- In situ vitrification previously has not been performed and may not work on the scale described for this alternative. Substantial research, development, and demonstration activities would be required. Current commercial experience is limited to melting areas 15 m (49 ft) in diameter by 6 m (20 ft) deep, while this alternative assumes an entire tank that is 23 m (75 ft) in diameter by 18 m (60 ft) deep can be vitrified. Concerns with implementing this alternative are not as great for small tanks such as MUSTs or larger tanks with small volumes of waste. Multiple melts using smaller in situ vitrification systems could be used to vitrify larger diameter tanks .
- The established safety envelope for much of the waste as it is stored in the tanks is dependent on the waste being wet. The vitrification process would dry out the waste before it was heated to melting temperatures and thereby raise the temperature of the waste and create the potential for initiating an uncontrolled reaction. This issue would require further analysis.
- The Tank Farm Confinement Facility design is conceptual, and further development would be required for it to comply with current DOE facility design requirements.
- The Tank Farm Confinement Facility could be difficult to construct because of the atypical nature of the design and restrictions associated with working in and around the tank farms. Smaller tank farm confinement facilities in a portable or moveable design could be used to replace the larger tank farm confinement facilities.
- Inspection of the final waste form to confirm that all of the waste is stabilized and the waste form is acceptable for disposal would be difficult to perform. Reprocessing waste that fails to meet disposal criteria would involve remelting sections of the vitrified waste form, which could affect the operating schedule.
- Decontamination and decommissioning of the Tank Farm Confinement facilities would be difficult because of the size of the facilities and the amount of surface area that would be contaminated.

Additional details on the implementability of this alternative are contained in Volume Two, Appendix B. This alternative could meet the RCRA land disposal requirements if hazardous waste is adequately treated during vitrification. Near-surface disposal of HLW would not meet DOE policy to dispose of readily retrievable HLW in a potential geologic repository (Section 6.2).

3.4.6 Ex Situ Intermediate Separations Alternative

3.4.6.1 Overview

Under the Ex Situ Intermediate Separations alternative, as much of the tank waste as practicable would be retrieved from each tank. This is assumed to be a minimum of 99 percent of the waste volume in each tank. The recovered waste stream then would be separated into HLW and LAW streams for vitrification in separate facilities (Figure 3.4.5). Separating the waste streams into HLW and LAW fractions would allow for processing and disposal methods best suited to the waste types and requirements.

The HLW stream would be vitrified and placed in canisters for disposal at the potential geologic repository. The LAW stream would be vitrified and quenched into glass cullet and placed into onsite near-surface vaults for retrievable disposal. Retrievable disposal means that the design of the disposal facility would be for permanent disposal, but the waste could be retrieved from the disposal facility within a certain amount of time (assumed to be approximately 50 years) if a different disposal method was determined to be necessary.

Information used throughout this section is from the Site Management and Operations contractor (WHC 1995 i, j, n) and the TWRS EIS contractor (Jacobs 1996).

Two vitrification facilities, one for HLW and one for LAW, as well as the shared support facilities, would be constructed. The HLW facility would be designed to produce 20 mt (22 tons) of HLW glass per day. The LAW facility would produce 200 mt (220 tons) of LAW glass cullet per day. The facilities are assumed to be located on the representative site in the 200 East Area, as shown in Figure 3.4.6. The vitrification facilities would be designed to treat all of the tank waste during a 21 -year operating period.

The following major operations would be implemented to treat waste under this alternative.

- Retrieve the waste.
- Pretreat the waste by sludge washing and enhanced sludge washing followed by separation of the liquid and solids.
- Remove cesium from the liquid waste stream and transfer cesium to the HLW vitrification stream.
- Transfer liquid and dissolved solids to the LAW vitrification facility.
- Transfer solids (as a slurry) to the HLW vitrification facility.
- Vitrify both HLW and LAW.
- Pour the molten HLW into canisters.
- Package the canisters into Hanford Multi-Purpose Canisters for interim storage and shipment.
- Place the vitrified LAW in disposal containers.

- Place the LAW disposal containers in onsite near-surface disposal vaults.
- Ship the HLW canisters to the potential geologic repository.

Following the treatment phase, the processing facilities and storage tanks would be decontaminated and decommissioned. Contaminated materials and equipment from the processing facilities would be disposed of onsite in the low-level waste burial grounds. Noncontaminated materials and equipment from the processing facility would be entombed in place. Closure activities would be performed on the LAW disposal vaults and tank farms.

Figure 3.4.5 Ex Situ Intermediate Separations Alternative

Figure 3.4.6 Ex Situ Intermediate Separations Site Plan

3.4.6.2 Process Description

The first step in waste processing would be to recover and transfer waste from the storage tanks to the separations facility. The waste recovery function would retrieve and blend waste to provide, as close as possible, an average or blended feed stream that would be batch transferred to the separations facility. The Tri-Party Agreement requires that the retrieval function remove waste to the extent that SST waste residues meet specific volume requirements based on tank type, or that as much waste is removed as technically possible, whichever action results in the least residual volume (Ecology et al. 1994).

Two methods for removing waste from the SSTs would be hydraulic sluicing and robotic arm-based retrieval systems. Hydraulic sluicing would use pressurized water and recycled tank liquid sprayed from a nozzle to dissolve, dislodge, and suspend the waste into a slurry, which has a thick, soup-like consistency (Figure 3.4.7). The sluicing nozzles would be rotated and angled to direct the slurry to a pump for removal from the tank. Remote cameras installed with the retrieval system would aid in the waste recovery operation. Hydraulic sluicing has been performed in the past to recover tank waste and is assumed to be capable of recovering the majority of SST waste.

For those cases where hydraulic sluicing could not achieve 99 percent recovery, where sluicing would not be deployed because of a known leak, or where sluicing was to be discontinued because of tank leakage, robotic arm-based recovery systems would be used for waste recovery (Figure 3.4.8). Robotic arm-based systems would allow using various engineered components on the end of a long-reach arm to minimize the addition of sluicing water to the tank or to provide remote cut up and removal of in-tank equipment. Recovered equipment, including hardware discarded in the tanks, would be containerized for onsite burial. A confinement structure would be needed over the enlarged tank access required by the arm-based systems.

Slurry pumping would be used for retrieving the waste from the DSTs (Figure 3.4.9) using mixer pumps to break up and suspend solids into a slurry. The current mixer pump design takes liquid from the upper liquid level and discharges it through nozzles approximately 0.6 m (2 ft) above the bottom of the tank. This directs the tank liquid at the solids that have settled in the bottom of the tank. Future DST mixer pumps would function in a similar manner. Future mixer pumps would be designed to accommodate the decreasing waste levels encountered during retrieval. The slurry would then be pumped out of the tank for transfer to the separations facility. Between two and four mixer pumps would be used in each DST. The retrieval for DSTs is assumed to be at least 99 percent.

The waste recovery system would consist of four waste transfer annexes and a waste staging and sampling facility. Each system would circulate sluicing liquid to the tanks as well as receive and accumulate slurry for batch transfer to the central separations facility located in the 200 East Area. The waste in the 200 West Area would be accumulated in the waste staging and sampling facility for cross-site transfer from the 200 West Area to the 200 East Area. A typical piping layout and location of a transfer annex are shown in Figure 3.4.10. The transfer annexes would be centrally located near groups of tank farms to expedite retrieval operations.

Figure 3.4.7 Sluicing Arrangement for Single-Shell Tank Waste Retrieval

Figure 3.4.8 Robotic Arm-Based Arrangement for Single-Shell Tank Waste Retrieval

Figure 3.4.9 Double-Shell Tank Mixer Pump Retrieval Arrangement

As a part of retrieval, piping would be installed to supply sluicing liquid to each tank and to transfer slurried waste from the tanks to the transfer annex or waste staging and sampling facility. The piping run from the transfer annexes or waste staging and sampling facility to the individual tanks would consist of three lines (i.e., supply, return, and spare). In the 200 West Area, waste transfer lines (one line and a spare) also would be installed to connect the waste transfer annexes to the waste staging and sampling facility. In the 200 East Area, transfer lines would be installed to connect the waste transfer annexes directly to the treatment facility. Waste retrieval and transfer lines all would be double-wall (encased) piping located on the ground inside concrete shielding enclosures. Locating these shielded transfer lines on the ground would facilitate removal following waste retrieval operations.

The waste retrieved in the 200 West Area would be collected in the waste staging and sampling facility, where it would be sent to the replacement cross-site transfer system for transfer to the treatment facilities located in the 200 East Area.

The waste transfer lines planned for the waste retrieval and transfer system would be used in conjunction with other waste transfer systems, such as the replacement cross-site transfer system and the waste transfer system upgrades, to meet the requirements for waste retrieval and transfer.

Waste contained in MUSTs would be retrieved using methods similar to those described for SST and DST waste retrieval. Waste recovered from MUSTs would be transported to the waste transfer system or directly to the treatment facilities in containers or a specialized truck (LR-56[H]) designed for the transport of nuclear waste (see discussion on LR-56[H] truck in Volume Two, Appendix B).

Figure 3.4.10 Slurry Transfer Piping and Facilities Layout

The next step in the process would be to separate the waste into LAW and HLW streams. The purpose of separations would be to split the waste volume into a small-volume HLW fraction and a larger-volume fraction that would be classified as LAW (Figure 3.4.11). This would reduce the volume of HLW requiring costly disposal at the potential geologic repository. The other goal of separations would be to limit the generation of additional waste during the separations processes.

The separations process would begin with a sludge wash followed by an enhanced sludge wash to remove the soluble components of the waste stream. The washing of solids and liquid-solid separation could be performed out-of-tank in a processing facility or in tank. For this alternative, sludge washing in the DSTs has been included as a representative process for analysis in the EIS. Future evaluation could result in the selection of other methods or combinations of methods, such as cross-flow filters or centrifuges. Most HLW constituents, which are made up of long-life and high-activity isotopes, are found as solid waste in the tanks and are intermixed with other nonradioactive solid waste. Washing the waste would involve adding water or sodium hydroxide solutions to dissolve a portion of the LAW solids and then separating the liquid and solids.

For SSTs, the dissolution of the waste would begin during retrieval when the waste is sluiced out of the SSTs and transferred. The second phase would take place in DSTs and the enhanced wash would dissolve some of the nonradioactive elements present in the solid waste and further reduce the volume of HLW. The third phase of separations would take place in the separations facility, which would be attached to the LAW vitrification facility. The third phase in the separations process would be to remove the cesium present in the liquid stream by ion exchange and feed it into the HLW stream. Cesium-137 is a high-activity isotope that is highly soluble and removing it from the liquid stream would allow the final LAW waste form to meet the assumed onsite LAW disposal criteria. Other radioisotopes, such as technetium, could also be removed during separations.

On receiving the waste from the separations operations, the waste would be sent to lag storage tanks within the vitrification facilities where it would be characterized before entering the melter feed section in either the HLW or LAW facility. In this area, the waste would be sampled, evaporated to remove excess water, and provided as a concentrated liquid or slurry feed stream to the melter.

The LAW vitrification facility and its support facilities would be designed to produce 200 mt (220 tons) of vitrified glass per day. This capacity would be provided by two melters operating in parallel, each making 100 mt (110 tons) of glass per day.

The glass product produced by each melter would be a combination of two separate material feed streams, the waste stream, and the glass formers. The energy source providing the heat to the melter would be separate kerosene and oxygen streams supplied directly to the melter. Fuel-fired melters have been included as a representative configuration for analysis in the EIS. Future evaluation may result in selection of another melter configuration. To make suitable glass with acceptable properties for waste immobilization, it has been determined that the LAW glass produced by this alternative would be limited to 15 weight percent sodium oxide in the glass. This means that glass formers would be added to the melter feed to maintain the required sodium oxide loading. Glass formers, primarily silica or sand and boron oxide, are similar to the components used to make commercial glass.

Figure 3.4.11 Ex Situ Intermediate Separations LW/LAW Separations Process Flow Diagram

The molten glass produced in the melter would flow into a water bath tank and be quenched into gravel-sized pieces of glass (referred to as cullet) and placed into containers approximately 1.8 m long by 1.2 m wide by 1.2 m high (6 ft long by 4 ft wide by 4 ft high) for onsite disposal. The engineering data supporting this alternative molten were based on a process that would blend the LAW glass cullet with a matrix material that would surround the glass cullet when placed into the disposal container. Disposing of LAW as glass cullet encapsulated by a matrix material has been included as a bounding condition for transportation and resource analysis in the EIS. Future evaluation of matrix materials and disposal forms may result in selecting other glass forms or eliminating the requirements for matrix materials. The potential benefits of a matrix material and glass cullet combination as a disposal waste form are reduced contaminant release rates and migration rates out of the disposal system. Additional details on matrix materials for LAW glass cullet are presented in Volume Two, Appendix B.

The HLW vitrification facility would be designed to produce 20 mt (22 tons) of HLW glass per day. This would be accomplished by using one electrically heated (joule-heated) melter making vitrified glass at 20 weight percent waste oxide. Following vitrification, the molten glass would be poured directly into a stainless-steel canister. The canisters then would be welded closed, the outside surfaces decontaminated, and the canisters placed into Hanford Multi-Purpose Canisters and transported to onsite storage pads for interim storage. Concrete shielding casks would be placed over the Hanford Multi-Purpose Canisters during interim storage.

Vitrifying waste would generate a large off-gas stream (gaseous air stream containing combustion gases) the would require mitigation measures to minimize air emissions. The off-gas treatment equipment would capture and partially recycle contaminants in the off-gas stream back into the melter feed stream.

3.4.6.3 Construction

New facilities that would be constructed for this alternative would include a HLW vitrification facility, a combined separations and LAW vitrification facility, a LAW disposal facility, an interim HLW storage facility, and multiple support facilities. When completed, the facilities would be in place to remove the waste from the tanks and provide the processing required to produce vitrified HLW for disposal at the potential geologic repository and vitrified LAW for disposal in onsite retrievable disposal vaults. Vitrification support facilities would support functions such as waste retrieval and transfer, utilities, raw material, storage and supply, and operations control. Several facilities and systems would be constructed for the Ex Situ Intermediate Separations alternative.

A retrieval and transfer system would be constructed to provide the facilities and systems to retrieve, blend, and transfer waste to the separations facility, which would include the following:

- Waste transfer annexes that would support sluicing and slurry transfer (two in the 200 East Area and two in the 200 West Area);
- Waste staging and sampling facility in the 200 West Area that would collect and blend batches of waste for cross-site transfer to the separations facility in the 200 East Area;

- 24 SST sluicing systems;
- 24 SST sluicing systems;
- 24 SST sluicing systems;
- Mixer pumps in DSTs (two to four mixer pumps per tank); and
- MUSTs retrieval and transfer system (retrieval similar to SSTs except that transfer would be by truck or container).

Support facilities would be constructed to provide utilities, resources, and personnel support to the vitrification facility, which would include the following:

- Mechanical utilities building (shared utilities);
- Cooling tower that would provide process water cooling;
- Cold chemical facilities that would provide bulk process chemical storage and chemical makeup;
- Warehouses and other support facilities; Operations control and operations support buildings that would provide administrative offices and centralized control rooms; and
- Electrical substation and 2.5 km (1.6 mi) of high-voltage electrical line.

A separation and LAW vitrification facility would be constructed that would separate the waste into HLW and LAW fractions and vitrify the LAW, which would include the following:

- Sludge-washing systems (the first step in the HLW and LAW separation process);
- Waste storage and sampling facility used for waste receipt and lag storage;
- Cesium ion-exchange system that would remove cesium from the liquid stream sent to the LAW vitrification facility;
- Melter feed system that would support the vitrification melter and include an evaporator, waste feed system, glass former handling systems, and fuel and oxygen supply systems;
- Two 100-mt/day (110-ton/day) combustion LAW melters;
- Cullet quench and handling system that would cool and fracture the molten glass into uniform-sized pieces and place them into containers;
- Cullet transport system that would transfer the containers of LAW cullet to the disposal vaults;
- Off-gas system that would collect, treat, and filter process off-gases before discharge; and
- Recycle systems that would recycle contaminants captured in the off-gas system and undersized cullet from the cullet handling system back into the melter feed system.

A LAW disposal facility would be constructed that would provide retrievable disposal of the LAW. This facility would consist of LAW vaults (66 vaults) constructed belowgrade, each with a capacity to hold 5,300 m^3 (7,000 yd^3) of LAW. These vaults would be constructed throughout operational period.

A HLW vitrification facility would be constructed that would include the systems to support the HLW vitrification melter including centrifuges, an evaporator, glass former handling systems, a waste feed system, and an electrical power supply. This HLW vitrification system would include one 20-mt/day (22-ton/day) joule-heated HLW melter; an off-gas system that would collect, treat, and filter process off-gases before being discharged; a canister handling system that would remotely fill canisters with molten glass, weld on a lid, and decontaminate the outer surface of the canister; and recycle streams that would recycle contaminants captured in the off-gas system back into the melter feed system. A HLW interim storage facility also would be constructed that would consist of concrete storage pads for interim storage of the Hanford Multi-Purpose Canisters.

Hanford Barriers would be constructed for LAW retrievable disposal facility and tank farms. Hanford Barrier construction would occur after completion of LAW vitrification, and barrier construction at the tank farms would take place after waste removal and tank stabilization.

3.4.6.4 Operation

Operations for this alternative would take place in a 21-year period between 2001 and 2022 . These dates would comply with the schedule for tank waste treatment in the Tri-Party Agreement. Several activities would take place during the operations period. Waste retrieval would involve the following:

- Sluice 110 SSTs. Sluicing is the preferred waste retrieval method and would be employed in as many tanks as possible where there would not be a high potential for leakage or an expected difficulty in waste recovery (engineering estimates were used to identify the number of SSTs that could be sluiced);
- Robotic arm-based retrieval from 50 SSTs. This recovery method would be employed only for tanks with high leakage potential or difficult waste (11 SSTs would assumed to be subject to both types of retrieval); and
- Slurry pump DST waste supplemented by sluicing or robotic arm-based retrieval if required.

Retrieval and confinement systems would be moved from tank to tank after completing waste retrieval from a tank. The SST sluicing systems would be moved 4 to 5 times during the 21-year operations time period and SST arm-based systems and confinement structures would be moved 4 times.

Waste would be separated to create separate HLW and LAW streams. This would involve sludge washing and enhanced washing with sodium hydroxide; solid/liquid separations evaporating the liquid stream to concentrate waste; and removing cesium from the LAW feed using ion exchange. The separated cesium-containing liquid stream that would come out of the ion-exchange process would be further evaporated and fed into the HLW stream. Waste would be transferred to the separation facility from the waste staging and sampling facility in the 200 West Area or from the transfer annexes in the 200 East Area.

The LAW vitrification facility would be operated to accomplish the following:

- Receive and sample waste;
- Evaporate water from waste and collect evaporator condensate for treatment or reuse for waste retrieval;
- Operate two combustion melters. Fuel-fired melters have been included as a representative process detail for analysis in the EIS. Future evaluation may result in the selection of another melter configuration;
- Quench molten glass to make cullet;
- Size and dry cullet to uniform size for handling; recycle undersize cullet back to melter; and
- Place cullet into disposal containers.

The LAW containers with vitrified cullet would be transported to nearby LAW retrievable disposal vaults.

The HLW vitrification facility would be operated to accomplish the following:

- Receive and sample waste;
- Separate solids and liquid with a centrifuge;
- Evaporate excess water from liquid waste and collect condensate for treatment;
- Operate one joule-heated melter with a capacity of 20 mt/day (22 ton/day);
- Form glass at approximately 20 weight percent waste oxides;
- Pour glass monoliths in 1.17-m^3 (41-ft^3) canisters; and
- Package glass into Hanford Multi-Purpose Canisters, four glass monoliths per canister.

The off-gas treatment system at both HLW and LAW vitrification facilities would be operated to quench and cool off-gas; remove radionuclides and recycle to vitrification process; and destroy nitrogen oxides and recover sulfur from sulfur dioxides.

Liquid effluent from both HLW and LAW vitrification facilities would be treated by transferring liquid effluent to the Effluent Treatment Facility. The liquid effluent would be similar to the 242-A Evaporator condensate liquid that meets current waste acceptance criteria for the Effluent Treatment Facility.

The Hanford Multi-Purpose Canisters containing HLW would be transported to onsite interim storage pads and covered with a shielding casks for long-term storage. The stored canisters would be monitored and maintained through routine surveillance of the 12,200 HLW canisters (3,050 Hanford Multi-Purpose Canisters) pending offsite disposal, and the Hanford Multi-Purpose Canisters would be transported by rail to the potential geologic repository.

3.4.6.5 Post Remediation

To provide a basis for comparison in this EIS, it was assumed that each ex situ alternative would involve the same post-remediation activities. Following remediation, processing facilities would be decontaminated and decommissioned, SSTs and DSTs and ancillary facilities would be filled, and tank farms and LAW disposal vaults would be capped with a Hanford Barrier. Post-remediation activities are discussed in detail in Volume Two, Appendix B. Regulatory compliance aspects of closure are discussed in Section 6.2.

Post-remediation activities would include closing tank farms and decontaminating and decommissioning facilities. Closing tank farms would involve ensuring that the tanks would contain a residual equal to no more than 1 percent of the initial tank inventory and would be stabilized by gravel filling; tank farm structures, such as MUSTs, pump pits, valve boxes, and diversion boxes would be stabilized with grout; and Hanford Barriers would be placed over SSTs, DSTs, and LAW disposal vaults. Facility decontaminating and decommissioning would involve disposing of noncontaminated facilities onsite (entombed in place) and contaminated material and equipment at an onsite low-level waste burial ground.

3.4.6.6 Schedule, Sequence, Cost

A schedule of the major components of the Ex Situ Intermediate Separations alternative is shown in Table 3.4.10. Construction for waste retrieval and transfer would involve installing pipelines between the tanks and the transfer facilities throughout the retrieval period, which explains the difference in the construction periods shown. The cost estimate summary for the Ex Situ Intermediate Separations alternative is shown in Table 3.4.11.

Table 3.4.10 Schedule - Ex Situ Intermediate Separations Alternative

Table 3.4.11 Cost - Ex Situ Intermediate Separations Alternative[1]

3.4.6.7 Implementability

Some of the technologies involved in this alternative would be first-of-a-kind and thus do not have a performance history. Performance histories would provide increased confidence in the feasibility of the technology and cost estimates. Other issues associated with implementing this alternative include the following.

- The waste loading and canister size criteria have not been finalized, and future negotiations could result in different canister sizes and waste loadings. Waste loading in the glass would directly affect the volume of HLW and number of waste packages for disposal.

- The proposed LAW form is unique and has not been used before.
- Performance of key processes (e.g., solid/liquid separation) has been assumed in the absence of substantive data.
- Cost estimates may have a high degree of uncertainty because some of the processes are first-of-a-kind.
- Retrieval criteria based on recovering 99 percent of the waste volume in each tank are uncertain in that hardened sludge present in some tanks may be difficult to retrieve to the extent required to meet the retrieval criteria.
- The disposal criteria for LAW have not been determined. When these criteria are decided on, additional separations steps could be required to meet LAW disposal criteria.
- A performance assessment has not been completed defining the LAW form requirements for storage and disposal at the Hanford Site, and DOE and the Nuclear Regulatory Comission have not yet completed negotiations on what constitutes "incidental waste" for disposal of LAW at the Hanford Site. Additional separations steps therefore may be required to meet LAW disposal criteria.

The design of the HLW vitrification facility would be similar to the vitrification facility built at the DOE Savannah River Site. Following startup of the Savannah River facility, performance data would be available for application to this implementability analysis and enhancement of the alternative design. Other key technology development or demonstration activities identified for the TWRS program include the following:

- Tank retrieval systems design and testing;
- Sludge washing evaluation;
- Solid/liquid separation;
- Cesium ion-exchange evaluation;
- HLW melter testing and evaluation; and
- LAW melter testing and evaluation.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components are adequately treated during waste processing or vitrification.

3.4.7 Ex Situ No Separations Alternative

3.4.7.1 Overview

Under the Ex Situ No Separations alternative, as much of the tank waste as practicable would be recovered from each tank. This is assumed to be 99 percent of the waste volume in each tank. The recovered waste stream then would be vitrified or calcined and placed into containers for disposal at the potential geologic repository. All of the waste would be HLW and there would be no onsite LAW disposal of tank waste associated with this alternative.

Information and data used in describing the Ex Situ No Separations (Vitrification) alternative are from the Site Management and Operations contractor (WHC 1995c, i, n) and the TWRS EIS contractor (Jacobs 1996). Information and data used in describing the Ex Situ No Separations (Calcination) alternative are from the Site Management and Operations contractor (WHC 1995c) and the TWRS EIS contractor (Jacobs 1996).

One processing facility, as well as the support facilities, would be constructed. The HLW vitrification facility would be designed to produce 200 mt (220 tons) of HLW glass per day. The HLW calcination facility would produce 92 mt (100 tons) of HLW calcined briquettes per day. The calcination process would produce about 70 percent less HLW for disposal to the potential geologic repository than the vitrification process. The facilities are assumed to be located on the representative site in the 200 East Area similar to those shown for Ex Situ Intermediate Separations alternative (Figure 3.4. 6). The following major operations are associated with waste treatment under this alternative:

- Retrieve waste;
- Vitrify or calcine the HLW;
- Place vitrified or calcined HLW in canisters;
- Place the canisters into Hanford Multi-Purpose Canisters for interim storage and shipment; and
- Ship the Hanford Multi-Purpose Canisters by rail to the potential geologic repository.

Following the treatment phase, the processing facilities and storage tanks would be decontaminated and decommissioned. Contaminated materials and equipment from the processing facilities would be disposed of onsite in the low-level waste burial grounds. Noncontaminated materials and equipment from the processing facility would be entombed in place. Closure activities, including filling the tanks and constructing Hanford Barriers, would be performed at the tank farms.

3.4.7.2 Process Description

The first step in waste processing would be to recover and transfer the waste from the storage tanks to the treatment facility. The waste recovery function would retrieve and blend waste to provide, as close as possible, an average or blended feed stream that would be transferred to the vitrification or calcination facility. A recovery rate of a minimum of 99 percent of the tank contents is a requirement for the retrieval function. The waste retrieval and transfer process for the Ex Situ No Separations alternative would be identical (without radioisotopic separation) to the process for the Ex Situ Intermediate Separations alternative (Section 3.4.6.2).

The waste received from the retrieval operations would be sampled, evaporated to remove excess water, and provided as a slurry feed stream to the melter or calciner in the HLW facility.

Vitrification Process

The HLW vitrification facility and its support facilities would be designed to produce 200 mt (220 tons) of vitrified glass per day. This capacity would be provided by two melters operating in parallel, each making 100 mt (110 tons) of glass per day.

The glass product produced by each melter would be a combination of two separate material feed streams, the waste stream and the glass formers. The energy source providing the heat to the melter would be separate kerosene and oxygen streams supplied directly to the melter. Fuel-fired melters have been included as a representative configuration for analysis in the EIS. Future evaluation could result in selection of another melter configuration. To make suitable glass with acceptable properties for waste immobilization, the HLW glass produced by this alternative would be limited to 20 weight percent sodium oxide in the glass. The glass formers, primarily silica or sand and calcium oxide, would be added to make a soda-lime glass and maintain the required sodium oxide loading.

The molten glass produced in the melter would flow into a water bath quench tank producing gravel-like glass cullet. The cullet would be screened for proper size, loaded into 10-m^3 (360-ft^3) stainless-steel canisters, and then placed into Hanford Multi-Purpose Canisters for interim storage and transport to the potential geologic repository.

Vitrifying waste would generate a large off-gas stream requiring mitigation measures to minimize air emissions. Treatment equipment would capture and recycle contaminants from the off-gas systems back into the melter feed stream.

Calcination Process

Calcination would heat precipitates or residues to a temperature high enough to break down chemical compounds such as hydroxides or nitrates. It differs from vitrification in that calcination temperatures would not necessarily cause the reacting materials to melt and form a glass. The final form of the calcined waste would be a dry powder material that would be hot processed in a roll-type compactor machine to produce small pellets or briquettes of high bulk density that would be loaded into 10-m^3 (360-ft^3) canisters, seal welded, and then placed into Hanford Multi-Purpose Canisters for interim storage and transport to the potential geologic repository.

The HLW calcination facility and its support facilities would be designed to produce 92 mt (100 tons) of calcined waste per day. This capacity would be provided by two spray calciners operating in parallel, each making 46 mt (50 tons) of calcined waste product per day. The same quantity of tank waste would be fed to the calciners as fed to the glass melters each day.

The prepared waste feed stream would be blended with sugar and pumped to the feed nozzles of a spray calciner, which would be externally heated by fuel-fired burners. The sugar supplied to the feed would act as a reducing agent to decompose the nitrate and nitrite in the waste to nitrogen oxides, carbon oxides, and water vapor. The atomized waste droplets would be dried through evaporation, and the remaining solids would react to release the gaseous decomposition products. The solid particles then would be collected in a tank and held at a temperature to allow further reaction. The product would be discharged to a roll-type compactor machine to produce small briquettes. The waste briquettes would be screened to remove the fines, if any, and then would be transported to the HLW cyclone bin by an air-cooled conveyor. The calcined product next would be transferred to a canister filling operation, where it would be placed in 10-m^3 (360-ft^3) canisters, identical to the canisters described for the Vitrification Process. The canisters would be welded shut, decontaminated, and placed in Hanford Multi-Purpose Canisters for interim storage and subsequent transport to the potential geologic repository.

Calcining waste would generate a large off-gas stream that would require mitigation measures to minimize air emissions. Treatment equipment would capture and recycle contaminants from the off-gas stream back into the calciner feed stream, if required. The calcined fines from the dust collection screen and hot gas filtering would be returned to the waste product tank as feed to the roll-type compactor machine.

3.4.7.3 Construction

New facilities that would be constructed for this alternative would include a HLW processing facility and multiple support facilities. A retrieval and transfer system identical to the system described for the Ex Situ Intermediate Separations alternatives (Section 3.4.6) would be constructed. When completed, the facilities would be in place to remove the waste from the tanks and provide the processing required to produce vitrified or calcined HLW. Support facilities similar to those described for the Ex Situ Intermediate Separations alternative (Section 3.4.6) would be constructed. Support facilities would supply waste retrieval and transfer, utilities, raw material, and operations control to the HLW processing facility.

A HLW processing facility would be constructed to include the systems to support the HLW vitrification melter including an evaporator, glass former handling system, and fuel and oxygen supply system. This HLW processing facility would include two combustion melters operating in parallel; a treated waste handling system that would remotely place the vitrified waste into canisters; and an off-gas system that would collect, treat, and filter process off-gases before being discharged.

A HLW processing facility would be constructed to include the systems to support the HLW calciner, including an evaporator, sugar addition system (dry bulk), fuel, oxygen, and hot gas filter system. This HLW processing facility would include two radiant heat spray calciners operating in parallel; a treated waste handling system that would remotely place the calcined waste into canisters; a roll-type compactor to densify the calcined product into briquettes; and an off-gas system that would collect, treat, and filter process off-gases before being discharged.

A HLW interim storage facility would be constructed consisting of concrete storage pads for interim HLW canister storage. In addition, Hanford Barriers for the tank farms would be installed after waste removal and tank stabilization.

3.4.7.4 Operation

Operations for this alternative would take place during a 17-year period between 2003 and 2020. Operations are the actions required to treat, store, and transport the waste. Several major activities would take place during the operations period. Waste would be retrieved and transferred in the same manner described for the Ex Situ Intermediate Separations alternatives (Section 3.4.6).

- A HLW vitrification facility (vitrification option) would be operated to accomplish the following.
- Receive and sample waste;
- Evaporate excess water from waste;
- Collect evaporator condensate for treatment;
- Operate two combustion melters;
- Form glass at approximately 20 weight percent sodium oxide;
- Quench molten glass to make cullet;
- Size and dry cullet to uniform size for handling, recycle undersize cullet back to melter; and
- Place cullet into 10-m^3 (360-ft^3) canisters and overpack canisters into Hanford Multi-Purpose Canisters for storage and handling.

A HLW calcination facility (calcination option) would be operated to accomplish the following.

- Receive and sample waste;
- Evaporate water from waste;
- Collect evaporator condensate for treatment;
- Operate spray calciners; and
- Place calcined product into 10-m^3 (360-ft^3) canisters and overpack canisters into Hanford Multi-Purpose Canisters for storage and handling.

An off-gas treatment system at the HLW facilities would be operated to quench and cool off-gas; remove radionuclides and recycle to process; and destroy nitrogen oxides and recover sulfur from sulfur dioxides.

Liquid effluent from HLW facilities would be treated by transferring liquid effluent to a retention basin for later transfer to the Effluent Treatment Facility. The HLW multi-purpose canisters would be transported to onsite interim storage pads. Stored canisters would be monitored and maintained through routine surveillance of the 29,100 HLW canisters of vitrified glass or 10,300 HLW canisters of calcined waste in interim storage pending offsite disposal. Hanford Multi-Purpose Canisters would be transported to the potential geologic repository.

3.4.7.5 Post Remediation

Following waste treatment operations, the tank farms would be closed and processing facilities decontaminated and decommissioned. Closing tank farms would involve ensuring that tanks contained a residual less than or equal to approximately 1 percent of the initial tank inventory; stabilizing tanks by gravel filling; stabilizing tank farm structures such as MUSTs, pump pits, valve boxes, and diversion boxes would be with grout or gravel; and placing Hanford Barriers over SSTs and DSTs.

Facility decontaminating and decommissioning activities would involve disposal of noncontaminated facilities onsite (entombed in place), and disposal of contaminated material and equipment at the onsite low-level waste burial ground.

3.4.7.6 Schedule, Sequence, Cost

A schedule of the major components of the Ex Situ No Separations alternative is shown in Table 3.4.12. Construction for waste retrieval and transfer would involve installing pipelines between the tanks and the transfer facilities throughout the retrieval period, which explains the difference in the construction periods shown. The cost estimate summary for the Ex Situ No Separations (Vitrification) alternative is shown in Table 3.4.13. The cost estimate summary for the Ex Situ No Separations (Calcination) alternative is shown in Table 3.4.14.

Table 3.4.12 Schedule Ex Situ No Separations (Vitrification or Calcination) Alternative

Table 3.4.13 Cost - Ex Situ No Separations (Vitrification) Alternative [1]

3.4.7.7 Implementability

Some technologies involved in this alternative would be first-of-a-kind and thus do not have a performance history. Performance histories would provide increased confidence in the feasibility of technology and cost estimates.

Table 3.4.14 Cost - Ex Situ No Separations (Calcination) Alternative [1]

Other issues would be associated with implementing this alternative. First, the vitrification option would have the same uncertainties as those listed for the Ex Situ Intermediate Separations alternative (Section 3.4.6). In addition, this alternative would result in a large volume of HLW. Second, calcination using sugar as a reducing agent on Hanford Site tank waste has had limited laboratory testing, and the proposed facilities, such as off-gas treatment, are conceptual. Calcination as a unit operation has been in use for many years on an industrial scale. The processing steps described for this alternative have been based on experience and engineering judgement. Third, the largest cost item for the Ex Situ No Separations (Vitrification) alternative would be the repository fee associated with disposal of the large volume of HLW.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste, assuming that the hazardous waste components were adequately treated during waste processing and vitrification or calcining. However, neither of the HLW forms (soda-lime glass and calcine) meet the current standard waste form (borosilicate glass) specified in the waste acceptance requirements for the potential geologic repository. The glass cullet waste form assumed for vitrification, with its high surface area to volume ratio, may not be acceptable for disposal at the potential geologic repository. The compacted powder calcine also would not meet the waste acceptance requirement for immobilization of particulates. In addition, the number of canisters of HLW produced under this alternative would greatly exceed the defense HLW limit of the first potential geologic repository (Volume One, Section 6.2).

3.4.8 Ex Situ Extensive Separations Alternative

3.4.8.1 Overview

The Ex Situ Extensive Separations alternative would be similar to the Ex Situ Intermediate Separations alternative except that multiple complex chemical separations processes would be performed to separate the HLW components from the recovered tank waste. These separations processes would concentrate and provide a smaller volume of HLW for disposal at the potential geologic repository, while at the same time provide a LAW that contained lower concentrations of radioactive contaminants than the Ex Situ Intermediate Separations alternative. Information and data used in describing the Ex Situ Extensive Separations alternative are from the Site Management and O perations contractor (WHC 1995e, i, n) and the TWRS EIS contractor (Jacobs 1996).

The Ex Situ Extensive Separations alternative would be similar to the Ex Situ Intermediate Separations alternative in that the waste recovered from the SSTs, DSTs, and MUSTs would be separated into HLW and LAW streams. The HLW would be vitrified and placed into canisters. The LAW would be vitrified and placed into onsite near-surface vaults for retrievable disposal.

3.4.8.2 Process Description

The first step in waste processing would be to recover and transfer the waste from the storage tanks to the separations facility. The waste recovery function would retrieve and blend waste to provide, as close as possible, an average or blended feed stream that would be transferred to the combined separations and HLW vitrification facility. A minimum recovery rate of 99 percent of the tank contents is a requirement for retrieval. The waste retrieval and transfer process for the Extensive Separations alternative would be identical to the process for the Ex Situ Intermediate Separations alternative (Section 3.4.6).

The term separations describes the process of separating the waste stream into HLW and LAW streams. Separations would split the waste volume into a smaller HLW fraction and a larger LAW fraction. This would reduce the volume of HLW requiring costly disposal at the potential geologic repository. The Ex Situ Extensive Separations alternative would include multiple processing steps for separating the tank waste, including the following.

- Cross-flow filters and centrifuges would be used to perform liquid-solid separations.
- Caustic leaching would be used to decrease the high-level solids fraction followed by additional sludge washing and liquid/solids separation.
- Acid dissolution would be used to dissolve the HLW solids.
- Solvent extracting and ion exchanging of acidic solutions would be used to concentrate HLW radionuclides.
- Ion exchange would be used to remove cesium, strontium, and technetium from the alkaline LAW stream.
- Recycling water, nitric acid, and sodium hydroxide would be used to reduce LAW volumes.

Following receipt of waste from the separations operations, the waste would enter the melter feed section in either the HLW or LAW facility. In this area of each facility, the waste would be sampled, evaporated to remove the excess water, and provided as a slurry feed stream to the melter.

The LAW vitrification facility and its support facilities would be designed to produce 200 mt (220 tons) of vitrified glass per day. This capacity would be provided by two combustion melters operating in parallel, each making 100 mt (110 tons) of glass per day. Fuel-fired melters have been included as a bounding condition for analysis in the EIS. Future evaluation may result in the selection of another melter configuration.

The glass product produced by each melter would be a combination of two separate material feed streams, the waste stream, and the glass formers. The energy source providing the heat to the melter would be separate kerosene and oxygen streams supplied directly to the melter. To make suitable glass with acceptable properties for waste immobilization, it has been determined that the LAW glass produced by this alternative would contain approximately 15 weight percent sodium oxide. Glass formers (primarily silica or sand and boron oxide), would be added to the melter feed to maintain the required oxide loading.

The molten glass produced in the melter would flow into a water bath tank and be quenched into gravel-like cullet, placed into large disposal containers, and transported to onsite near-surface vaults for disposal. The engineering data supporting this alternative were based on a process that would blend the LAW glass cullet with a matrix material before it was placed into the disposal containers. Disposing of LAW as glass cullet in a matrix material has been included as a bounding condition for analysis in the EIS. Future evaluation of matrix materials and disposal forms could result in selecting other glass forms, alternate matrix materials, or disposal without a matrix material.

The HLW vitrification facility would be designed to produce 1 mt (1.1 tons) of HLW glass per day. This would be accomplished using one electrically heated (joule-heated) melter making a vitrified glass containing approximately 20 weight percent waste oxides. Following vitrification, the molten glass would be poured directly into stainless-steel canisters. The canisters then would be welded shut, the outside surfaces decontaminated, and they would be placed into Hanford Multi-Purpose Canisters.

The sealed units would be transported to onsite interim storage pads where they would be covered with concrete shielding casks pending future transport to the potential geologic repository.

Vitrifying waste would generate a large off-gas stream requiring mitigation measures to minimize air emissions. Treatment equipment would capture and recycle contaminants from the off-gas stream back into the melter feed stream.

3.4.8.3 Construction

New facilities that would be constructed for this alternative would include a combined HLW vitrification and separations facility, a LAW vitrification facility, and multiple support facilities.

A retrieval and transfer system identical to the system described for the Ex Situ Intermediate Separations alternative (Section 3.4.6) would be constructed. When completed, the facilities would be in place to remove the waste from the tanks and provide the processing required to produce vitrified HLW for disposal at the potential geologic repository and vitrified LAW for disposal in onsite near-surface retrievable disposal vaults. Support facilities similar to those described for the Ex Situ Intermediate Separations alternative (Section 3.4.6) would be constructed. Support facilities would provide support functions to the vitrification facility, such as waste retrieval and transfer, utilities, raw material, and operations control. The facilities are assumed to be located on the representative site in the 200 East Area similar to those shown for the Ex Situ Intermediate Separations alternative (Figure 3.4. 6).

A combined separations and HLW vitrification facility would be constructed and include the following:

- Separations facility that would perform the 15-unit separations processes;
- Melter feed system, which would provide the melter with an evaporated waste feed stream, and a stream of glass formers;
- Single 1-mt/day (1.1-ton/day) joule-heated HLW melter;
- Off-gas system that would collect, treat, and filter process off-gases before release;
- Canister handling system that would remotely fill canisters with molten glass; and
- Recycle systems that would recycle contaminants captured in the off-gas system back into the melter feed system.

A LAW vitrification facility would be constructed and include the following:

- Melter feed system that would include an evaporator, a glass former handling system, and a fuel and oxygen supply system to fire the melter;
- Two 100-mt/day (110-ton/day) combustion melters;
- Cullet quench and handling system that would cool and fracture the molten glass into uniform-sized pieces (cullet) and place them in disposal containers;
- Cullet transport system that would transfer the LAW cullet in disposal containers to the disposal vaults;
- Off-gas system that would collect, treat, and filter process off-gases before discharge; and
- Recycle systems that would recycle contaminants captured in the off-gas system and undersized cullet from the cullet handling system back into the melter feed.

A LAW disposal facility would be constructed that would provide for retrievable disposal of the LAW. Vaults would be constructed throughout the operational period (66 vaults), and vaults would be belowgrade with a capacity of 5,300 m^3 (7,000 yd^3) each.

A HLW interim storage facility would be constructed that would consist of concrete storage pads for interim storage of the Hanford Multi-Purpose Canisters.

Hanford Barriers for the LAW disposal facility and tank farms would be installed. Barrier construction for disposal vaults would commence after completion of LAW vitrification, and barrier construction for tank farms would take place after completion of waste removal and tank stabilization.

3.4.8.4 Operation

Operations for this alternative would take place in a 20-year period between the years 2003 and 2023. Several major activities would take place during the operations period. Waste would be retrieved in the same manner described for the Ex Situ Intermediate Separations alternative (Section 3.4.6). Waste would be separated as follows into HLW and LAW streams:

- Sludge wash to remove water-soluble fractions;
- Caustic leach to decrease the high-level solids fraction;

- Acid dissolution to dissolve HLW solids;
- Solvent extraction and ion exchange of acidic solutions;
- Ion exchange of alkaline solutions; and
- Recycling to reduce LAW volumes.

The LAW vitrification facility would be operated to accomplish the following.

- Receive and sample waste;
- Evaporate excess water from waste;
- Collect evaporator condensate for treatment;
- Operate two combustion melters (feed streams of oxygen, kerosene, waste, and glass formers);
- Form glass at approximately 15 weight percent sodium oxide;
- Quench molten glass to make cullet; and
- Size and dry cullet to uniform size for handling, and recycle undersize cullet back to melter.

Vitrified cullet would be placed into disposal containers and transported to nearby LAW disposal vaults.

The HLW vitrification facility would be operated to accomplish the following.

- Receive and sample waste;
- Evaporate water from waste;
- Collect evaporator condensate for treatment;
- Operate one joule-heated melter
- Form glass at approximately 20 weight percent waste oxides;
- Pour glass monoliths 0.6 m (2 ft) in diameter by 4.5 m (15 ft) long; and
- Overpack glass into Hanford Multi-Purpose Canisters, four glass monoliths per canister.

The off-gas treatment system at both HLW and LAW vitrification facilities would be operated to quench and cool off-gas, remove radionuclides and recycle to vitrification process, and destroy nitrogen oxides. The LAW vitrification facility also would recover sulfur from the sulfur oxides.

Liquid effluent would be transferred from the HLW and LAW vitrification facilities to the Effluent Treatment Facility. The HLW multi-purpose canisters would be transported to interim storage pads. Stored canisters would be monitored and maintained through routine surveillance of the Hanford Multi-Purpose Canisters in interim storage pending offsite disposal, and Hanford Multi-Purpose Canisters would be transported to the potential geologic repository.

3.4.8.5 Post Remediation

Following waste treatment operations, the tank farms would be closed and processing facilities would be decontaminated and decommissioned. Closing tank farms would involve ensuring that the tanks contained a residual less than or equal to approximately 1 percent of the initial tank inventory; stabilizing tanks by gravel filling; stabilizing tank farm structures such as pump pits, valve boxes, and diversion boxes with grout or gravel; and placing Hanford Barriers over SSTs, DSTs, and LAW burial vaults.

Facility decontaminating and decommissioning activities would involve disposal of noncontaminated facilities onsite (entombed in place), and disposal of contaminated material and equipment at the onsite low-level waste burial grounds.

3.4.8.6 Schedule, Sequence, Cost

A schedule of the major components of the Ex Situ Extensive Separations alternative is shown in Table 3.4.15. Construction for waste retrieval and transfer would involve installing pipelines between the tanks and the transfer facilities throughout the retrieval period, which explains the difference in the construction periods shown. The cost estimate summary for the Ex Situ Extensive Separations alternative is shown in Table 3.4.16.

Table 3.4.15 Schedule - Ex Situ Extensive Separations Alternative

Table 3.4.16 Schedule - Ex Situ Extensive Separations Alternative

3.4.8.7 Implementability

The Ex Situ Extensive Separations alternative would have the same uncertainties as the Ex Situ Intermediate Separations alternative, plus additional uncertainties associated with the chemical separations processes (Section 3.4.6.7). The key implementability issue associated with this alternative is that the performance of key separations processes has been assumed in the absence of substantive data. Further testing and development would be required to determine if the processes would function as intended to make the required separations.

The HLW canisters produced under this alternative would have a higher thermal loading than other alternatives and the assumed method of interim onsite storage, which would rely on dry storage with passive cooling, would require further evaluation. This alternative could require using a storage facility with active cooling to remove decay heat generated by the vitrified HLW.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components were adequately treated during waste processing and vitrification.

3.4.9 Ex Situ/In Situ Combination 1 and 2 Alternatives

3.4.9.1 Overview

The e x s itu/i n s itu c ombination alternatives were developed to assess the impacts that would result if a combination of two or more of the tank waste alternatives were selected for implementation. Because the tank waste differs greatly in the physical, chemical, and radiological characteristics, it might be appropriate to implement different alternatives for different tanks. There are a wide variety of potential combinations of alternatives that could be developed and criteria that could be used to select a combination of alternatives for implementation. Two ex situ/ i n situ c ombination alternatives were developed to bound the impacts that could result from a combination of alternatives, and are intended to represent a variety of potential alternative combinations that could be developed to remediate the tank waste.

The Ex Situ/In Situ Combination 1 and 2 alternatives represent a combination of the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives (Figure 3.4.12). Tanks would be evaluated on a tank-by-tank basis to determine the appropriate remediation method based on the contents of the tanks. The objective would be to effectively treat the tank waste in a manner that has acceptable risk and less overall cost than using the Ex Situ Intermediate Separations alternative for all tanks. This objective could be achieved by selecting tanks for ex situ treatment based on their contribution to post-remediation risk. The tanks that were not selected for ex situ treatment would be treated in situ by filling and capping. Two Ex Situ/In Situ Combination alternatives exist, one based on the recovery of approximately 90 percent of the long-term risk contaminants and the other based on recovery of approximately 85 percent of the long-term risk contaminants. See Volume Two, Section B.3.8 for discussion on tank selections methodology

Ex Situ/In Situ Combination 1

Waste from tanks selected for ex situ treatment would be retrieved and transferred to processing facilities for treatment. Closure activities would consist of filling those tanks selected for ex situ treatment with gravel and constructing a Hanford Barrier over all tank farms and the LAW retrievable disposal vaults from ex situ treatment. Approximately one-half of the volume of the tank waste would be treated using the ex situ method and one-half would be treated using the in situ method.

By selecting the appropriate tanks for ex situ treatment, approximately 90 percent of the contaminants that contribute to long-term risk would be disposed of ex situ while retrieving only 50 percent of the waste (Jacobs 1996). The process used to determine which tank waste would be retrieved for the purpose of analyzing this alternative is described in Volume Two, Appendix B. The human health risk associated with selectively retrieving tanks is discussed in Section 5.0.

Ex Situ/In Situ Combination 2

Waste from tanks selected for ex situ treatment would be retrieved and transferred to processing facilities for treatment. Closure activities would consist of filling those tanks selected for ex situ treatment with gravel and constructing a Hanford Barrier over all tank farms and the LAW retrievable disposal vaults from ex situ treatment. Approximately one-quarter of the volume of the tank waste would be treated using the ex situ method and three-quarters would be treated using the in situ method.

Figure 3.4.12 Ex Situ/In Situ Combination (1 and 2) Alternatives

By selecting the appropriate tanks for ex situ treatment, approximately 85 percent of the contaminants that contribute to long-term risk would be disposed of ex situ while retrieving only 25 percent of the waste (Jacobs 1996). The purpose of developing the Ex Situ/In Situ Combination 2 alternative was to analyze lower cost methods for remediation of the tank waste while maintaining long-term risk reduction. The process used to determine which tank waste would be retrieved for the purpose of analyzing this alternative is described in Volume Two, Appendix B. The human health risk associated with selectively retrieving tanks is discussed in Section 5.0.

3.4.9.2 Process Description

Ex Situ/In Situ Combination 1

The waste that would be retrieved for ex situ treatment would be treated using the process identified for the Ex Situ Intermediate Separations alternative (Section 3.4.6). The retrieved waste stream would be separated into HLW and LAW streams. Separations processes would include liquid solid separations followed by cesium recovery from the liquid stream, which would be fed back into the high-level stream. Both HLW and LAW streams would be vitrified in separate vitrification facilities. The HLW facility would be designed to produce 8 mt/day (8.8 tons/day) and the LAW facility would be sized to produce 120 mt/day (130 tons/day).

Following vitrification, the HLW would be poured into canisters. The canisters would be overpacked into Hanford Multi-Purpose Canisters (Figure 3.4.13) for onsite interim storage. The LAW would be quenched into gravel-like cullet, placed into disposal containers, and transported to onsite vaults for near-surface disposal. The engineering data supporting this alternative were based on a process that would blend the LAW glass cullet with a matrix material before placing it into the disposal containers. Disposing of LAW as glass cullet in matrix material has been included as a representative condition for analysis in the EIS. Future evaluation of matrix materials and disposal forms could result in selecting other glass forms, alternate matrix materials, or elimination of the matrix material.

Tanks not selected for retrieval would be treated in situ using the In Situ Fill and Cap process (Section 3.4.4). This process would involve reducing the DST liquid using the 242-A Evaporator, filling the tanks with gravel, and installing a Hanford Barrier over the tank farms.

Existing MUSTs (both inactive and active) would be filled with grout to stabilize the waste. All MUSTs would be covered with a Hanford Barrier during post remediation.

Figure 3.4.13 Hanford Multi-Purpose Canister (HMPC) System for High-Level Waste

Ex Situ/In Situ Combination 2

The waste that would be retrieved for ex situ treatment would be treated using the process identified for the Ex Situ Intermediate Separations alternative (Section 3.4.6). The retrieved waste stream would be separated into HLW and LAW streams. Separations processes would include liquid solid separations followed by cesium recovery from the liquid stream, which would be fed back into the HLW stream. Both HLW and LAW streams would be vitrified in separate vitrification facilities. The HLW facility would be designed to produce 5 mt/day (5.5 tons/day) and the LAW facility would be sized to produce 70 mt/day (77 tons/day).

Following vitrification, the HLW would be poured into canisters. The canisters would be overpacked into Hanford Multi-Purpose Canisters (Figure 3.4.13) for interim onsite storage and eventual transport to the potential geological repository. The LAW would be quenched into gravel-like cullet, placed into disposal containers, and transported to onsite vaults for near-surface disposal. The engineering data supporting this alternative were based on a process that would blend the LAW glass cullet with a matrix material before placing it into the disposal containers.

Tanks not selected for retrieval would be treated in situ using the In Situ Fill and Cap process

(Section 3.4.4). This process would involve reducing the DST liquid using the 242-A Evaporator, filling the tanks with gravel, and installing a Hanford Barrier over the tank farms. Existing MUSTs (both inactive and active) would be filled with grout to stabilize the waste. All MUSTs would be covered with a Hanford Barrier during post remediation.

3.4.9.3 Construction

Ex Situ/In Situ Combination 1

Construction activities required for this alternative would involve constructing all of the facilities identified for the Ex Situ Intermediate Separations alternative and the In Situ Fill and Cap alternative, but on a reduced scale. For the ex situ portion, the volume of waste requiring treatment and immobilization would come from approximately 70 tanks instead of 177 tanks. In situ treatment would be required for the remaining tanks.

The following major activities would take place during the construction phase for the ex situ component of the Ex Situ/In Situ Combination 1 alternative.

- Install retrieval and transfer facilities.
- Construct separations (pretreatment) facilities.
- Construct an 8-mt/day (8.8-ton/day) HLW vitrification facility.
- Construct a HLW interim storage facility.
- Construct a 120-mt/day (130-ton/day) LAW vitrification facility.
- Construct a LAW disposal facility (vaults).

For the in situ component of this alternative, construction activities would involve installing gravel handling systems, constructing gravel storage sites for stockpiles, and modifying tank openings to accommodate gravel handling equipment.

Ex Situ/In Situ Combination 2

Construction activities required for this alternative would involve constructing all of the facilities identified for the Ex Situ Intermediate Separations alternative and the In Situ Fill and Cap alternative, but on a reduced scale. For the ex situ portion, the volume of waste requiring treatment and immobilization would come from approximately 25 tanks instead of 177 tanks. In situ treatment would be required for the remaining tanks.

The following major activities would take place during the construction phase for the ex situ component of the Ex Situ/In Situ Combination 2 alternative.

- Install retrieval and transfer facilities.
- Construct separations (pretreatment) facilities.
- Construct a 5-mt/day (5.5-ton/day) HLW vitrification facility.
- Construct a HLW interim storage facility.
- Construct a 70-mt/day (77-ton/day) LAW vitrification facility.
- Construct a LAW disposal facility (vaults).

For the in situ component of this alternative, construction activities would involve installing gravel handling systems, constructing gravel storage sites for stockpiles, and modifying tank openings to accommodate gravel handling equipment.

3.4.9.4 Operations

Operations for the Ex Situ/In Situ Combination 1 and 2 alternatives would be a combination of the operations described for the Ex Situ Intermediate Separations alternative in Section 3.4.6 and the In Situ Fill and Cap alternative in Section 3.4.4, but on a reduced scale.

Waste retrieved from the tanks for treatment would be retrieved and processed in the same manner as described for extensive retrieval. The operation would be scaled down to accommodate the smaller waste volume to be treated.

Those tanks not selected for ex situ treatment would be remediated using the process described for the In Situ Fill and Cap alternative. The DST liquid in those tanks not selected for retrieval would be retrieved and reduced in the 242-A Evaporator. Following waste reduction operations for the DSTs, the tanks would be stabilized by filling with gravel.

3.4.9.5 Post Remediation

After remediation, tank farm closure and decontamination and decommissioning would take place. Tank farm closure would involve the following activities. First, retrieved tanks would be stabilized with gravel (in situ tanks would have been stabilized during in situ operations). Second, tank farm structures such as MUSTs, pump pits, valve boxes, and diversion boxes would be stabilized with grout. Finally, Hanford Barriers would be constructed over SSTs, DSTs, and LAW retrievable disposal vaults.

Decontamination and decommissioning of equipment and facilities would include disposing of noncontaminated material by in place entombing onsite and disposing of contaminated equipment and materials at the onsite low-level waste burial grounds.

3.4.9.6 Schedule, Sequence, Cost

Ex Situ/In Situ Combination 1

A schedule for the major components of the Ex Situ/In Situ Combination 1 selective retrieval alternative is shown in Table 3.4.17. This schedule covers both in situ and ex situ portions of the alternative. The estimated cost for this alternative is provided in Table 3.4.18.

Ex Situ/In Situ Combination 2

A schedule for the major components of the Ex Situ/In Situ Combination 2 alternative is shown in Table 3.4.19. This schedule covers both in situ and ex situ portions of the alternative. The estimated cost for this alternative is provided in Table 3.4.20.

Table 3.4.17 Schedule - Ex Situ/In Situ Combination 1 Alternative

Table 3.4.18 Cost - Ex Situ/In Situ Combination 1 Alternative [1]

Table 3.4.19 Schedule - Ex Situ/In Situ Combination 2 Alternative

3.4.9.7 Implementability

Because this alternative represents a combination of alternatives, the implementability issues would be a combination of those issues identified for the implementability of both the In Situ Fill and Cap alternative and the Ex Situ Intermediate Separations alternative (Sections 3.4.4 and 3.4.6). Developing acceptable tank selection criteria would be an issue unique to the ex situ/in situ combination concept and would require more complete and accurate waste characterization than currently exists.

Implementability issues relating to both the in situ and ex situ portions of this alternative would include the following.

- LAW form (glass cullets in a matrix material) is unique and has not been used before.
- Successful performance of key processes (e.g., sludge washing) has been assumed in the absence of substantive data.
- Final design of a combination alternative would consider retrieval and treatment of all DST liquids.
- Cost estimates could have a high degree of uncertainty because these would be first-of-a-kind systems.
- The ability to achieve retrieval criteria based on recovering 99 percent of the waste volume in each tank would be uncertain.

- Incidental blending of waste during retrieval would be more uncertain for the ex situ/in situ combination alternatives because fewer tanks would be subject to retrieval. The affect of blending on HLW volumes for the combination alternatives would require further evaluation.
- Additional separations steps could be required to meet LAW disposal criteria.

The in situ portion of this alternative would not meet the RCRA land disposal requirements for hazardous waste or DOE policy to dispose of readily retrievable HLW in a geologic repository. The ex situ portion of the alternative would meet all regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components are adequately treated during processing or vitrification.

3.4.10 Phased Implementation Alternative

3.4.10.1 Overview

The Phased Implementation alternative includes remediating the tank waste in two phases. The first phase would be a demonstration of the separations and immobilization processes for selected tank waste. The second phase would involve scaling-up the demonstration processes and constructing larger treatment facilities to remediate the remaining tank waste.

This two-phased implementation approach could be applied to any of the tank waste alternatives involving ex situ waste treatment. However, for the purposes of analysis, the processes and activities described for the Ex Situ Intermediate Separations alternative, with some additional separations, was selected as the basis for developing the Phased Implementation alternative. This basis included vitrified glass cullet as a LAW form and vitrified borosilicate glass as a HLW form. Other types of glass or wastes forms could be selected for HLW or LAW treatment; however, they would have to meet the repository acceptance criteria or performance assessment criteria. The Phased Implementation alternative is presented in two parts; Phase 1 first, then Phase 2.

This alternative also could be implemented by decommissioning the two demonstration-scale facilities after the demonstration phase and constructing and operating two larger size facilities. The environmental impacts of each approach would be approximately the same.

Phase 1

During Phase 1, readily retrievable and well-characterized DST waste would be retrieved and processed in two separate demonstration facilities. The waste processed during Phase 1 could also include selected SST waste. One of the facilities would process liquid waste to produce immobilized LAW, while the other facility would produce immobilized LAW and vitrified HLW. The facility for both LAW and HLW immobilization could be constructed as separate facilities. Information used in describing this alternative was developed by the TWRS EIS contractor (Jacobs 1996).

The immobilized LAW would be sealed in containers at the treatment facilities and then transported to an interim onsite storage facility where it would be stored for disposal during Phase 2. The vitrified HLW would be placed in canisters and transported to an interim onsite storage facility, where it would be stored awaiting shipment and disposal at the potential geologic repository.

During Phase 1, canisters of vitrified HLW and canisters of separated radionuclides would be placed into shipping casks and transported to the onsite Canister Storage Building for interim storage. Each canister would be placed into a storage tube in one of the Canister Storage Building vaults. The Canister Storage Building is located in the 200 East Area and was constructed as an interim storage facility. The NEPA analysis for construction of the Canister Storage Building was performed under the K Basins Spent Nuclear Fuel EIS (DOE 1995j).

The Phase 1 immobilized LAW would be placed into disposal containers and transported to the existing grout vaults for interim storage until the permanent onsite disposal vaults were constructed during Phase 2. The NEPA analysis for the construction of the grout vaults was previously performed in the Hanford Defense Waste EIS (DOE 1987). The LAW placed in interim storage during Phase 1 would be retrieved and transported to the LAW disposal vaults during Phase 2.

Each of the LAW treatment facilities would operate for a 10-year period. The HLW treatment facility would operate for a 6-year period, which could be extended to a 10-year period.

The following operations would be implemented under Phase 1.

- Retrieve selected liquid waste for LAW processing.
- Retrieve selected DST and SST waste for HLW processing.
- Transfer liquid waste to receiver tanks.
- Transfer selected waste for HLW processing directly to the HLW facility.
- Perform separations to remove cesium, technetium, strontium, transuranic elements, and sludge from the LAW stream.
- Store separated cesium and technetium at the treatment facilities or package and transport to the Canister Storage Building for onsite interim storage pending future HLW waste treatment.
- Return the sludge, strontium, and transuranic waste separated prior to LAW processing to DSTs for storage.
- Immobilize the LAW and vitrify the HLW.
- Place the vitrified HLW into canisters.
- Place the immobilized LAW into containers.
- Transport the immobilized waste to onsite interim storage facilities.

Phase 2

Phase 2 would be implemented to complete the remediation of the tank waste following successful implementation of Phase 1. Implementation of Phase 2 would involve the continued operation of Phase 1 facilities plus construction of two full-scale separations and LAW vitrification facilit ies and a full-scale HLW vitrification facility. Phase 2 would include the retrieval and treatment of the remaining DST and SST waste as well as the waste contained in the MUSTs. As much of the tank waste as practicable (assumed to be 99 percent) would be recovered from each tank. The recovered waste stream then would be transferred to one of the treatment facilities where it would be separated into HLW and LAW waste streams for immobilization.

The HLW stream would be vitrified, placed into canisters and then placed into Hanford Multi-Purpose Canisters for interim storage and disposal at the potential geologic repository . The LAW would be immobilized and placed into sealed containers similar to those used in Phase 1. The immobilized LAW would be placed into near-surface retrievable disposal vaults.

For purposes of analysis and in order to present a complete and representative alternative, the complete Phased Implementation alternative would include the following components:

- Completion of the waste retrieval and transfer system as described for the Ex Situ Intermediate Separations alternative;

- Construction and operation of the ex situ treatment facilities, similar to those described for the Ex Situ Intermediate Separations alternative, to provide the treatment capacity required to complete tank waste remediation; and
- Construction and operation of interim HLW storage and LAW disposal vaults of the same size and type as described for the Ex Situ Intermediate Separations alternative to provide for interim HLW storage and LAW disposal.

3.4.10.2 Process Description

Phase 1

The first step in waste processing would be to recover and transfer selected waste for treatment. Liquid waste retrieval and transfer would use equipment and systems currently in place in the DST farms. Waste retrieved from selected SSTs also could be used as waste feed for the treatment facilities. The waste feed to the LAW facilities would be retrieved and transferred in batches from selected DSTs into two existing DSTs used as feed tanks. Each LAW facility would have one designated DST as a feed tank. The waste feed to the HLW facility would be retrieved, sludge washed, and transferred directly to the HLW processing facility. The waste treated at the HLW facility would be the HLW recovered from selected tanks and sludge washed and might or might not include the HLW separated out of the LAW stream.

The separations and immobilization technologies employed for waste immobilization would be based on waste product specifications, which would set the requirements for the physical properties, chemistry, radionuclide content, and volume of the immobilized LAW and HLW. During the demonstration phase, different types of waste would be processed to demonstrate process capability for easy, moderate, and difficult-to-process waste. For purposes of this analysis, the technologies employed would be assumed to be similar to those described for the other ex situ alternatives.

Separations prior to LAW immobilization would be performed to remove the cesium, strontium, technetium, transuranic elements, and entrained sludge particles from the waste stream to the extent required to meet LAW product specifications. The separated cesium and technetium would be stored at the treatment facilities or packaged in canisters for onsite dry storage; the sludge and other radionuclides would be returned to the DST farms for storage; and the remaining liquid waste stream then would be immobilized. The immobilization process would include evaporation of the waste stream followed by vitrification. The LAW processing facilities each would be designed to treat up to 3.8 million L (1 million gal) of liquid waste per year. This is equivalent to a treatment facility with a capacity of 20 mt (22 tons) of vitrified glass per day at a 15 weight percent sodium oxide waste loading, operating at an overall efficiency of 60 percent. The immobilized LAW would be placed into containers approximately 1.8 m long by 1.2 m wide by 1.2 m high (6 ft long by 4 ft wide by 4 ft high).

The HLW treatment process, which would involve only sludge washing and solid/liquid separations processes, would convert the entire waste feed stream into vitrified borosilicate HLW glass. The HLW facility would be designed to produce the equivalent of 1 mt/day (1.1 ton/day) of HLW glass at a 20 weight percent waste oxide loading. The HLW would be placed directly into 1.17-m^3 (41-ft^3) canisters for packaging in a Hanford Multi-Purpose Canister for interim storage.

Phase 2

Under Phase 2, the waste retrieval and transfer operations would use the same processes and would be subject to the same requirements for tank residuals as the retrieval and transfer function described for the Ex Situ Intermediate Separations alternative. Waste would be retrieved and blended for batch transfer to the treatment facilities. Radionuclides that previously had been separated from the LAW stream and placed in containers for storage would be transported to a HLW vitrification facility and blended with a HLW feed stream.

The HLW and LAW separations processes would be similar to those described for the Ex Situ Intermediate Separations alternative, but would include additional separations processes to remove strontium, technetium, and transuranic elements from the LAW stream to the extent required to meet the LAW product specifications.

During Phase 2, a HLW vitrification facility and two LAW treatment facilities would be constructed. The HLW vitrification facility would be designed to produce 10 mt (11 tons) of HLW glass per day. The LAW treatment facilities would each be designed to produce 100 mt (110 tons) of glass per day.

The LAW produced during Phase 1 and the LAW produced during Phase 2 would be disposed of onsite in near-surface retrievable disposal vaults.

3.4.10.3 Construction

Phase 1

The two facilities would be located on the east side of the 200 East Area within the area previously identified as the grout disposal area. Separate treatment and support facilities would be constructed (Figure 3.4.14). The following systems and facilities would be constructed:

- Waste transfer systems - This would include pipelines from the receiver tanks to each of the treatment facilities and a separate pipeline to transfer HLW from the existing waste transfer system to one of the treatment facilities.
- Electrical service to each of the sites - This would involve installing overhead power lines from the existing 200 East Area power grid to the designated sites.
- Process water and potable water - These services would be installed to connect the sites with existing distribution lines in the 200 East Area.
- Treatment facilities - This would include one separations/LAW processing facility and one separations/LAW/HLW processing facility.

Figure 3.4.14 Phased Implementation Facility Layout

Modify the Canister Storage building for interim storage of vitrified HLW. This would include modifying the underground vaults and ventilation system to accommodate the physical and thermal loading associated with interim storage of all HLW produced during Phase 1.

Modify the existing grout vaults to accommodate interim LAW storage during Phase 1 operations. This would include modifications to the existing vaults to allow placement and interim storage of the LAW disposal containers pending future retrieval and disposal during Phase 2.

Phase 2

Constructing new facilities for Phase 2 would include new treatment facilities with higher capacities than the Phase 1 demonstration facilities. The new facilities constructed during Phase 2 would include a HLW vitrification facility, two combined separations and LAW treatment facilities , a LAW disposal facility, an interim HLW storage facility, waste retrieval and transfer facilities, and support facilities (Figure 3.4.15). The facilities that would be constructed for Phase 2 operations would include the following:

- Waste retrieval and transfer facilities as described for Ex Situ Intermediate Separations;
- Support facilities that would provide utilities, resources, and personnel support to the Phase 2 treatment facilities (these support facilities would be similar to those described for the Ex Situ Intermediate Separations alternative);
- Two separations and LAW treatment facilities that would be similar to the LAW vitrification facility described for the Ex Situ Intermediate Separations alternative;
- A LAW disposal facility for retrievable disposal of LAW produced throughout Phase 1 and Phase 2 (this facility would be similar to the LAW disposal facility described for the Ex Situ Intermediate Separations alternative);
- A HLW vitrification facility that would be similar to the HLW vitrification facility described for the Ex Situ Intermediate Separations alternative;

A HLW interim storage facility for interim storage of the Hanford Multi-Purpose Canisters (this facility would be similar to the interim storage facility described for the Ex Situ Intermediate Separations alternative); and
- Hanford Barriers over the LAW retrievable disposal facility and tank farms at the completion of remediation.

3.4.10.4 Operations

Phase 1

Operations under Phase 1 would take place simultaneously at the two treatment facilities. Both LAW facilities would operate for 10 years. The HLW treatment operations would take place for 6 years but could be extended to 10 years.

Figure 3.4.15 Phased Implementation (Total Alternative) Facility Layout

The waste (mainly DST liquid waste) would be retrieved and transferred to receiver tanks for LAW treatment. The waste then would be transferred from the receiver tanks to the treatment facilities on an as-needed basis. The HLW would be retrieved from selected tanks and transferred to DSTs for in-tank sludge washing. The washed HLW would then undergo solid/liquid separation followed by vitrification of the HLW.

Each facility would perform the necessary separations processes on the waste stream. Separated cesium and technetium radionuclides would be stored at the treatment facilities or packaged for interim onsite storage at the Canister Storage Building . The LAW stream would be vitrified to meet established performance characteristics. The HLW stream would be vitrified to produce borosilicate glass and then would be placed into canisters. The HLW produced would meet established acceptance criteria.

Each of the waste treatment facilities would operate off-gas treatment systems using control technologies for priority pollutants and radionuclides. The treatment of the off-gas would use processes and equipment similar to those described for the Ex Situ Intermediate Separations alternative.

Phase 2

Phase 2 operations would follow Phase 1 and would consist of the following:

- Retrieve waste from the tanks and MUSTs. This operation would be the same as described for waste retrieval under Ex Situ Intermediate Separations alternative;
- Perform sludge washing and solid/liquid separation; and
- Operate the two LAW vitrification facilities and the HLW vitrification facility . Waste treatment operations would be similar to those described for the Ex Situ Intermediate Separations alternative but at a reduced scale.

3.4.10.5 Post Remediation

Following waste treatment and tank farm closure, decontamination and decommissioning would take place. Post-remediation activities for the Phased Implementation alternative would be the same as those described for the Ex Situ Intermediate Separations alternative. The tank farms would be closed and the processing facilities would be decontaminated and entombed in place.

3.4.10.6 Schedule, Sequence, and Cost

A schedule for the major components of the Phased Implementation alternative is shown in Table 3.4. 21 . The cost estimate for the Phased Implementation alternative was developed by combining applicable components from other ex situ alternatives and applying ratios as required to account for differences in facility sizes and capacities and the degree of separations in LAW and HLW. This approach inherently assumes that the Phased Implementation alternative would use similar types of processes and facilities to those described for the other ex situ alternatives. The estimated cost for the Phased Implementation alternative is shown in Table 3.4.22 .

Table 3.4.21 Schedule - Phased Implementation Alternative

Table 3.4.22 Cost - Phased Implementation Alternative [1]

3.4.10.7 Implementability

Many of implementability issues identified for the ex situ alternatives would not be as well defined for the Phased Implementation alternative. Issues related to the implementability of phased implementation would include successfully producing immobilized waste that would meet waste form specifications. Successful implementation of Phase 1 would be required to start Phase 2.

Phase 1 would share some of the same implementability issues as the Ex Situ Intermediate Separations alternative because several of the processes were assumed to be similar. Performance of key processes was assumed in the absence of substantive data. Cost estimates could have a high degree of uncertainty because some of the processes are unproven.

The phased implementation approach would reduce uncertainties as compared to the other ex situ alternatives because the process would be demonstrated on a smaller scale and optimized before being used on a larger scale.

Retrieval criteria based on recovering 99 percent of the waste volume in each tank would be uncertain because hardened sludge present in some tanks could be difficult to retrieve, making it difficult to meet the retrieval criteria. This would be an implementability issue associated with Phase 2. The ability of the alternative to comply with regulatory requirements is discussed in Section 6.2.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components are adequately treated during waste processing or vitrification.

3.5 CESIUM AND STRONTIUM CAPSULE ALTERNATIVES

3.5.1 No Action Alternative (Capsules)

3.5.1.1 Overview

The capsules No Action alternative would involve the continued storage of the cesium capsules and strontium capsules in WESF. Current planning indicates that WESF will be maintained until approximately 2007. Selecting this alternative would require that DOE select an alternate storage method for the capsules within the next 10 years. If the No Action alternative were selected for implementation, one of the other capsule alternatives would have to be selected and implemented by 2007. This will be considered in the Cesium and Strontium Capsule Management Plan.

3.5.1.2 Process Description

Cesium and strontium capsules would continue to be stored in water-filled basins. The capsules would continue to be monitored for signs of leakage and physical change, and the facility would be maintained to provide for continued safe management.

3.5.1.3 Construction

No major construction activities would take place under this alternative. Limited construction activities would be required to complete life extension programs required for continued safe operations.

3.5.1.4 Operations

The operational activities associated with this alternative would involve the continued storage and management of these capsules at WESF.

3.5.1.5 Post Remediation

There would be no post-remediation activities associated with the No Action alternative. Administrative controls would be assumed to be effective until another capsule alternative were implemented.

3.5.1.6 Schedule, Sequence, Cost

A schedule for major activities for this alternative is shown in Table 3.5.1. The estimated cost for this alternative is summarized in Table 3.5.2.

Table 3.5.1 Schedule - No Action Alternative (Capsules)

Table 3.5.2 Cost - No Action Alternative (Capsules)[1]

3.5.1.7 Implementability

Implementing this alternative would include continued storage of the capsules in WESF and present no new processes or technology challenges. This alternative would meet all applicable regulations (Section 6.2).

3.5.2 Onsite Disposal Alternative

3.5.2.1 Overview

The Onsite Disposal alternative would involve removing the capsules from their current storage in water-filled basins at WESF and packaging them in 3-m [10-ft]-long canisters for onsite disposal. Disposal would consist of placing the sealed canisters into onsite engineered subsurface wells at specified intervals to provide safe, long-term, passively-cooled disposal (Figure 3.5.1). Information used in describing cesium and strontium capsule alternatives is from Disposition of Cesium and Strontium Capsules Engineering Data Package for the TWRS EIS (WHC 1995h and Jacobs 1996).

Figure 3.5.1 Capsules - Onsite Disposal Alternative

Construction activities associated with this alternative would involve minor modifications to WESF for capsule packaging and building the Drywell Disposal Facility. Operations would involve placing the capsules into sealed canisters and placing the canisters in the drywells for disposal.

3.5.2.2 Process Description

Cesium and strontium capsules would continue to be stored in water-filled basins until the packaging and canister handling facilities were ready to begin operations. Disposal of the capsules would involve the following process steps: 1) retrieve the capsules from storage basins; 2) inspect the capsules for integrity; 3) place the capsules in a rack to support the capsule within the canister; 4) insert the capsules into canisters (three or four capsules placed in each canister); 5) seal the canisters by welding closed; 6) decontaminate and inspect the canisters; 7) place the canisters into drywells for disposal; and 8) monitor the capsules and maintain the facility.

3.5.2.3 Construction

The subsurface disposal facility would be the main construction activity for this alternative. This facility would cover approximately 3.8 hectares (ha) (9.4 acres [ac]) including a 30-m (100-ft)-wide surrounding buffer zone. The proposed location is shown in Figure 3.5.2. The site would be leveled, and security fencing and an estimated 672 drywells would be installed (Figure 3.5.3). The drywells would be 4.6 m (15 ft) deep by 0.76 m (2.5 ft) in diameter. A steel encasement would be placed into each hole to house the canister (Figure 3.5.4). A shielded transporter vehicle would be designed and constructed to place the capsules into the drywells.

Capsule packaging operations would require modifications and upgrades to WESF. These modifications would involve installing equipment and utilities to perform remote capsule handling and packaging, as well as canister welding, decontamination, and inspection.

3.5.2.4 Operation

The major operational activities for this alternative would include the following:

- Operating the capsule/canister packaging facility;
- Transporting the canisters to the disposal facility;
- Placing the canisters into the drywells;
- Placing intrusion prevention barriers over the drywells; and
- Monitoring and maintaining the disposal facility.

3.5.2.5 Post Remediation

Post-remediation activities would consist of decontamination and decommissioning of capsule packaging facilities and closure of the disposal facility. Decontamination and decommissioning activities associated with this alternative would include facility decontamination. Contaminated equipment would be decontaminated to the extent possible and disposed of according to State and Federal regulations. Closure of the disposal facilities would involve placing intrusion prevention barriers over the drywells.

3.5.2.6 Schedule, Sequence, Cost

The schedule of major activities for this alternative is shown in Table 3.5.3. The cost associated with this alternative is shown in Table 3.5.4.

Table 3.5.3 Schedule - Onsite Disposal Alternative

3.5.2.7 Implementability

Implementing this alternative would involve storage practices used periodically in the past and thus would present no new technology challenges.

This alternative would not meet the land disposal requirements of RCRA for hazardous waste. Near-surface disposal of HLW would not meet DOE policy for disposal of readily retrievable HLW in a potential geologic repository (Section 6.2).

Figure 3.5.2 Capsules - Onsite Disposal Location

Figure 3.5.3 Capsules Onsite Disposal Arrangement (Conceptual)

Table 3.5.4 Cost - Onsite Disposal Alternative [1]

Figure 3.5.4 Capsule Dry-Well Disposal Assembly

3.5.3 Overpack and Ship Alternative

3.5.3.1 Overview

The Overpack and Ship alternative would consist of placing the capsules into canisters (4.6 m [15 ft] long), which then would be overpacked into Hanford Multi-Purpose Canisters. Four canisters containing capsules would be placed into each Hanford Multi-Purpose Canister. The Hanford Multi-Purpose Canisters would be stored temporarily onsite pending shipment and disposal at the potential geologic repository (Figure 3.5.5).

Construction activities for this alternative would involve modifying WESF to support capsule packaging operations. Operations would involve packaging the capsules into sealed canisters, overpacking the canisters into Hanford Multi-Purpose Canisters for interim storage, and transporting the Hanford Multi-Purpose Canisters by rail to the potential geologic repository. Final design of the canister packaging would include design criteria for waste acceptance at the potential geologic repository.

3.5.3.2 Process Description

Cesium and strontium capsules would continue to be stored in water-filled basins until the packaging facilities were ready to begin operations. Overpacking the capsules would involve the following process steps.

1. Retrieve capsules from storage basins.
2. Inspect capsules for integrity.
3. Place capsules in a rack to support the capsule within the canister.
4. Insert capsule into canisters (three to four capsules placed in each canister).
5. Seal canister by welding closed.
6. Decontaminate and inspect canisters.
7. Overpack sealed canisters into Hanford Multi-Purpose Canisters.
8. Place canisters into storage.
9. Monitor and maintain canisters.

3.5.3.3 Construction

Capsule packaging would require minor modifications and upgrades to WESF. These modifications would involve installing equipment and utilities and modifying existing facilities to perform remote capsule handling and packaging, as well as canister welding, decontamination, and inspection activities.

Interim storage of the Hanford Multi-Purpose Canisters containing the sealed capsule canisters would require the construction of a concrete storage pad similar to the interim HLW storage pads. The interim storage location would be adjacent to the HLW interim storage associated with the tank waste Ex Situ Extensive Separations alternative or other ex situ alternatives .

3.5.3.4 Operation

The major operational activities for this alternative would include the following.

- Remove capsules from wet storage.
- Operate packaging facility.
- Transport Hanford Multi-Purpose Canisters to onsite interim storage pad and cover with a shielding cask.
- Monitor Hanford Multi-Purpose Canisters in interim storage.

- Transport Hanford Multi-Purpose Canisters to the potential geologic repository for disposal.

3.5.3.5 Post Remediation

After all of the capsules were packaged and transported to the interim storage pad, the equipment installed for capsule handling and packaging would be decontaminated and decommissioned. After transporting the Hanford Multi-Purpose Canisters to the repository, the storage pad associated with the interim storage of capsules would be decontaminated and decommissioned.

Figure 3.5.5 Capsules - Overpack and Ship Alternative

3.5.3.6 Schedule, Sequence, Cost

The schedule of activities for this alternative is shown in Table 3.5.5. The cost associated with this alternative is shown in Table 3.5.6.

Table 3.5.5 Schedule - Overpack and Ship Alternative

Table 3.5.6 Cost - Overpack and Ship Alternative [1]

3.5.3.7 Implementability

This alternative would use common practices, which present no new technology issues. This alternative might not meet the land disposal restrictions of RCRA because of the characteristic corrosivity of the cesium chloride and strontium fluoride. Also, assuming the waste was mixed waste, it would not meet the DOE restriction against disposal of mixed waste in the first potential geologic repository. Also, the powder waste form of the strontium fluoride would not meet the waste acceptance requirements to immobilize particulate waste (Section 6.2). Further evaluation would be required to resolve technical and programmatic concerns associated with disposal of the cesium and strontium capsules in the potential geologic repository.

3.5.4 Vitrify with Tank Waste Alternative

3.5.4.1 Overview

Vitrifying the capsule contents with the tank waste would involve removing the capsule contents, dissolving or suspending it in a slurry, possibly chemically processing it, and blending it into the vitrification feed stream at the HLW vitrification facility. This would combine the high-activity cesium chloride and strontium fluoride from the capsules with the HLW waste for vitrification. Following the vitrification step, the cesium and strontium would be handled in the same manner as described previously for HLW glass. This eventually would lead to offsite disposal in the potential geologic repository (Figure 3.5.6).

This alternative could be implemented only if one of the ex situ alternatives involving vitrification were selected for the tank waste.

Construction activities associated with this alternative would involve installing the equipment required to remove the capsule contents, processing the cesium chloride and strontium fluoride, and feeding the capsule waste into the HLW vitrification feed stream. This equipment would be installed in a dedicated area of the HLW vitrification facility.

The capsules would be taken from their current storage location to the HLW vitrification facility where they would be cut up, possibly chemically processed, and metered into the waste stream, which would be fed to the HLW vitrification melter. Following remediation, the capsule contents would be a part of the vitrified high-level tank waste and stored onsite temporarily awaiting transport and disposal at the potential geologic repository.

3.5.4.2 Process Description

Cesium and strontium capsules would continue to be stored in water-filled basins at WESF until the HLW vitrification facility was operating and ready to accept the capsules. Vitrifying the capsule contents with the tank waste would involve retrieving the capsules from storage basins; transporting the capsules to the HLW facility in shielded transport casks; dismantling the capsules and remove the cesium and strontium salts; and blending the capsule contents into the HLW stream.

3.5.4.3 Construction

This alternative would require additional construction within the HLW vitrification facility to accommodate capsule-related activities. Construction in the HLW vitrification facility would include shielding and remote equipment to cut up the capsules, removing the contents, chemically treating the cesium chloride and strontium fluoride if required, and blending the capsule material into the HLW feed stream.

3.5.4.4 Operation

Operations for this capsule alternative would be conducted in the HLW vitrification facility and WESF and include the following.

- Continue storing the capsules in WESF until all capsules are removed.
- Remove and truck transport the capsules to the HLW vitrification facility in shielded transport casks.
- Cut up the capsules and remove the contents.
- Perform chemical processing of the capsule contents as required.
- Blend the capsule contents into the vitrification feed stream by slowly metering the dissolved cesium chloride and slurry containing strontium fluoride just before the waste enters the HLW melter.
- Decontaminate and shred the empty capsule containers.
- Dispose of the shredded capsule container materials onsite at the low-level waste burial grounds.

Figure 3.5.6 Capsules - Vitrify with Tank Waste Alternative

3.5.4.5 Post Remediation

Following vitrification, the contents of the capsules would be incorporated into the vitrified HLW. The HLW produced would be stored onsite temporarily and then transported to the potential geologic repository for permanent disposal.

After all HLW was been vitrified, the equipment and facilities dedicated to capsule processing in the HLW vitrification facility would be decontaminated and decommissioned. Contaminated equipment would be disposed of according to State and Federal regulations. The capsule facility portion of the HLW vitrification facility would be decommissioned along with the HLW vitrification facility.

3.5.4.6 Schedule, Sequence, Cost

The schedule of activities for this alternative is provided in Table 3.5.7. Cost associated with this alternative is shown in Table 3.5.8.

3.5.4.7 Implementability

This alternative could be implemented only if one of the ex situ alternatives were selected. This cesium and strontium could require chemical processing to remove the chloride and fluoride from the cesium and strontium salts. The cesium and strontium would need to meet the required feed specifications that would be developed for the HLW stream as part of the vitrification process. This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components were adequately treated during waste processing or vitrification.

Table 3.5.7 Schedule - Vitrify with Tank Waste Alternative

Table 3.5.8 Cost - Vitrify with Tank Waste Alternative [1]

3.6 BORROW SITE SUMMARY

A summary of the earthen borrow materials that would be required by each of the alternatives is shown in Tables 3.6.1, 3.6.2, and 3.6.3. These tables identify the type, amount, and possible sources of the borrow. The final selection of borrow sites for earthen material has not been made; however, the locations indicated represent potential borrow sites that would support each of the alternatives in both volume and location. Future borrow site decisions will be made in future NEPA analysis . Figure 3.6.1 identifies the potential borrow site locations for the TWRS alternatives.

3.7 DISPOSAL OF HANFORD SITE HLW AT THE POTENTIAL GEOLOGIC REPOSITORY

3.7.1 Number of HLW Canisters for Disposal

The range in number of canisters that would be produced under the different alternatives would vary widely based on the amount of separations and would not agree with the current planning basis for the geologic repository. The current geologic repository technical planning baseline includes acceptance of up to 13,200 standard sized (0.62-m^3 [22-ft^3]) canisters of defense HLW (DOE 1994g). This baseline number of HLW canisters would come from multiple DOE Sites with the number allocated to each Site based on waste inventory and volume projections. The number of canisters used for the technical planning baseline was developed using assumptions for canister size, vitrified waste volume, and the amount of the repository capacity set aside for DOE (10 percent). These assumptions resulted in identifying approximately 7,100 canisters (1,800 Hanford Multi-Purpose Canisters) for the Hanford Site. The number of canisters and Hanford Multi-Purpose Canisters that would be produced under the different alternatives would be subject to change during final design (see Table 3.7.1).

Figure 3.6.1 Potential Borrow Sites for TWRS

Table 3.6.1 Borrow Site Summary - Materials Used During Construction and Operations

Table 3.6.2 Borrow Site Summary - Materials Used for Backfill of Empty Tanks for all Ex Situ Alternatives

Two factors that would affect disposal of TWRS HLW in the potential geologic repository are the statutory limit on the number of metric tons of uranium or equivalent in the waste and the physical limit on the number of waste packages that would require placement in the potential geologic repository. Allex situ alternatives would process the same waste and would contain approximately the same amount of uranium or equivalent. The alternatives that generate fewer Hanford Multi-Purpose Canisters than the geologic repository planning baseline would have little or no physical limitation on repository placement. The alternatives that greatly exceed the number of Hanford Multi-Purpose Canisters used in the geologic repository planning baseline could exceed the physical limitations of the potential geologic repository.

Table 3.6.3 Borrow Site Summary Materials Used for Construction of Hanford Barriers

3.7.2 HLW Disposal Cost

Repository fees for alternatives that included shipment of HLW to the potential geologic repository were based on analysis performed by the Office of Civilian and Radioactive Waste Management in support of the TWRS EIS (Milner 1996a). This analysis was performed using a consistent methodology, as used by the Civilian Radioactive Waste Management Program in development of the

Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program of September 1995 (DOE 1995u). Life cycle cost estimates for four alternative scenarios were provided for disposal of vitrified HLW from the Hanford Site. The four alternatives varied the volume and HLW canister sizes from the 1995 Total System Life Cycle Cost estimate basis. The analysis included estimates for two new HLW waste packages, two new transportation casks, and estimates of changes to repository surface facilities, subsurface impacts, transportation, and other program cost elements. The analysis provided scoping level detail, scaled from the detailed point estimate reported in the 1995 Total System Life Cycle Cost analysis.

Estimates of the total defense share, based on application of the 1987 Federal Register methodology were provided in the cost estimate report. Allocating the defense share between the Hanford Site and other defense sites was estimated by the ratio of the number of Hanford Site waste packages to the total number of defense waste packages. A waste package consists of up to four canisters of HLW and is equivalent to a Hanford Multi-Purpose Canister from a quantity standpoint. Repository fees for alternatives that were not addressed in the Office of Civilian and Radioactive Waste Management report were estimated by extrapolating data from the estimate. The estimated disposal fees for placement of HLW in the potential geologic repository are shown in Table 3.7.1. For additional detail see Volume Two, Section B.10.

Table 3.7.1 HLW Disposal Fees

3.8 COMPARISON OF ACTIVITIES ASSOCIATED WITH THE ALTERNATIVES

The alternatives described in this section provided a range of alternatives from continued storage under the No Action alternative to retrieval and treatment of as much of the waste as practical under the ex situ alternatives. These alternatives also provided for varying levels of waste treatment from containment under the In Situ Fill and Cap alternative to extensive immobilization of all retrieved waste using vitrification under the Ex Situ Intermediate Separations alternative. It should be recognized that there are differences in the level of development between the alternatives, which means there are additional uncertainties associated with the data for some of the alternatives.

Closure for each of the alternatives (except No Action and Long-Term Management) is described to assess the cumulative impacts only. Each of the alternatives included continued routine operations, which included monitoring, maintenance, and waste management activities. Closure will be the subject of future NEPA decision making.

Major activities for each of the tank waste alternatives are summarized as follows:

- No Action alternative:
  - The waste would be left in the current state. Current operations would be continued for 100 years, at which time administrative control would assumed to be lost.
- Long-Term Management alternative:
  - DST waste would be retrieved and transferred to replacement DSTs at 50-year intervals (two times) during the 100-year period.
  - The SST waste would remain in the current state.
  - Current operations would be continued for 100 years, at which time administrative control would assumed to be lost.
- In Situ Fill and Cap alternative:
  - All of the tank waste would remain onsite where it would be disposed of in place following DST waste evaporation and tank stabilization operations.
  - No measures would be taken to immobilize the waste.
  - Minimal construction would be required (no Tank Farm Confinement Facilities are assumed to be required).
- In Situ Vitrification alternative:
  - All of the tank waste would remain onsite where it would be vitrified (turned into glass) and disposed of in place.
  - Considerable construction would be involved in building the Tank Farm Confinement Facilities over each tank farm.
  - In Situ Vitrification has not been attempted on this scale before and would require development.
- Ex Situ Intermediate Separations alternative:
  - Major construction would be involved building the retrieval systems and processing, disposal, and support facilities. -
  - All tank waste practicable (assumed to be 99 percent) would be retrieved and processed into vitrified HLW or LAW.
  - LAW would be vitrified and disposed of onsite in a retrievable manner in near-surface vaults, and HLW would be vitrified and shipped to the potential geologic repository for final disposal.
- Ex Situ No Separations (Vitrification or Calcination) alternative:
  - Major construction would be involved with building the retrieval systems, HLW processing facility, and support facilities.
  - All tank waste practicable (assumed to be 99 percent) would be retrieved and processed into vitrified or calcined HLW.
  - All recovered waste would be disposed of in the potential geologic repository.
- Ex Situ Extensive Separations alternative:
  - Major construction would be involved with building the retrieval, processing, and disposal facilities.

  - All tank waste practicable (assumed to be 99 percent) would be retrieved and processed into vitrified HLW or vitrified LAW.
  - The volume of HLW requiring transportation and disposal would be minimized by extensive separations of waste into HLW and LAW streams.
  - HLW would be disposed of at the potential geologic repository and LAW would be disposed of onsite in vaults.
- Ex Situ/In Situ Combination 1 alternative :
  - Tanks would be selected for retrieval and processing based on their potential contribution to long-term risk.
  - This alternative would use a combination of in situ and ex situ waste treatment aimed at achieving acceptable risk levels at a lower cost than ex situ treatment of all tank waste.
  - Using the aforementioned assumption, the waste from approximately 70 of the tanks would be retrieved and the remaining tanks would be filled and disposed of in place.
  - Considerable construction would be involved in building retrieval systems, processing, and disposal facilities. These facilities would be similar in type, but smaller than those described for the Ex Situ Intermediate Separations alternative.
  - Retrieved HLW would be vitrified and shipped to the potential geologic repository; retrieved LAW would be vitrified and disposed of onsite in vaults; and waste that is not recovered would be disposed of in place.
- Ex Situ/In Situ Combination 2 alternative:
  - Tanks would be selected for retrieval and processing based on their potential contribution to long-term risk.
  - This alternative would use a combination of in situ and ex situ waste treatment aimed at achieving acceptable risk levels at a lower cost than the Ex Situ/In Situ Combination 1 alternative.
  - Using the aforementioned assumption, the waste from approximately 25 of the tanks would be retrieved and the remaining tanks would be filled and disposed of in place.
  - Considerable construction would be involved in building retrieval systems, processing, and disposal facilities. These facilities would be similar in type, but smaller than those described for the Ex Situ Intermediate Separations alternative.
  - Retrieved HLW would be vitrified and shipped to the potential geologic repository; retrieved LAW would be vitrified and disposed of onsite in vaults; and waste that was not recovered would be disposed of in place.
- Phased Implementation alternative:
  <u>Phase 1</u>
  - Two demonstration-scale processing facilities would be constructed. One facility would process LAW, and one facility would process both LAW and HLW.
  - Selected HLW would be retrieved and processed.
  - Immobilized HLW and LAW would be stored onsite for disposition during Phase 2.

  <u>Phase 2</u>
  - Major construction would be involved with building the retrieval, processing, disposal, and support facilities.
  - All tank waste practicable (assumed to be 99 percent) would be retrieved and processed into vitrified HLW or LAW.
  - LAW would be vitrified and disposed of in a retrievable manner onsite in near-surface vaults. HLW would be vitrified and shipped to the potential geologic repository for final disposal.

Major activities for each of the capsule alternatives are summarized as follows:

- No Action alternative:
  - Storage of capsules would continue in WESF for a period of 10 years, at which time one of the other alternatives would have to be implemented.
- Onsite Disposal alternative:
  - Capsules would be retrieved, packaged into canisters (3 m [10 ft] long), and placed in drywells for indefinite storage.
  - Monitoring and maintenance would continue for 100 years, at which time administrative control is

assumed to be lost.

- Overpack and Ship alternative:
  - Capsules would be retrieved and packaged into sealed canisters (4.5 m [15 ft] long).
  - Canisters would be overpacked into Hanford Multi-Purpose Canisters for interim storage and disposal at the potential geologic repository.
- Vitrify with Tank Waste alternative:
  - Capsules would be retrieved, cut up, and the contents would be vitrified with the HLW from the tanks.
  - This alternative assumes that a tank waste alternative using ex situ vitrification would be selected.
  - Following vitrification, the capsule waste would become part of the vitrified HLW for disposal at the potential geologic repository.

A comparison of the waste volumes produced, schedule, and cost for the alternatives is presented in Table 3. 8 .1 for tank waste and in Table 3. 8 .2 for capsules.

Table 3.8 .1 Comparison of Tank Waste Alternatives

3.9 ALTERNATIVES CONSIDERED BUT DISMISSED

The evaluation of alternatives to dispose of tank waste has been an ongoing effort since recognizing that waste storage in underground tanks is a temporary solution to a long-term problem. One of the most recent and comprehensive analyses of the options available for tank waste disposal is the Tank Waste Technical Options Report (Boomer et al. 1993).

Table 3.8 .2 Comparison of Capsule Alternatives

The public scoping process resulted in identifying several technologies and alternatives for consideration. Several technologies and alternatives were included in the alternatives presented in this section. Others were addressed in the EIS as technologies available for consideration by decision makers (Volume Two, Appendix B).

Other technologies and alternatives were dismissed from detailed consideration. These are presented in Volume Two, Appendix C along with the reasoning behind dismissal of the technology.

The criteria used to evaluate alternatives for consideration in the EIS involved asking the following questions.

- Is the alternative within the scope of the EIS?
- Is the alternative technically viable and practicable?
- Can the alternative be designed to be protective of human health and the environment with reasonable mitigative measures?
- Is the technology sufficiently mature to allow detailed evaluation?

The dismissed specialized alternatives, or alternatives that proposed exceptional treatment or disposal components, included the following:

- Seabed disposal, space disposal, deep hole disposal, ice sheet disposal, and island disposal;
- Geologic disposal of tank contents, tanks, equipment and contaminated soil;
- Rock melting or injecting the waste into a deep mined cavity; and
- Transmutation.

Alternatives identified during the public scoping process for this EIS but dismissed from further consideration included the following:

- Grouting the retired canyon facilities with hot grout;
- Launching to the sun, seabed subduction, deep hole disposal; and
- Disposing of glass logs in grout vaults and allowing solids in tanks to decay.

Specific technologies identified in the public scoping process for this EIS but dismissed from further consideration include the following:

- Using contaminated lead or steel from onsite for HLW containers;
- Building an unenclosed furnace in the ground;
- Using clinkers or marbles, not ingots, for vitrified waste;
- Placing marbles or clinkers into casks of currently contaminated steel and concrete;
- Filling the interstitial space around clinkers or marbles with lead or graphite from material onsite; and
- Burning the waste in a breeder reactor or at a Washington Public Power Supply System reactor.

Numerous technologies were examined for the retrieval, transfer, separations, and immobilization of the tank waste. Those technologies examined and dismissed are discussed in Volume Two, Appendix C.

4.0 AFFECTED ENVIRONMENT

This section provides a summary description of the existing environment that could be impacted by the Tank Waste Remediation System (TWRS) activities at the Hanford Site. More detailed descriptions of environmental baseline conditions are provided in Volume Five, Appendix I of this Environmental Impact Statement (EIS), in the Hanford Site National Environmental Policy Act Characterization Report (Cushing 1994 and 1995 and Neitzel 1996), in the Hanford Site Environmental Report for Calendar Years 1994 and 1995 , (PNL 1995 and 1996), and in the Site Evaluation Report for Candidate Basalt Quarry Sites (Duranceau 1995). All information contained in this section is from these sources unless otherwise noted.

The Hanford Site is in the semi-arid region of the Columbia Plateau in southeastern Washington State (Figure 4.0.1). The Hanford Site occupies about 1,450 square kilometers (km^2) (560 square miles [mi^2]) of shrub-steppe and grasslands just north of Richland, Washington. The majority of this large land area, with restricted public access, provides a buffer to the smaller areas within the Hanford Site historically used for producing nuclear materials, waste storage, and waste disposal. About 6 percent of the land has been disturbed and is actively used. The Hanford Site extends approximately 77 kilometers (km) (48 miles [mi]) north to south and 61 km (38 mi) east to west.

The Columbia River flows through the northern part of the Hanford Site, turning south to form part of its eastern boundary. The Yakima River runs along part of the southern boundary and joins the Columbia River within the city of Richland. Adjoining lands to the west, north, and east are principally range and agricultural land. The cities of Richland, Kennewick, and Pasco (also known as the Tri-Cities) comprise the nearest population centers and are located southeast of the Site.

Figure 4.0.1 Hanford Site Map and Vicinity

4.1 GEOLOGY

The geology section, which provides an overview of the Hanford Site's subsurface environment, focuses primarily on the 200 Areas, which are located in the center of the Site. With the exception of two potential borrow sites found approximately 6.5 km (4 mi) to the north and west of the 200 Areas and a third potential borrow site located between the 200 East and 200 West Areas, the 200 Areas would be the location of virtually all TWRS activities under all tank waste and cesium and strontium capsule alternatives. The section describes Hanford Site topography, geologic structure, stratigraphy, soil, and seismicity (including earthquake history). Reports by Delaney (Delaney et al. 1991), Reidel (Reidel et al. 1992), and Cushing (Cushing 1994), summarize information collected in various earlier Hanford Site projects and are the primary basis for the material presented.

4.1.1 Topography

The TWRS sites are located on and near a broad flat area of the Hanford Site commonly referred to as the Central Plateau. The Central Plateau is within the Pasco Basin, a topographic and structural depression in the southwest corner of the Columbia Basin, characterized by generally low-relief hills with deeply incised river drainage (Figure 4.1.1). The Hanford Site is an area of generally low relief, ranging from 120 meters (m) (390 feet [ft]) above mean sea level at the Columbia River to 230 m (750 ft) above mean sea level in the vicinity of the TWRS sites.

Geologic processes that alter topography include landslides, floods, and volcanic activity. Landslides are not a common occurrence in the 200 Areas because of flat topography, the deep water table, and the absence of any actively eroding streams. The nearest potential flooding source to the TWRS sites is Cold Creek, located in the southwest portion of the Hanford Site. Studies of the probable maximum flood show its effect would be limited to the southwestern corner of the 200 West Area (Cushing 1994). The potential McGee Ranch and Vernita Quarry borrow sites, possible sources of rip rap (Vernita) and silt (McGee) for post-remediation surface barrier construction, are located in the northwest corner of the Hanford Site and are not within the probable maximum flood area (Figure 3.6.1) (Cushing 1994). The third potential borrow site (Pit 30) is located on the Central Plateau between the 200 East and 200 West Areas and is well removed from potential flooding sources. The only likely source of volcanic activity that could impact the TWRS sites would be volcanism in the Cascade Mountain Range more than 100 km (60 mi) west of the Hanford Site. The 1980 eruption of Mount St. Helens is an example of such a volcanic event. This eruption caused ashfalls at the Site but had no other effect.

Figure 4.1.1 Geographic Setting and General Structural Geology of the Pasco Basin and Hanford Site

4.1.2 Geologic Structure

The Hanford Site lies in the Pasco Basin near the eastern boundary of the Yakima Fold Belt. The Pasco Basin is bounded by anticlinal ridges on the north, west, and south. A monocline bounds the east. The Pasco Basin is divided by the Gable Mountain anticline, and the Wahluke syncline to the north and the Cold Creek syncline to the south.

The 200 Areas are situated between the Gable Mountain anticline and the Cold Creek syncline. The Gable Mountain anticline is of particular importance to the groundwater flow. Portions of this anticline have been uplifted to a point where basalt is above the current water table (Figure 4.1.1). These basalts have a low hydraulic conductivity and act as a barrier to horizontal groundwater flow in the unconfined aquifer.

4.1.3 Stratigraphy

Hanford Site stratigraphy is summarized in Figure 4.1.2. A generalized west to east cross-section depicting the Site's structure and topography is shown as Figure 4.1.3. Basalt flows more than 3,000 m (10,000 ft) thick, called the Columbia River Basalt Group, lie beneath the Hanford Site. Interbedded between many of these basalt flows is the Ellensburg Formation, a series of sand, gravel, or silt layers deposited by the ancestral Clearwater and Columbia rivers. The stratigraphy beneath the Hanford Site is described in the following paragraphs in ascending order, from the deepest formation directly overlying the Columbia River Basalt Group upward to the ground surface.

The suprabasalt sediments are a sedimentary sequence up to 230 m (750 ft) thick overlying the Columbia River Basalt Group, and include the Ringold and Hanford Formations.

Thin, laterally discontinuous alluvial deposits, referred to as the Plio-Pleistocene unit, pre-Missoula gravels, and early Palouse soil, separate the Ringold Formation from the overlying Hanford Formation in various parts of the Hanford Site. Alluvial deposits are sediments deposited by flowing water. Of particular note is the Plio-Pleistocene Unit, which in the TWRS project vicinity is generally restricted to the 200 West Area. Depending on location, two types of material may be present in the Plio-Pleistocene unit. It may consist either of carbonate-cemented silt (locally referred to as a caliche layer) interfingered with sand and gravel, or of carbonate-poor silt and sand interfingered with basaltic material, sand and gravel, or both (Trent 1992a).

Figure 4.1.2 Generalized Stratigraphy of the Hanford Site

Figure 4.1.3 Geologic Cross Section of the Hanford Site

The Ringold Formation consists of clay, silt, fine-to coarse grained sand, and gravel. The Ringold Formation is up to 180 m (600 ft) thick south of the 200 West Area, but is largely absent in the northern and northeastern portions of the 200 East Area and adjacent areas to the north. The Ringold Formation is delineated by five different kinds of sediments, associated with fluvial (river-related) sands and gravels, floodplain and lake deposits, and alluvial fan deposits. The lower portion of the formation contains five separate stratigraphic intervals dominated by gravels known as Units A, B, C, D, and E. These gravels are separated by finer materials, including what is referred to as the lower mud sequence (Figure 4.1.4).

Figure 4.1.4 General Stratigraphy of the Suprabasalt Sediments of the Hanford Site

The lower mud sequence is important hydrologically because it is a potential confining layer that may offer some hydraulic separation between the saturated Ringold Formation above and the underlying Unit A gravels below. The lower mud sequence is generally absent in the northern part of the 200 East Area and at the main lobe of B Pond (Trent 1992b). The lower mud sequence is generally present throughout the 200 West Area, except in the northeast corner (Trent 1992a).

The Hanford Formation consists of pebble to boulder gravel, fine to coarse grained sand, and silt. The Hanford Formation, which is thickest in the vicinity of the Central Plateau (up to 65 m [210 ft] thick), was deposited by cataclysmic flood waters in glacial times. Gravel dominates the Hanford Formation in the northern part of the Central Plateau. Sand-dominated material is found most commonly in the central to southern parts of the Central Plateau. The silty materials are found within and south of the Central Plateau. Holocene surficial deposits consisting of silt, sand, and gravel form a thin (less than 10 m [33 ft]) surface layer across much of the Hanford Site. These surficial materials were deposited by a mix of eolian (wind) and alluvial processes.

4.1.4 Soil

The surface and near-surface soils in the 200 Areas are generally not well developed and consist of a number of soil types such as Rupert sand, Burbank loamy sand, and Ephrata sandy loam. An additional soil unit, Hezel sand, is also present on the western boundary of the 200 West Area (Cushing 1994).

The vicinity of the potential McGee Ranch borrow site contains two soil types: Warden silt-loam and Ritzville silt-loam. Soil at the potential Vernita Quarry borrow site includes the Burbank loamy sand, Ephrata silt-loam, and Kiona silt-loam. The Burbank loamy sand is the predominant soil type in the vicinity of the potential Pit 30 borrow site.

Soil monitoring is conducted at the Hanford Site for radionuclides. Concentrations of cobalt-60, strontium-90, cesium-137, plutonium-239, plutonium-240, and uranium were consistently detected at higher levels in Hanford Site soil than at offsite locations in 1994 and 1995 . In general, radionuclide concentrations near waste disposal sites are higher than concentrations further away. Data for 1995 are quite similar to data for 1994. In general, over the 11-year period from 1983 to 1994, concentrations of cobalt-60, cesium-137, uranium isotopes, and plutonium isotopes in soil did not change. Concentrations of strontium-90 in soil declined because of radiological decay and a downward migration of strontium-90 from the 2.5-centimeters (cm) (1-inch [in.]) soil sampling horizon (PNL 1996).

There are over 2,500 hectares (ha) (6,200 acres [ac]) of surface on the Site that are posted as radiologically controlled areas because contamination exceeds specified levels. Ninety percent of this total is within and near the 200 Areas (PNL 1996) .

4.1.5 Mineral Resources

The only mineral resources produced from the Pasco Basin are crushed rock, sand, and gravel. Deep natural gas production has been tested in the Pasco Basin without commercial success. Local borrow areas would supply rock, silt, sand, and gravel for those alternatives requiring the materials. Although specific borrow sites have not been selected for potential TWRS use, the EIS analyzes the possible use of three potential onsite borrow sites: 1) Pit 30, a potential source of sand and gravel for concrete during construction activities; 2) Vernita Quarry, a potential source of basalt to use as riprap for post-remediation surface barriers; and 3) McGee Ranch, a possible source of silt for post-remediation surface barriers (BHI 1995) .

4.1.6 Seismicity

Earthquakes are the result of stresses that build up in the tectonic plates comprising the earth's surface. These stresses build up due to friction between tectonic plates as they move past each other. Movement can occur within tectonic plates or between plates, such as in subduction zones, where one plate slides underneath another. Seismicity at the Hanford Site is associated with the Cascadia Subduction Zone off the coast of the Pacific Northwest, more than 300 km (180 mi) to the west. The Cascadia Subduction Zone is where the Juan de Fuca tectonic plate slides beneath the North American tectonic plate. Other relevant sources of seismic activity are shallow geologic structures of the Yakima Fold Belt or the Columbia River basalts, and deep structures of the Columbia Basin that underlie the Columbia Plateau.

Seismic activity in the Hanford Site area is low compared to other regions of the Pacific Northwest. In 1936, the largest known earthquake (a Richter magnitude of 5.75) in the Columbia Plateau occurred near Milton-Freewater, Oregon (Cushing 1994). Other earthquakes with a Richter magnitude of 5.0 or larger have occurred near Lake Chelan, Washington to the northwest, along the boundary of the Columbia Plateau and the Cascade Mountain Range, west and north of the Hanford Site, and east of the Hanford Site in Washington State and northern Idaho. In addition, earthquake swarms of small magnitudes that are not associated with mapped faults occur on and around the Hanford Site. An earthquake swarm is a series of earthquakes closely related in terms of time and location.

Four earthquake sources are considered relevant for the purpose of seismic design of TWRS sites: the Rattlesnake-Wallula alignment, Gable Mountain, an earthquake anywhere in the tectonic province, and the swarm area. For the Rattlesnake-Wallula alignment, which passes along the southwest boundary of the Hanford Site, a maximum Richter magnitude of 6.5 has been estimated. For Gable Mountain, an east-west structure that passes through the northern portion of the Hanford Site a maximum Richter magnitude of 5.0 has been estimated. The earthquake for the tectonic province was developed from the Milton-Freewater earthquake, with a Richter magnitude of 5.75. A Richter magnitude 4.0 event is considered the maximum swarm earthquake, based on the maximum swarm earthquake in 1973 (Cushing 1994). The Hanford Site current design basis for new facilities is for facilities to withstand a 0.2 gravity earthquake (Richter magnitude of approximately 6.4) with a reoccurrence frequency of 2.0E-04.

4.2 WATER RESOURCES

Baseline conditions for water and hydrology encompass surface water, the vadose zone (the area between the ground surface and underlying groundwater), and groundwater. The contaminants that presently exist in the Hanford Site water resources are not within the scope of the EIS. The behavior and remediation of existing surface water, the vadose zone, or groundwater contamination will be the subject of other environmental documentation. However, potential cumulative impacts of the TWRS EIS alternatives are discussed in Section 5.13.

4.2.1 Surface Water

West Lake and two small spring-fed streams in the Fitzner Eberhardt Arid Lands Ecology Reserve are the only naturally-occurring water bodies on the Hanford Site other than the Columbia River. West Lake is several hectares in size and is located approximately 8 km (5 mi) northeast of the 200 West Area and about 3 km (2 mi) north of the 200 East Area. The lake, which is situated in a topographically low-lying area, is sustained by groundwater inflow. West Lake was considered to be an ephemeral water body before Hanford Site operations began, with water level fluctuations dependent on groundwater level fluctuations. Water levels in West Lake became more stable because of recharge primarily from B Pond, which contains secondary wastewater and cooling water from the B Plant. The two small streams in the Fitzner Eberhardt Arid Lands Ecology Reserve are fed by Rattlesnake Springs and Snively Springs (Cushing 1994).

Two ephemeral creeks, Cold Creek and Dry Creek, traverse the uplands of the Hanford Site southwest and south of the 200 Areas. These creeks drain southeasterly toward the Yakima River, located south of the Hanford Site. Surface runoff from the uplands is minor, and creeks flow only during and shortly after rainfall and snow melt. The Columbia

River is 11 km (7 mi) or more downgradient from the 200 Areas. The river forms the eastern boundary of the Hanford Site and it comprises the base level and receiving water for groundwater and surface water in the region.

There are no floodplains in the 200 Areas or between the 200 East and 200 West Areas where the potential Pit 30 borrow site is located. Floods in Cold Creek and Dry Creek have occurred historically; however, there have not been any observed flood events or evidence of flooding that has reached the 200 Areas. Natural runoff generated onsite or from offsite upgradient sources is not known to occur in the 200 Areas (Newcomb et al. 1972).

The potential Vernita Quarry borrow site is about 3 km (2 mi) south of the Columbia River. The potential McGee Ranch borrow site is approximately 5 km (3 mi) south of the River. No perennial streams, wetlands, or bodies of surface water have been observed on either site, although the McGee Ranch is dissected by numerous eastward ephemeral drainage systems.

4.2.2 Groundwater

4.2.2.1 Hydrogeologic Setting

A thick vadose zone (70 to over 90 m [230 to over 300 ft] thick) as well as both confined and unconfined aquifers are present beneath the 200 Areas (DOE 1993a, 1993b). The vadose zone is over 90 m (300 ft) thick in the vicinity of the TWRS sites in the 200 East Areas (DOE 1993a). The confined aquifers are found primarily within the Columbia River Basalts. These aquifers are not a major focus of this EIS because they are separated from the TWRS sites by the vadose zone, unconfined aquifer, and confining layer(s) and thus are not likely to be impacted. The unconfined aquifer has not been formally named. This aquifer consists variably of the Ringold Formation (where the Ringold is present) and the lower portion of the Hanford Formation. The occurrence and flow of groundwater in the unconfined aquifer is inferred from discrete water level measurements in monitoring wells. The following five important concepts describe flow in this aquifer.

- The numerous strata within the Ringold Formation that were described previously in the stratigraphy discussion result in a much lower vertical hydraulic conductivity compared to the horizontal hydraulic conductivity. This results in a strong preference for groundwater to move horizontally rather than vertically.
- Most groundwater movement occurs in the sands and gravel that predominate in the upper portions of the Ringold Formation (Unit E gravels).
- The lower mud sequence and overbank deposits near the base of the Ringold Formation act as confining layers, hydraulically separating the overlying unconfined aquifer from the confined aquifer.
- Recharge to the unconfined aquifer is primarily from artificial sources such as B Pond, groundwater inflow from the Dry Creek and Cold Creek synclines, and recharge from the Columbia River in the general area of N Reactor in the northern portion of the Site.
- Discharge from the unconfined aquifer is primarily to the Columbia River, approximately from the point where the river turns southward in the northern portion of the Site south to the 300 Areas, and in the vicinity of B and C Reactors. Groundwater discharge also occurs to West Lake.

Natural recharge to the unconfined aquifer of the Hanford Site is extremely low and occurs primarily in the upland areas west of the Hanford Site. Artificial recharge from retention ponds and trenches contribute approximately 10 times more recharge than natural recharge. Seasonal water table fluctuations are small because of the low natural recharge.

4.2.2.2 Vadose Zone

At the Hanford Site the vadose zone often includes the Hanford Formation and the Ringold Unit E gravel. The thick vadose zone (70 to over 90 m [230 to over 300 ft]) thick beneath the 200 Areas), combined with the arid climate, result in natural infiltration rates ranging from near 0 to approximately 11 cm/year (4.3 in./year).

The total natural recharge in the 200 West Area is estimated to be approximately 1.3E+08 liters per year (L/year) (3.4E+07 gallons per year [gal/year]) (DOE 1993b). This is based on a recharge rate of 0.1 cm/year (0.04 in./year) through fine-textured soil with deep-rooted vegetation. This value is approximately 10 times lower than recharge volumes from artificial sources.

The current principal sources of artificial recharge in the 200 West Area are four cribs and one ditch associated with the U Plant area, located near the western edge of the 200 West Areas (DOE 1993b). There are also four septic tanks and drain fields that actively discharge water to the vadose zone. The combined volume discharged from these drain fields is estimated to be 12,000 L/day (3,200 gal/day). The total wastewater discharged from these facilities from 1944 to 1992, including the U Plant cribs and ditches, is estimated to have been 1.7E+11 L (4.4E+10 gal). T Plant and S Plant operations also resulted in large volumes of wastewater discharged to the soil. Liquid is no longer discharged from T, U, or S Plants.

DOE injects treated wastewater from the Effluent Treatment Facility, at the State- approved land disposal site located slightly north of the 200 West Area and at the Treated Effluent Disposal Facility, located in the 200 East Area. This water meets all State and Federal discharge requirements except for tritium. The treated water is injected at a location where it is projected that the tritium levels will be within drinking water standards in the groundwater before it reaches the Columbia River.

Natural recharge in the 200 East Area is estimated to be approximately 2E+07 L/year (5E+06 gal/year) (DOE 1993a). This is based on a similar natural recharge rate through fine-textured soil with deep-rooted vegetation, as noted previously for the 200 West Area. Artificial recharge in the 200 East Area is associated with approximately 140 ponds, trenches, cribs, and drains that were used to dispose of approximately 1E+12 L (3E+11 gal) of wastewater. Currently, there are 11 active waste management units and 20 active drain fields. The primary recipients of the wastewater were the ponds and trenches associated with B Plant and the Plutonium-Uranium Extraction (PUREX) Plant; the 216-A-25 trench and 216-B-3 Pond received approximately 8.0E+11 L (2.1E+11 gal). Liquids are no longer discharged from B Plant or the PUREX Plant.

Perched water (small pockets of water trapped in the vadose zone) may occur in the 200 West Area within the vadose zone upon a layer of silt and sand cemented by calcium carbonate (caliche layer). The caliche layer is located approximately 55 m (180 ft) beneath the ground surface (DOE 1993b). Measured hydraulic conductivities of this unit range from 0.0009 to 0.09 m/day (0.003 to 0.3 ft/day). Caliche layers have not been identified in the 200 East Area and generally , perched groundwater is not expected except in localized areas (Hoffman et al. 1992). Perched water has been reported in the vicinity of B Pond within the lower part of the Hanford Formation.

In areas where artificial recharge is occurring from ponds and trenches, soil is expected to be close to saturation and would not likely be capable of holding large amounts of additional liquid. In addition, two groundwater mounds have developed beneath recharge areas, one each in the 200 East and West Areas. Drier soil in portions of the 200 Areas where there is no artificial recharge has a large moisture holding capacity.

4.2.2.3 Aquifer Characterization

Groundwater of the unconfined aquifer occurs throughout the Hanford Site in the sediment layers above the basalt known as the suprabasalt sediments. The relationship between the various stratigraphic units and the hydrogeologic units is shown in Figure 4.2.1. The depth to groundwater on the Hanford Site is illustrated in Figure 4.2.2.

Groundwater occurs in the 200 West Area within the Ringold Formation primarily under unconfined conditions, approximately 70 m (230 ft) beneath the surface. The saturated section is approximately 110 m (350 ft) thick. Hydraulic conductivities measured in the 200 West Area in the Ringold Unit E aquifer range from approximately 0.02 to 60 m/day (0.06 to 200 ft/day). Hydraulic conductivities range from 0.5 to 1.2 m/day (1.6 to 4 ft/day) in the semiconfined to confined Ringold Unit A gravels (DOE 1993b).

A discontinuous layer of silt and sand cemented by calcium carbonate with thickness of up to 9 m (30 ft) occurs locally at a depth of about 55 m (180 ft) below the 200 West Area. This unit is believed to be responsible for perched water conditions in the vicinity of the TWRS sites in the 200 West Area.

Depth to groundwater in the 200 East Area ranges from 97 m (320 ft) in the southeast to 37 m (120 ft) in the vicinity of the 216-B-3C pond (B Pond mound), which is located approximately 5 km (3 mi) east of the TWRS sites (DOE 1993a). Groundwater near the TWRS sites occurs under unconfined conditions within Ringold Unit A, approximately 96 m (320 ft) deep. The saturated (groundwater) section is approximately 34 m (110 ft) thick. Interconnection between the unconfined and lower confined aquifer is possible across the Central Plateau; however, except for the area near the erosional windows that occur in the basalt several kilometers north of the 200 East Area and B Pond vicinity in the 200 East Area, there is no indication of aquifer interconnection. In the vicinity of B Pond, groundwater mounding from discharges from B Pond have resulted in a downward hydraulic gradient. Several kilometers north of the 200 East Area, there is an absence of confining layer(s) associated with an erosional window which has results in enhanced interconnection of the aquifers in this area. Hydraulic conductivities of the unconfined aquifer near the TWRS sites in the 200 East Area range from 150 to 300 m/day (500 to 1,000 ft/day) (DOE 1993a).

Figure 4.2.1 Conceptual Hydrologic Column for the Hanford Site

Figure 4.2.2 Groundwater Elevation Map of the Hanford Site

4.2.2.4 Groundwater Flow

Groundwater in the 200 West Area generally flows from west to east with some localized exceptions (PNL 1993a). In the northwest corner of the 200 West Area, groundwater flows northward. Also, it appears that flow from the 200 West Area branches out east of Gable Butte, with a flow component northerly toward the gap between Gable Butte and Gable Mountain and the remaining flow branching eastward and southeastward toward the Columbia River.

Groundwater flow in much of the 200 East Area is characterized by relatively low hydraulic gradients, ranging from 0.01 percent to 0.02 percent. Water table elevations in the uppermost aquifer generally decrease from the margins of the Yakima Ridge in the west to the Columbia River in the east. Data indicate that groundwater flow in the vicinity of the TWRS sites in the 200 East Area is toward the southeast (Figure 4.2.2) (PNL 1993a).

The mound resulting from discharge from the 216-B-3 pond (approximately 5 km [3 mi] east of the TWRS site in the 200 Areas) is a notable difference from the generally easterly flow direction. Near the western portion of the mound, the groundwater gradient is reversed to a westerly direction. The magnitude of this gradient direction reversal is currently diminishing as the mound diminishes. The groundwater gradient in the southeastern portion of the 200 East Area is expected to resume a more easterly trend as the mound continues to decline.

Downward hydraulic gradients have been observed in both the 200 East and 200 West Areas. In general, these downward gradients are associated with the groundwater mounds that have been created from infiltration of water discharged to the U Pond and B Pond. Interconnection between the unconfined and lower confined aquifer is possible across the Central Plateau; however, except for the area near the erosional windows that occur in the basalt several kilometers north of the 200 East Area and B Pond vicinity in the 200 East Area, there is no indication of aquifer interconnection. In the vicinity of B Pond, groundwater mounding from discharges from B Pond have resulted in a downward hydraulic gradient. Several kilometers north of the 200 East Area, there is an absence of confining layer(s) associated with an erosional window, which has results in enhanced interconnection of the aquifers in this area.

The groundwater impact analysis provides calculated concentrations of tank waste contaminants for a 10,000-year period of interest. These calculations rely on a conceptual model of the hydrogeologic conditions on the Site and monitoring and characterization data.

The conceptual model for the TWRS EIS is based on characterization data that include geologic structure, the pattern of geologic materials deposited in the vadose zone and underlying aquifer, existing contaminant migration, and the bounding affects of features such as the Columbia River, Yakima River, and Horse Heaven Hills. This results in an expectation that most of the contaminants from the tank sources would move in a west to east/southeast direction with a very small amount flowing northerly through the gap between Gable Butte and Gable Mountain.

The approach used in the TWRS EIS for groundwater impact assessment includes transient contaminant transport through the vadose coupled with steady state contaminant transport through the unconfined aquifer. Data that have been used include measurement of vadose zone and aquifer characteristics and geometry that will remain constant (e.g., hydraulic conductivities, grain size and distribution, and strata thicknesses) and data that are transient (e.g., moisture contents in the vadose zone and groundwater levels in the unconfined aquifer). Of importance here are the transient groundwater data sets that were used for the TWRS EIS and the Hanford Remedial Action EIS (DOE 1996c) analyses. The TWRS groundwater impact analysis focuses on impacts in the groundwater that would occur from about 100 years to 10,000 years from the present based on contaminants reaching the groundwater within about 130 years for the No Action alternative, up to about 3,400 years for the In Situ Vitrification alternative, and a 10,000-year period of interest for all of the alternatives. The TWRS groundwater impact assessment is based on the December 1979 groundwater level data, considering the period in which impacts are expected to occur. The December 1979 groundwater levels used in the TWRS EIS represent a point in time where 1) conditions were relatively steady; and 2) groundwater contaminant transport in the unconfined aquifer is primarily in a southeast/east direction with a small component going in a northerly direction through the gap between Gable Butte and Gable Mountain. For these two reasons, the December 1979 Site groundwater levels were selected as the basis for the TWRS EIS long-term, steady-state groundwater contaminant transport calculation. A slight drawback to use of the December 1979 groundwater level data is that the groundwater mounds associated with B Pond, U Pond, and Gable Mountain Pond are present but they would be expected to be absent in the future (i.e., within 100 years). The presence of the mounds result in a faster vadose zone contaminant transport because the vadose zone was thinner in 1979 than it would be in the future.

The Hanford Remedial Action EIS used 1992 groundwater levels for the impact assessment. These groundwater levels represent a point in time where many transients are ongoing in the groundwater system. Waste water discharges to the vadose zone are decreasing or have been terminated. The groundwater mound associated with Gable Mountain Pond is not present, the mounds associated with B Pond and U Pond have declined, and groundwater is being released from storage in the interstitial pore space of the unconfined aquifer. All of the contaminants originating in the 200 Areas would flow through the gap between Gable Mountain and Gable Butte into the 100 Areas, based on the 1992 groundwater levels used in the Hanford Remedial Action assessment. This is an accurate assumption for the near-term flow directions.

The proportion of contaminants flowing in an easterly direction would be expected to increase from zero percent in 1992 to near 100 percent as the groundwater mound associated with B Pond declines. Therefore by the time contaminants from tank waste remediations reaches the groundwater, the groundwater flow would be to the east as shown in the TWRS EIS. Additional discussion of the sensitivity and potential affect of groundwater mounding is provided in Volume Five, Appendix K.

4.2.3 Water Quality and Supply

4.2.3.1 Surface Water

Water at the Hanford Site is supplied by the Columbia River, which is a source of raw water. River water is supplied to Hanford Site facilities through several distribution systems. In addition, wells supply water to the 400 Area and several remote facilities.

The Tri-Cities draw most (Richland and Kennewick) or all (Pasco) of their water supplies from the Columbia River. In 1994, water usage ranged from 8.7E+09 L (2.3E+09 gal) in Pasco to 2.6E+10 L (6.9E+09 gal) in Richland (Cushing

1995). Each community operates its own water supply and treatment system.

The Columbia River provides water for both irrigation and municipal uses. Washington State has classified the stretch of the Columbia River that includes the Hanford Reach as Class A, Excellent (Neitzel 1996). Class A waters must be suitable for essentially all uses, including raw drinking water, recreation, and wildlife habitat. Both Federal and State drinking water quality standards apply to the Columbia River and are currently being met (Neitzel 1996).

Samples from the Columbia River and three onsite ponds are routinely collected (Figure 4.2.3). Radionuclides consistently detected during 1994 were tritium, strontium-90, uranium-234, uranium-238, iodine-129, plutonium-239, and plutonium-240. The iodine-129, plutonium-239, plutonium-240, strontium-90, and tritium may come from worldwide fallout as well as from releases of Hanford Site effluent. Tritium and uranium also occur naturally in the environment. Total alpha and beta measurements are useful indicators of the general radiological quality of the river; they provide a useful early indication of changes in radiological contamination because results are obtained quickly. Total alpha and beta measurements in 1994 were similar to 1993 and were approximately 5 percent less than the applicable State and Federal drinking water standards at 15 and 50 picocuries per liter (pCi/L), respectively. In general, radiological concentrations at Priest Rapids Dam (upstream of the Site) were generally lower than those at the Richland Pumphouse (downstream of the Site). Concentrations in 1995 were generally similar to those observed in recent years and in most cases were slightly lower than in 1994. Radiological contaminant concentrations measured in 1995 were less than the DOE Derived Concentration Guides and Washington State water quality criteria.

Nonradiological contaminants measured in the Columbia River in 1995 were similar to levels observed in recent years. All nonradiological water quality standards for Class A-designated water were met (PNL 1995). During 1995, there was no indication of any deterioration of water quality resulting from Site operations along the Hanford Reach (PNL 1996).

The three ponds routinely sampled onsite are West Lake (north of the 200 East Area), B Pond (east of the 200 East Area), and the Fast Flux Test Facility Pond (southeast of the 200 Areas). Monitoring data show that all three ponds are impacted by Site activities, although pond water is not used for human consumption. With the exception of uranium-234 and -238 in the October 1995 sample of West Lake, all radionuclide concentrations were less than the DOE Derived Concentration Guides. Average annual total beta concentrations exceeded the ambient surface water quality criteria level in West Lake. The EPA's proposed Hanford Site-specific drinking water standard for uranium also was exceeded in West Lake. The concentrations of all other radionuclides were less than the applicable surface water quality criteria (PNL 1996). West Lake surface water quality reflects the quality of the groundwater that feeds it and thus is potentially impacted by groundwater transport (PNL 1993a).

Figure 4.2.3 Water and Sediment Sampling Locations, 1992

Several springs in the 100 Areas, the old Hanford Townsite Springs and the 200 Area Springs, are routinely sampled. Water flows from these springs are a mechanism by which groundwater contaminated by past Site activities enters the Columbia River. All radiological contaminants measured in 1995 were less than the DOE Derived Concentration Guides. However, strontium-90 in the 100-H Area, and tritium in the 100-B Area and along the Old Hanford Townsite exceeded Federal and Washington State drinking water standards. Total uranium exceeded the EPA's proposed Hanford Site-specific standards in the 300 Area. All other radionuclide concentrations were below applicable surface water quality standards (PNL 1996). The 1995 nonradiological contaminant concentrations were below Washington State ambient surface water acute toxicity standards with the exception of copper and zinc in the 100-K Area spring. The chronic toxicity level of cadmium and the EPA standard for trichlorethylene also were exceeded at the 100-K Area Spring (PNL 1996).

4.2.3.2 Groundwater

Groundwater is not used in the 200 Areas except for emergency cooling water, nor do any water supply wells exist downgradient of the 200 Areas. Three wells for emergency cooling water are located near B Plant in the 200 East

Area. However, there are dry and groundwater monitoring wells in and around the 200 Areas. Hanford Site water supply wells are located at the Yakima Barricade, the Fast Flux Test Facility, and at the Hanford Safety Patrol Training Academy, all 13 km (8 mi) or more from the TWRS sites in the 200 East Area.

Groundwater Quality

Contamination by both radionuclide and nonradionuclide contaminants has been identified in the groundwater on the Hanford Site. Liquid effluents have been discharged to various ponds, cribs, and other waste management structures located onsite. Adsorption onto soil particles, chemical precipitation, and ion exchange delay the movement of some radionuclides and nonradionuclide contaminants in the effluent as they percolate downward through the vadose zone. Constituents such as strontium-90, cesium-137, and plutonium-239 and -240 are attenuated to varying degrees but eventually may enter the groundwater. Ions such as nitrate and radionuclides such as tritium, technetium-99, and iodine-129, which are not readily attenuated in the soil, reach the groundwater sooner than those that are readily attenuated, and then travel downgradient at essentially the same rate as the natural groundwater. The potential sources of groundwater contamination in the tank farms area are the focus of ongoing investigations (Caggiano 1996 and DOE 1995t). DOE is conducting a RCRA assessment to determine the nature and extent of groundwater contamination beneath certain tank farms (Ecology 1996).

Figure 4.2.4 Distribution of Tritium in the Unconfined Aquifer, 1994

Figure 4.2.5 Distribution of Iodine-129 in the Unconfined Aquifer, 1994

Figure 4.2.6 Distribution of Nitrate in the Unconfined Aquifer, 1994

4.3 METEOROLOGY AND AIR QUALITY

4.3.1 Meteorology

The Hanford Site is located in a semi-arid region. The Cascade Mountains to the west greatly influence the Hanford Site's climate by providing rainshadow. This range also serves as a source of cold air drainage, which has a considerable effect on the Site's wind regime. The following meteorological discussion is based on the Hanford Climatological Summaries (Stone et al. 1972 and PNL 1994g) and information compiled by Cushing (Cushing 1994 and 1995).

Prevailing winds at the Hanford Meteorological Station, located between the 200 Areas, are from the west-northwest and northwest in all months of the year. Monthly average wind speeds are lowest during December, averaging approximately 10 km/hr (6 mi/hr), and highest during June, averaging approximately 15 km/hr (9 mi/hr).

From 1961 through 1990, average monthly temperatures varied from -1 degrees centigrade (C) (30 degrees Fahrenheit [F]) in January to 24 C (76 F) in July with a yearly average of 12 C (53 F). On the average, 51 days during the year have maximum temperatures greater than or equal to 32 C (90 F) and 12 days have a maximum greater than or equal to 38 C (100 F). Also, an average of 25 days during the year have maximum temperatures less than 0 C (32 F) and 106 days per year have minimum temperatures less than 0 C (32 F).

The average annual precipitation measured is 16 cm (6.5 in.) with over half of this occurring from November through February. December, the wettest month, receives an average of 2.5 cm (1 in.), while July, the driest month, averages 0.5 cm (0.2 in.) of precipitation. The annual average snowfall is 38 cm (15 in.).

Although fog has been recorded throughout the year, nearly 90 percent of the occurrences are during the late fall and winter months. Other phenomena that restrict visibility to 10 km (6 mi) or less include dust and smoke (typically from wildfires, orchard smudging, and agricultural field burning). Reduced visibility from blowing dust occurs an average of five days per year, and reduced visibility resulting from smoke occurs an average of two days per year.

Severe high winds are often associated with thunderstorms. On average, the Hanford Site experiences 10 thunderstorms per year, most frequently (80 percent) during May through August.

Good atmospheric dispersion conditions exist at the Hanford Site about 57 percent of the time during the summer (PNL 1994g). Less favorable dispersion conditions occur when the wind speed is light and the mixing layer is shallow. These conditions are most common during the winter when moderately to extremely stable stratification exists about 66 percent of the time. The probability of an inversion period (e.g., poor dispersion conditions) extending more than 12 hours varies from a low of about 10 percent in May and June to a high of about 64 percent in September and October (Holzworth 1972).

4.3.2 Air Quality

Air quality in the Hanford Site area is good. However, levels of particulate matter occasionally exceed regulatory standards. These elevated levels are believed to result from natural sources such as the dust storms and brush fires that occur in arid eastern Washington State (PNL 1993a and Cushing 1994).

National Ambient Air Quality Standards have been established, as mandated in the Clean Air Act. Ambient air refers to air outside of buildings to which the general public has access. The National Ambient Air Quality Standards define levels of air quality that are considered protective of public health (primary standards) and welfare (secondary standards). The standards exist for the following pollutants: sulfur oxides (measured as sulfur dioxide), nitrogen dioxide, carbon monoxide, particulate matter (a particle that is less than 10 micrometers in diameter), lead, and ozone. The air quality standards specify maximum allowable pollutant concentrations and frequencies of occurrence for averaging periods ranging from one hour to one year, depending on the pollutant. Washington State has largely adopted the current Federal standards. However, Washington State has established more stringent standards for sulfur dioxide and ozone and also maintains an air quality standard for total suspended particulates and gaseous fluorides. Air quality standards are provided in Volume Five, Appendix G.

For selected pollutants for which no Federal or State air quality standards exist, the Hanford Site uses alternate methods of evaluation. For toxic organic compounds (e.g., benzene, toluene), comparisons are made to Occupational Health and Safety Administration's maximum allowable concentrations (29 Code of Federal Regulations [CFR] 1910). Polychlorinated biphenyls are evaluated against National Institute of Occupational Safety and Health occupational limits.

Sources of airborne emissions at the Hanford Site include combustion equipment (e.g., steam boilers, electric generation plants), coal handling operations, storage tanks, and waste handling and disposal. Operations such as these result in routine emissions of air pollutants, including radionuclides.

Under the Clean Air Act Amendments of 1990, the Hanford Site is classified as a major source for one or more criteria pollutants, as well as hazardous air pollutants. The Hanford Site is currently subject to the radionuclide National Emission Standard for Hazardous Air Pollutants (10 millirems per year [mrem/year]). The Clean Air Act requires an operating permit covering all emission sources of pollutants for which the Site is considered a major source. DOE has applied for a Sitewide Air Operating Permit for the Hanford Site.

For areas in attainment of the National Ambient Air Quality Standards, the EPA's Prevention of Significant Deterioration program is designed to protect existing ambient air quality in an area while also allowing a margin for future growth. Under the Prevention of Significant Deterioration program, new stationary sources of air pollution may only impact air quality by set increments, and best available control technology emission controls must be installed. The Hanford Site obtained a Prevention of Significant Deterioration permit in 1980 requiring specific limits for oxides of nitrogen emitted from the PUREX Plant and U Plant. These facilities were not operated in 1995 and no Prevention of Significant Deterioration permit violations occurred (Neitzel 1996).

Onsite air quality monitoring data are available for nitrogen oxides, polychlorinated biphenyls, and volatile organic compounds (PNL 1995). Monitoring of nitrogen oxides was discontinued after 1990 because the primary source (the PUREX Plant) ceased operation. The highest annual average nitrogen oxides concentration was approximately an order of magnitude below the Federal and Washington State standard of 0.05 parts per million. Nine out of 17 polychlorinated biphenyls samples collected during 1993 were below the detection limit of 0.29 nanograms per cubic meter, and thus well below the level of concern. Eight samples were above the detection limit, with results from 0.25 to 3.9 nanograms per cubic meter (Cushing 1995).

Based on a review of chemicals of concern for surveillance at the Site, three types of semi-volatile organic compounds were identified for monitoring, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and a phthalate ester plasticizer. Organochlorine pesticides also were analyzed. No phthalate esters were found above detection limits. Polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and organochlorine pesticides were found above detection limits. The measured pesticide concentrations were orders of magnitude below occupational exposure limits (PNL 1996).

Ten volatile organic compound samples were collected and analyzed in 1994. The samples were analyzed for halogenated alkanes and alkenes, benzene, and ethylbenzenes. Overall, the concentrations measured in 1994 were within the range of values reported in previous studies and also were within allowable regulatory limits (PNL 1995).

During 1993, the only offsite monitoring near the Hanford Site showed the 24-hour particulate matter standard of 50 micrograms per cubic meter ($\mu g/m^3$) being exceeded twice at the Columbia Center monitoring location in Kennewick. The maximum 24-hour concentration of 150 $\mu g/m^3$ was exceeded twice, with the highest level reaching 1,166 $\mu g/m^3$. The suspected cause was windblown dust. The annual primary standard of 50 $\mu g/m^3$ was not exceeded.

Radiological data were collected during 1995 through a network of 47 continuously operating samplers at onsite radiological monitoring stations, at the Site perimeter, and at nearby and distant communities. Cesium-137, plutonium-239, plutonium-240, strontium-90, and uranium were consistently detected in air samples collected in the 200 Areas. Concentrations were higher than those measured at offsite locations and were in the same range as measured in previous years . Levels measured at both onsite and offsite locations were much lower than the applicable standards (PNL 1996).

4.4 BIOLOGICAL AND ECOLOGICAL RESOURCES

The Hanford Site and adjacent region are a shrub-steppe vegetation zone that is dominated by a shrub overstory (top layer) with an understory (bottom layer) of grasses (Daubenmire 1970). Ecological resources on the Site are extensive, diverse, and important. Because the Hanford Site has not been farmed or grazed for over 50 years, it has become a refuge for a variety of plant and animal species (Gray-Rickard 1989). The Site contains one of the largest remaining undisturbed shrub-steppe areas in Washington State. Approximately 665 km^2 (257 mi^2) of undeveloped lands located onsite (nearly half the Site's total area) have been designated as ecological study areas or refuges.

4.4.1 Biodiversity

Biodiversity is the diversity of ecosystems, species and genes, and the variety and variability of life (CEQ 1993). Major components of biodiversity are plant and animal species, microorganisms, ecosystems, ecological processes, and the interrelationships between and among these components. Biodiversity is a qualitative measure of the richness and abundance of ecosystems and species in a given area (NPS 1994). Biodiversity also provides a moderating effect on wide fluctuations in environmental conditions .

Two major factors contributing to biodiversity on the Hanford Site are that 1) the Site is one of the largest relatively undisturbed tracts of native shrub-steppe left in the State of Washington; and 2) the Hanford Reach is the last free-flowing nontidal stretch of the Columbia River in the United States (Sackschewsky et al. 1992 and Cushing 1992). Other factors contributing to the Site's biodiversity include topographic features such as Rattlesnake Mountain, Gable Butte, and Gable Mountain; a variety of soil textures ranging from sand to silty and sandy loam; and the lack of human use and development over much of the Hanford Site. Specialized terrestrial habitats contributing to the biodiversity of the Hanford Site include areas of sagebrush-steppe, basalt outcrops, cliffs, and sand dunes. Aquatic components of biodiversity are mainly associated with the Columbia River and include aquatic habitats, wetland and riparian areas, and riverine habitats along the Hanford Reach shoreline and islands in the Columbia River.

Ecologically important plant and animal species on the Hanford Site include Federal and Washington State protected wildlife and plant species (Section 4.4.5); commercial and recreational wildlife species such as salmon, steelhead, mule deer, and upland game birds; and plant species used as a source of food, medicine, fiber, and dye by native people of the Columbia Basin (Section 4.4.6) (Sackschewsky et al. 1992).

As an indication of the Site's biodiversity, the Nature Conservancy of Washington has recently discovered 21 new plant and insect species on the Site. This includes new species of buckwheat and bladderwart plants and 19 species of insects (Nature Conservancy 1996) .

4.4.2 Vegetation

The Hanford Site is a relatively undisturbed area of shrub-steppe (Sackschewsky et al. 1992). Approximately 600 different plant species exist on the Site (Cushing 1994). Historically, the predominant plant in the area was big sagebrush with an understory of perennial bunch grasses. Following Euro-American settlement that began in the early 1800's, grazing and agriculture disrupted the native vegetation and opened the way for invader species such as tumbleweed, Russian-thistle, and cheatgrass.

The Central Plateau and the nearby area that contains the potential Vernita Quarry and McGee Ranch borrow sites predominantly consist of shrub-steppe. Figure 4.4.1 is a simplified vegetation map of the areas of the Hanford Site where TWRS activities are proposed. This includes plant communities dominated by big sagebrush and bitterbrush with an understory of cheatgrass or Sandbergs bluegrass. Shrub-steppe is considered a priority habitat by Washington State because of its importance to wildlife species of concern. Also, the National Biological Service has listed native shrub- and grassland-steppe in Washington State and Oregon as an endangered ecosystem. Over 100 plant species occur on the Central Plateau. Common species include big sagebrush, rabbitbrush, cheatgrass, and Sandbergs bluegrass. Much of the land surface of the 200 Areas has been disturbed by human activities. Introduced species such as Russian-thistle and cheatgrass are common in these disturbed areas (Cushing 1994). Approximately 58 percent of the 200 Area's 2,600 ha (6,400 ac) is disturbed by facilities, about 40 percent is shrub-steppe or recovering shrub-steppe, and 2 percent is cheatgrass (ASI 1995).

Figure 4.4.1 TWRS Areas Vegetation Types (Simplified)

Other vegetation in the 200 Areas includes wetland species associated with human-made ditches and ponds and introduced perennial grass planted to revegetate disturbed areas. Wetland species (e.g., cattail, reeds, and trees such as willow, cottonwood, and Russian-olive) are established around some of these ponds, none of which are in the immediate vicinity of any of the TWRS sites. Introduced perennial grass, such as Siberian crested wheatgrass, also has been used in the 200 Areas to revegetate and stabilize waste burial grounds against wind and water erosion.

Biological surveys of the TWRS sites in the 200 East Area and the immediately surrounding vicinity show that approximately 40 percent of the area is big sagebrush and grey rabbitbrush, both native species characteristic of shrub-steppe communities. Another 20 percent is Russian-thistle, with the remainder being either disturbed vegetation or bare gravel (PNL 1994e). The area of the proposed Phased Implementation alternative site in the easternmost portion of the 200 East Area contains both mature sagebrush habitat and areas disturbed by the development of grout vaults in the 1980's. None of the new plant species recorded by the Nature Conservancy were identified at any of the potential TWRS locations in the 200 Areas (Brandt 1996).

The tank farms and immediate surrounding areas in both the 200 East and West Areas are heavily disturbed. The potential Vernita Quarry, McGee Ranch, and Pit 30 borrow sites are all largely undisturbed shrub-steppe areas, with species such as big sagebrush, rigid sage, and spiny hopsage, and an understory of grasses such as Sandbergs bluegrass. Portions of the potential McGee Ranch borrow site were farmed in the early part of the twentieth century, and these farmed areas are dominated by cheatgrass and Russian-thistle. The McGee Ranch area is also an important wildlife and vegetation corridor connecting the Site with the Yakima Training Center further to the west. The Yakima Training Center and the Hanford Site are the two largest tracts of shrub-steppe remaining in Washington State (Fitzner 1992). The Washington State Department of Fish and Wildlife has asked DOE to preserve the McGee Ranch area as a wildlife corridor (Baker 1996).

4.4.3 Wildlife

Approximately 290 species of terrestrial vertebrates have been observed at the Hanford Site, including 41 species of mammals, 238 species of birds, 3 species of amphibians, and 9 species of reptiles (Weiss-Mitchell 1992). Major terrestrial habitat types on the Hanford Site include basalt outcrops, scarps (cliffs) and screes, riparian areas, shrub-steppe, sand dunes, and abandoned fields (Downs et al. 1993).

Predominant mammal species include the mule deer and Rocky Mountain elk; predators such as coyotes, bobcats, and badger; and a variety of small mammals (marmots, squirrels, rabbits) (Cushing 1992). The elk population, which has grown during the Hanford Site's existence, occurs primarily on the Fitzner Eberhardt Arid Lands Ecology Reserve , although elk reportedly also have been sighted on the islands in the Columbia River and along the Columbia River (CTUIR 1996) . Mule deer may occur almost anywhere on the Hanford Site, although they are found more commonly along the Columbia River. White-tailed deer have been sighted occasionally along the Columbia River and at the Yakima River Delta in Richland.

The approximately 240 bird species on the Hanford Site include a variety of raptors (birds of prey), songbirds, and species associated with riparian and upland habitats (Landeen et al. 1992). No riparian or upland habitats exist within 3 km (2 mi) of any of the TWRS sites under any alternative. Twenty-six species of raptors have been sighted, 11 of which are known to nest on the Site. These include five species of owls, the northern harrier, three hawk species, the prairie falcon, and the American kestrel. Songbird species known to occur in the Hanford Site's shrub-steppe vegetation include the loggerhead shrike, sage sparrow, western meadowlark, grasshopper sparrow, common raven, horned lark, and sage thrush. The western meadowlark, sage sparrow, and horned lark are the most abundant shrub-steppe songbird species that breed on the Site. Common upland game bird species include the chukar partridge, California quail, and Chinese ring-necked pheasant. Sage grouse and gray partridge are less common, with the once common sage grouse now essentially displaced from the Site since a major wildfire occurred in 1984. None of the upland birds are native to the area except the sage grouse.

Nine species of reptiles and three species of amphibians occur on the Hanford Site. The most abundant reptile is the side-blotched lizard. The short-horned lizard and northern sagebrush lizard also are common in habitats such as mature sagebrush. Common snakes include the gopher snake, yellow-bellied racer, and Pacific rattlesnake. Less common are the striped whipsnake and desert night snake. Amphibians on the Hanford Site, which are associated with riparian habitats located along permanent water bodies of the Columbia River, include the Great Basin spadefoot, Woodhouses toad, and the Pacific treefrog. More than 300 species of terrestrial and aquatic insects occur on the Hanford Site (Cushing 1992). Grasshoppers and darkling beetles represent some of the more conspicuous groups.

Aquatic habitats on the Hanford Site, none of which are near any TWRS sites, are associated primarily with the Columbia River, two small spring-fed streams on the Fitzner Eberhardt Arid Lands Ecology Reserve, West Lake, and artificial ponds and ditches occurring in or near the 200 Areas (Cushing-Watson 1974, Emery-McShane 1978, and Cushing 1994). The Columbia River supports a large and diverse community of plankton, benthic invertebrates, and fish. The springs are also diverse and productive (e.g., dense watercress blooms and a fairly high insect production). The artificial ponds and ditches, many of which are abandoned and dried out, often provide lush riparian habitat and support populations of migrating and breeding birds, particularly waterfowl.

4.4.4 Sensitive Habitats

Sensitive habitats on the Hanford Site include wetlands and riparian habitats. However, there are no sensitive habitats at or near any TWRS sites (Cowardin et al. 1979). The Hanford Site's primary wetlands occur along the Columbia River. Other Hanford Site wetland habitats are associated with human-made ponds and ditches (e.g., B Pond and its associated ditches located near the 200 East Area). Wetland plants occurring along the shoreline of B Pond include herbaceous and woody species such as showy milkweed, western goldenrod, three square bulrush, horsetail rush, common cattail, and mulberry, among others (Sackschewsky et al. 1992). Wildlife species observed at B Pond include a variety of mammals and waterfowl species (Meinhardt-Frostenson 1979).

4.4.5 Species of Concern

Species of concern on the Hanford Site include Federally-listed threatened and endangered species, Federal candidate species (50 CFR 17), Washington State threatened or endangered species, Washington State candidate species, monitor species, and sensitive plant species.

No Federally-listed threatened or endangered plant or animal species occur on or around the Central Plateau (Sackschewsky et al. 1992). Pipers daisy, a Washington State sensitive species, has been found at B Pond near the 200 East Area and at the potential Pit 30 borrow site between the 200 East and 200 West Areas. The crouching milkvetch, stalked-pod milkvetch, and squill onion, all Washington State Class 3 monitor species, also are found in the vicinity (Duranceau 1995). Class 3 monitor species are either more abundant or less threatened than previously assumed, or both.

Wildlife species of concern on the Central Plateau and vicinity include the loggerhead shrike, which is a Federal and Washington State candidate species, and the sage sparrow, which is a Washington State candidate species. Both species nest in undisturbed sagebrush habitat in the Central Plateau and nearby areas. Other bird species of concern that may occur in shrub-steppe habitat of the Hanford Site are the burrowing owl, a Washington State candidate species; the ferruginous hawk, a Washington State threatened and Federal Category 2 candidate species; the golden eagle, a Washington State candidate species; the long-billed curlew, a Washington State monitor species; the sage thrasher, a Washington State candidate species; the prairie falcon, a Washington State monitor species; and Swainsons hawk, a Washington State candidate species (Downs et al. 1993, Sacksewsky et al. 1992, and Landeen et al. 1992).

The western sage grouse, a Federal and State-listed threatened species, was present in areas near the Central Plateau until the local population was displaced by a major wildfire in 1984. The sage grouse has not been observed on the Site since that time. The bald eagle, also a Federal and State-listed species, has been a regular winter resident in recent years of the Hanford Reach of the Columbia River. The bald eagle forages on salmon carcasses and waterfowl along the river and is not known to use the Central Plateau of the Site, which is 10 km (6 mi) or more from the river.

Nonavian wildlife species of concern include the striped whipsnake, a Washington State candidate species; the desert night snake, a Washington State monitor species; the pygmy rabbit, a Federal Category 2 candidate species; and the northern sagebrush lizard, also a Federal Category 2 candidate species.

Prehistorically and historically, the Native Americans of the Hanford Site vicinity fished for salmon in the Columbia River, gathered roots in the areas now called Moses Lake and Ephrata, and hunted and gathered berries in the mountains. They wintered in the lowlands by the Columbia River. However, the Native Americans hunted, fished, and gathered foods whenever the opportunities presented themselves.

Big game , including elk and antelope, were abundant on the Columbia Plateau , according to affected Tribal Nations (CTUIR 1996) . Smaller mammals (marmots, squirrels, rabbits) were important food sources in the area. Bird species were a food source , and birds and bird parts also were used for medicinal and religious purposes (Hunn 1990). Fish were and remain an important part of the Native American diet in the Columbia River area. Although the 200 Areas themselves have no fishery resources, the fishery resource of the Hanford Reach of the Columbia River is important to Native Americans.

Plants have been and remain important to Native Americans for food, medicine, cordage, building materials, and as materials of religious and spiritual significance. For example, a substantial portion of the aboriginal diet was composed of food plants, with tubers being the most important food plant type (Hunn 1990). Several dozen plant species with specific uses (e.g., medicine, food) in traditional Native American culture and lifestyles have been identified on the Hanford Site by non-Native American researchers. A number of these species were identified in the 200 East Area during 1994 biological surveys (Fortner 1994). In the Native American view, however, identifying specific plant species as being of particular value is inappropriate because "any such attempts at separating interdependent components of a holistic system are contrary to tribal and cultural resources values" (CTUIR 1994).

4.5 CULTURAL RESOURCES

Three categories of cultural sites at the Hanford Site include 1) prehistoric sites, which represent Native American cultures and societies; 2) historic era sites, which generally must be at least 50 years old, although items and structures built in support of the Hanford Site's defense mission during World War II and the Cold War Era must also be considered (PNL 1989); and 3) ethnographic sites (traditional cultural sites) that are important to the heritage of contemporary Native American communities. The Hanford Site contains a rich diversity of known cultural sites in all three categories.

The Hanford Site contains seven districts listed in the National Register of Historic Places, as well as numerous other well-preserved archaeological sites. The overall condition and thus potential importance of the Hanford Site's cultural sites is high because the area has had limited public access for over 50 years. Limited access has preserved most archaeological sites from looting and other adverse impacts. Areas similar to the Hanford Site along the Columbia River have been inundated by water from hydroelectric development. Because the Hanford Site has not experienced this type of development and the resulting depletion of cultural sites, it represents a uniquely preserved area.

In addition to its archaeological and historic sites, the Hanford Site land is of importance to Native American peoples because all natural resources are also cultural resources to indigenous peoples (CTUIR 1996) . The Hanford Site also is part of the original homeland of several Hanford Site Nations (CTUIR 1996) .

Archaeological sites in the 200 Areas are scarce (Chatters-Cadoret 1990). Cultural resource surveys have been conducted within the 200 East Area covering all undeveloped areas (Chatters-Cadoret 1990). The number of prehistoric and historic archaeological sites recorded as the result of these surveys is very limited. Findings recorded in the areas around and including the TWRS sites consist of isolated artifacts and four archaeological sites (ASI 1994). Cultural resources surveys of the TWRS sites and immediate vicinity in the 200 East Area, which were conducted in 1994, found no sites eligible for the National Register of Historic Places (PNL 1994a, b, c). Past surveys of the Phased Implementation alternative site in the easternmost portion of the 200 East Area revealed no archaeological sites (Cadoret 1995). However, both the 200 East and 200 West Areas contain potentially historic buildings and structures associated with the Hanford Site's defense mission (Crist 1994).

Surveys of the 200 West Areas recorded a few historic sites, isolated archaeological artifacts, and a segment of the historic White Bluffs Road that runs across the Site between Rattlesnake Springs and the Columbia River (Chatters-Cadoret 1990). The White Bluffs Road, which has been nominated for the National Register of Historic Places, traverses the northwest corner of the 200 West Area. This road was used in prehistoric and historic times by Native Americans and was an important transportation route for Euro-Americans in the 19th and early 20th century for mining, agriculture, and other development uses. The segment in the 200 West Area is not considered an important element in its historic value because it has been fragmented by past activities (Cadoret 1995). However, the Confederated Tribes of the Umatilla Indian Reservation have indicated that the White Bluffs Road is important culturally to Native Americans even though it has been affected by past activities (CTUIR 1996).

The potential Vernita Quarry and McGee Ranch borrow sites have potential for both historic and prehistoric materials. Surveys have identified prehistoric isolated artifacts and prehistoric or historic sites at both Vernita and McGee Ranch (Duranceau 1995). The McGee Ranch area has been determined to be eligible for nomination to the National Register of Historic Places as the McGee Ranch/Cold Creek District (Cadoret 1995). No prehistoric sites are known at the potential Pit 30 borrow site, which is located between the 200 East and 200 West Areas, although one structure from the homestead era is located at Pit 30.

4.5.1 Prehistoric Resources

As indicated previously, survey data for the 200 East Area revealed no substantial prehistoric resources (Chatters-Cadoret 1990). Much of the land surface in the 200 Areas has been extensively disturbed by previous construction and other development activity, although disturbed areas still have the potential to contain cultural resources . The 1994 survey of the TWRS sites and surrounding vicinity in the 200 East Area revealed only isolated artifacts and sites (scattered stone tool fragments) (PNL 1994a, b, c). There also are very few known prehistoric sites in the relevant portions of the 200 West Area. Prehistoric materials have been found at the potential Vernita Quarry and McGee Ranch borrow sites.

4.5.2 Historical Resources

The first Euro-Americans to enter this region were Lewis and Clark in the beginning of the nineteenth century. By the early twentieth century, cattle ranching, farming and several small, thriving towns were present, including Hanford, White Bluffs, and Ringold. The towns, settlements, and nearly all other structures were razed after the Federal government acquired the land for the Hanford Site in the early 1940's (PNL 1989 and Cushing 1994). Today, the remnants of homesteads, farm fields, ranches, and abandoned military installations can be found throughout the Hanford Site. There are nearly 5,200 ha (13,000 ac) of abandoned agricultural lands on the Site.

More recent are the nuclear reactors and associated processing facilities developed during the Manhattan Project and the Cold War era that are found on the Site. The various reactor sites around the Hanford Site cover over 900 ha (2,300 ac) of land area. All of the reactor buildings and major processing facilities still stand, although many ancillary support structures have been removed. The 100-B Reactor has been listed individually on the National Register of Historic Places and is a National Mechanical Engineering Monument and approximately 110 other buildings have been evaluated. The Washington State Historic Preservation officer and DOE have determined that the Hanford Site is a Manhattan Project/Cold War era historic district (Neitzel 1996). There are plans to complete the process of inventorying and evaluating the remaining buildings and structures associated with the Manhattan Project and Cold War Era in the 200 Areas by the end of 2000 (DOE 1996e) . Currently, historic structure evaluations at the Hanford Site are conducted on an as-needed basis before altering or demolishing a structure.

Historic buildings associated with the development of nuclear technology exist in both of the 200 Areas, particularly plutonium production and processing facilities. Few of these have been evaluated for National Register of Historic Places eligibility, although none are expected to be impacted by TWRS activities under any alternative (PNL 1989 and Cushing 1995). The underground storage tanks that currently contain the tank waste may be considered historically important. A Programmatic Agreement concerning cultural resources management of the built environment at the Hanford Site has been signed by the U.S. Department of Energy (DOE) , the Advisory Council on Historic Preservation, and the Washington State Historic Preservation Office (DOE 1996e). Under the agreement, DOE will document one SST and one DST on historic property inventory form.

4.5.3 Native American Sites

The Hanford Site vicinity contains lands ceded to the United States by both the Confederated Tribes and Bands of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation in the treaties of 1855. Until 1942, the Wanapum resided on land that is now part of the Hanford Site. In 1942, the Wanapum People moved to Priest Rapids when the Hanford Site was established. The Nez Perce Tribe also retained rights to the Columbia River under a separate treaty with the U.S. Government.

The area of the Hanford Site near the Columbia River has been occupied by humans for over 10,000 years, as reflected by the extensive archaeological deposits along the river shores. Inland areas with water resources also point to evidence of concentrated human activity. Recent surveys indicate extensive although dispersed use of semi-arid lowlands for hunting. However, surveys have recorded very few Native American sites or artifacts in and around the 200 Areas (Chatters-Cadoret 1990). Native American sites and artifacts have been identified at both McGee Ranch and the Vernita Quarry (potential borrow sites) .

Native Americans have retained traditional secular and religious ties to the Hanford Site. No specific sites of religious significance have been identified at the TWRS sites. However, affected Tribal Nations indicate that there are culturally important biota, sacred sites such as Gable Mountain, and other culturally important properties within areas that might be impacted by TWRS alternatives (i.e., groundwater downgradient from TWRS sites, the Columbia River, and locations downwind of possible TWRS air releases) (CTUIR 1996).

4.6 SOCIOECONOMICS

The socioeconomic analysis focuses on Benton and Franklin counties. The counties make up the Richland-Kennewick-Pasco Metropolitan Statistical Area, also known as the Tri-Cities, a term that is frequently used to designate the Metropolitan Statistical Area. Other jurisdictions in Benton County include Benton City, Prosser, and West Richland. Connell is the largest city in Franklin County after Pasco. Neighboring counties (Yakima, Walla Walla, Adams, and Grant counties in Washington and Umatilla and Morrow counties in Oregon) are impacted by activities at the Hanford Site; however, in terms of socioeconomics, the Site's impacts on these counties is very small (Serot 1995).

On February 11, 1994, Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, was published in the Federal Register. The Order requires Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. Currently, no formal guidelines have been adopted to implement the Executive Order; however, EPA has published relevant studies and information on environmental justice. DOE is a participating member of this task force.

In accordance with Executive Order 12898, information is provided in Section 4.6.1 concerning the minority populations and low-income populations within an 80-km (50-mi) radius of the Hanford Site. This discussion provides the basis for analyzing potential disproportionate and adverse environmental impacts of TWRS EIS alternatives on minority populations and low-income populations. The 80-km (50-mi) radius includes counties not otherwise addressed in this section because overall Hanford Site socioeconomic impacts on these counties are very minor. However, the section does describe minority population and employment within the Hanford Site's primary zone of socioeconomic influence, the Tri-Cities area (Benton and Franklin counties).

Before World War II, the economy in the Tri-Cities area was based primarily on agriculture. Since World War II, the Hanford Site has been the largest factor in the local economy. Plutonium production and processing was the primary mission of the Site until 1988, when the mission changed to environmental restoration and waste management. Basic and applied research are an important secondary mission.

Historically, changes in the Hanford Site's mission and the cancellation in the early 1980's of a Washington Public Power Supply System project at the Hanford Site have had measurable impacts on the economy of the Tri-Cities area. Boom-bust cycles have occurred that have had ramifications for employment, population, housing, and infrastructure. Table 4.6.1 shows Hanford Site employment, Washington Public Power Supply System employment, and total nonfarm employment for the Tri-Cities area, together with the area's population for 1980 to 1994. These data do not reflect the ongoing reductions in Site employment in 1995 (i.e., an expected reduction from 1994 levels of approximately 4,500 jobs by the end of 1995). The Washington Public Power Supply System workforce was reduced to approximately 1,500 by mid-1995.

4.6.1 Demographics

4.6.1.1 Population Trends

Population tended to follow changes in nonfarm employment in the Tri-Cities area during the 1980's and early 1990's

(Table 4.6.1). The population trends apparently reflected not only existing employment at the Hanford Site and elsewhere in the area, but also expectations about future employment opportunities.

Table 4.6.1 Population and Employment in the Tri-Cities Area, 1980 to 1994

Table 4.6.2 shows the 1990 population for Benton and Franklin counties and, for comparison, Washington State by race and minority status. The data show that minorities are a smaller percentage of Benton County population (8.7 percent) than in Franklin County (28.2 percent) or in Washington State (11.5 percent). The largest minority group in the area is the Hispanic Origin group, which makes up 30.2 percent of the population of Franklin County and 7.7 percent of Benton County. African Americans make up 1 percent of Benton County's population and 3.5 percent of Franklin County's population. Native Americans account for less than 1 percent of the population in each county, while Asians and Pacific Islanders account for approximately 2 percent of each county's population.

Benton County's farm population is more than twice as large (as a percentage of total population), than for Washington State as a whole (12.6 percent to 5.5 percent). Franklin County's farm population is almost five times as large on a percentage basis (24.9 percent) as Washington State's farm population. Franklin County's nonfarm rural population makes up 30 percent of the county's total population, which is virtually the same as the State's (29.3 percent), while more than twice the percentage in Benton County (13.0 percent). These data suggest the relative importance of farming in Franklin County and to a lesser extent in Benton County as compared to Washington State as a whole.

Table 4.6.2 Population by Race and Minority Status, 1990

4.6.1.2 Minority and Native American Populations and Low-Income Populations Within an 80-km (50-mi) Radius of the Hanford Site

Federal environmental justice policy requires identifying all minority and Native American and low-income populations that potentially could be subject to disproportionately high and adverse impacts resulting from the proposed action (EO 12898). Identifying potentially impacted minority and Native American populations and low-income populations in the 80-km (50-mi) area surrounding the Hanford Site's Central Plateau (where TWRS activities would be focused) involved analyzing the 1990 census data (DOC 1991). In 1990 the 80-km (50-mi) radius surrounding the Hanford Site contained a total population of approximately 448,000 and includes all of Benton County and portions of another nine surrounding counties (seven in Washington State and two in Oregon). Much of the Yakama Indian Reservation is located within the 80-km (50-mi) radius. The Wanapum People maintain a small residential community north of the Site near Priest Rapids Dam. In addition, the Confederated Tribes of the Umatilla Indian Reservation (located in northeastern Oregon) and the Nez Perce Tribe (located in northern Idaho) have historical and treaty interests in the Hanford Site area.

The process of identifying minority and Native American and low-income communities for the EIS environmental justice analysis is described in Volume Five, Appendix I (Section I.6.1).

Minority and Native American Populations

As of the 1990 census, the 80-km (50-mi) area surrounding the Hanford Site's Central Plateau had a total minority and Native American population of 86,400. The area's minority and Native American population of 19.3 percent exceeded the Washington State average of 13.1 percent. The Hispanic population (14.3 percent or 64,300 individuals) is the area's principal minority group. The Hispanic population is relatively evenly dispersed throughout the area. African American (1.2 percent or 5,200 individuals) and Asian (1.4 percent or 6,100 individuals) populations are very small and are located predominantly in Yakima, Benton, and Franklin counties. The Native American population consists of 2.4 percent or 10,800 of the area's population. The Native American population is predominantly located on the Yakama Indian Reservation. Other Native American populations include members of the Confederated Tribes of the Umatilla Indian Reservation, the Wanapum People, and the Nez Perce Tribe.

Of the 97 census tracts that are contained completely or partially within the 80-km (50-mi) radius of the Site in 1990, 17 had minority and Native American populations greater than 33 percent of the census tracts, total population (Figure 4.6.1). These 17 census tracts contained less than one-fifth of the area's total population, but more than half of its total minority and Native American population. Moreover, these 17 census tracts were home to over 63 percent of the area's Native American residents and at least 56 percent of the area's Hispanic population. The 17 tracts had an average minority and Native American population of nearly 52 percent per tract. The fact that these 17 tracts contained more than half of the 80-km (50-mi) area of interest's total minority and Native American population is the reason that they are the focus of the EIS environmental justice analysis.

Figure 4.6.1 Census Tracts Within an 80-km (50-mi) Radius of the Hanford Site With Minority Populations Greater Than 33 Percent of the Tract Populations

Geographically, the tracts with the highest fraction of minority and Native American populations are located in Adams, Grant, Franklin, and Yakima counties, and the Yakama Indian Reservation. Of the remaining 80 census tracts in the area of interest, 49 had 1990 minority and Native American populations of less than 10 percent, 23 had minority and Native American populations under 20 percent, and eight had minority and Native American populations between 21 percent and 33 percent. Five census tracts, all located within the Yakama Indian Reservation, contained substantial Native American populations. In 1990, these tracts had nearly 57 percent of the 80-km (50-mi) radius area's Native American population and were the only census tracts in the area where the percentage of Native American population exceeded 8 percent of the census tract's total population.

All of the 17 census tracts with a minority and Native American population greater than 33 percent in 1990 had large numbers of individuals listed in the census "Other" category (census categories include White, Black, American Indian, Asian, and Other; the Other category generally is thought to include many Hispanics). In all but 3 of the 17 tracts, the Other category alone accounted for more than 33 percent of the tract's total population. Two of these three tracts are located on the Yakama Indian Reservation and have substantial Native American populations; the third tract is located in Franklin County.

Low-Income Populations

In all, 25 of the 97 census tracts within the 80-km (50-mi) radius of the Hanford Site had 1990 low-income populations greater than 22 percent of their total population (Figure 4.6.2). These 25 census tracts contained approximately 28 percent of the area's total residents and 51 percent of the region's total low-income population. The fact that the 25 tracts contained more than half of the region's total low-income population is the reason that they are the focus of the environmental justice analysis of low-income populations. The 25 tracts had a total average low-income population of more than 31 percent. The tracts with high low-income populations (22 percent or greater) are located in Adams, Grant, Franklin, and Yakima counties (including the Yakama Indian Reservation). Of the remaining 72 census tracts, 30 tracts had low-income populations in 1990 less than the Washington State average of 10.9 percent; 27 tracts had low-income populations between 11 percent and 17.3 percent (the average low-income population level for the 80-km [50-mi] radius); and 15 tracts had low-income populations between 17.4 percent and 21.4 percent. Fourteen of the 26 census tracts with low-income populations under the Washington State average of 10.9 percent were located in Benton County (12 tracts) or in the two Franklin County tracts closest to the Hanford Site transportation access.

4.6.1.3 Household Income and Educational Attainment

The largest fraction of Franklin County's households is in the $15,000 to $24,999 yearly income range (DOC 1991). Benton County has the largest fraction of its households in the $35,000 to $49,999 yearly income range. Median household yearly income in Benton County was $ 41,800 in 1993 , while per capita income was $21,030 . Median household yearly income in Franklin County was $ 30,525 in 1990, while per capita income was $ 17,230 . For Washington State, 1993 median household yearly income was $37,316 , per capita income was $ 21,770 and the largest fraction of its households have yearly incomes in the $35,000 to $49,000 range (Neitzel 1996) .

Figure 4.6.2 Census Tracts Within 80-km (50-mi) of the Hanford Site With Low-Income Populations Greater

Than 22 Percent of the Tract Populations

Data on persons and families below the poverty level indicate that for most categories, Benton County has very similar poverty rates to Washington State as a whole (11.1 percent compared to 10.9 percent), while Franklin County has substantially higher poverty rates, at 23 percent of the population. Benton County residents have approximately the same level of educational attainment as residents statewide, while Franklin County residents tend to have a lower level of educational attainment.

4.6.2 Public Facilities and Services

Police protection is provided by the county sheriff departments of Benton and Franklin counties, local municipal police departments (Pasco, Richland, Kennewick, and West Richland), and the Washington State Patrol division in Kennewick. Fire protection in the Tri-Cities area is provided by fire departments in the cities of Kennewick, Pasco, and Richland, a volunteer fire department in West Richland, and three rural fire departments in Benton County. While recent population growth has created additional stress on local public safety agencies' service capabilities, discussions with local government representatives indicated that to date it has not impacted the agencies' ability to adequately serve their jurisdictions. Pasco, Richland, and West Richland indicate that any additional growth will require augmenting public safety agencies' capabilities (McDonald 1995, Milspa 1995, Corcoran 1995). Kennewick's existing agencies could handle modest growth (up to 1,000 additional residents) before additional capabilities are needed (White 1995).

Public safety services are also provided at the Hanford Site. Historically, the Hanford Patrol has provided security and law enforcement services at the Site, although the Benton County Sheriffs Department began providing law enforcement support at the Site in 1994. The Hanford Fire Department has five fire stations onsite and a complement of 155 firefighters (Neitzel 1996) .

There are three major hospitals in the Tri-City area; the Kadlec Medical Center in Richland, Kennewick General Hospital in Kennewick, and Our Lady of Lourdes Hospital in Pasco, all of which operat e at 35 to 50 percent of their capacity (Neitzel 1996). There are also four minor emergency centers in the area. The Hanford Environmental Health Foundation operates five health service centers on the Hanford Site.

Educational services at the primary and secondary levels are provided by four school districts. Kennewick is the largest district, serving approximately 13,000 students in 1994, with 8,700 students in the Richland district, 7,800 students in the Pasco district, and 1,500 students in the Kiona-Benton district. Enrollments have been on the rise over the last few years and all four districts were operating at or near their capacity during the 1994 school year (Cushing 1995). Preliminary data for the 1995 school year show enrollment growth continuing at 2.6 percent in Kennewick, 0.9 percent in Richland, 1.1 percent in Pasco, and 5.1 percent in Kiona-Benton over 1994 levels (Foley 1995, Marsh 1995, Brown 1995, Meilour 1995, and Haun 1995). In 1995, the Richland, Kennewick, and Kiona-Benton districts were operating at capacity, while the Pasco district was at capacity in the primary grades but had more room for secondary students (Neitzel 1996). Post-secondary education in the area is provided by Columbia Basin College (1995 enrollment of 6,700) and the Washington State University Tri-Cities branch campus (1995 enrollment of 1,200).

Electricity in the Tri-Cities is provided by the Benton County Public Utility District, Benton Rural Electrical Association, Franklin County Utility District, and the city of Richland Energy Services Department. The Bonneville Power Administration, a Federal power marketing agency, supplies all the power that these utilities provide in the local area as well as the Hanford Site's electrical power. Hydroelectric is the region's largest electrical power source. Throughout the 1980's, the Pacific Northwest had more electrical power than it needed and operated with a surplus. This surplus has been exhausted, however, and the regional system generates only enough power to meet regional needs (Neitzel 1996). Natural gas serves only a small portion of the regions residents (Neitzel 1996).

The major incorporated areas of Benton and Franklin counties are served by municipal wastewater treatment systems and the unincorporated areas are served by onsite septic systems. The wastewater treatment systems of the cities of Richland, Kennewick, and Pasco all currently operate well under their capacity (Cushing 1995).

Sanitary waste in the Hanford Site's 200 Areas is currently disposed of through septic tanks and drain fields. There are concerns about the ability of the current system to handle projected sanitary waste disposal needs. Planned construction of a central collection and treatment facility in the 200 Areas was cancelled in 1995 because of funding problems (Harvey 1995).

The city-operated Richland Sanitary Landfill (with a current life expectancy of 50 years), serves Richland and Benton County (Penour 1994). The city of Kennewick contracts for solid waste disposal; city waste is disposed of at a landfill in Arlington, Oregon, which has a life expectancy of approximately 50 years (Denley 1994). The cities of Pasco and West Richland also contract for solid waste disposal; wastes from both communities are taken to a facility in Roosevelt, Washington, which has a life expectancy of 40 years (Thiele 1995).

The existing Hanford Site nonradioactive solid waste landfill is expected to reach its capacity in 1996. In October 1995 it was announced that DOE and the city of Richland reached an agreement to send the Site's nonregulated, nonradioactive solid waste to the Richland Sanitary Landfill (DOE 1995k).

4.6.3 Economy

The Hanford Site is the largest employer in the Tri-Cities area and is a key factor in the local economy. In 1994, total nonfarm employment in the area averaged about 72,300, while Hanford Site employment averaged about 18,400. The Hanford Site thus represents approximately 25 percent of total nonfarm employment in the Tri-Cities. Most Hanford Site employees are considered as part of the services sector of the local economy. In addition, other workers not included in DOE's count of Hanford Site employees provided goods and services to the Site or its contractors.

Nonfarm employment grew to approximately 72,300 in 1994. However, as Hanford Site employment declined in 1995 from 18,100 to 14,500 from August 1994 to August 1995, and as construction employment also declined with a slowdown in housing construction, total nonfarm employment as of August 1995 declined to approximately 70,900 (Schafer 1995a). Agriculture, food processing, retail trade, and other industries provide a considerable and increasing amount of economic diversity to the Tri-Cities area. Farm employment, which fluctuates seasonally, averages a total of nearly 8,000 in the Tri-Cities area. Because farm employment is not impacted by Hanford Site activities it is not discussed further in this section.

4.6.3.1 Industries and Employment

Table 4.6.3 details average annual employment by different sectors of the economy in 1993. The economic sector with the highest employment is services, which includes most of the Hanford Site workforce. The next largest sector is wholesale and retail trade. The Tri-Cities area is the main retailing center for southeastern Washington State and northeastern Oregon. Government is the third largest sector, including Federal, State, and local governments and the public schools. Construction has been a key employment sector in the past few years. Food processing is the largest manufacturing industry, followed by chemicals. The 1995 decline in nonfarm employment previously mentioned most strongly impacted the services sector (which includes most Site employees) and the construction sector.

The services sector dominates the Tri-Cities economy, accounting for $769 million in wages, or about 43 percent of total wages paid in the two counties (WSDES 1994). Statewide, services accounted for

only 21 percent of annual wages paid. The average annual wage in the services sector in Benton County was more than $34,000, compared to $17,000 in Franklin County and $23,000 statewide. The higher annual wage in the services sector in Benton County reflects the Hanford Site-related technical and professional work force.

4.6.3.2 Labor Force

Data for 1990 show that the Benton County labor force is concentrated in the managerial and professional, and the technical, sales, and administrative occupations, each of which accounts for about 30 percent of the work force (WSDES 1994). Franklin County has far lower percentages in these categories.

Table 4.6.3 Average Annual Employment by Sector Tri-Cities Area, 1993 and 1995

Technical, sales, and administrative occupations and farming, forestry, and fishing occupations each account for about 21 percent of the Franklin County labor force. Franklin County also has a higher percentage of workers in the operators, fabricators, and laborers occupational category (17.3 percent) than Benton County (12.0 percent).

Hispanics make up 6.9 percent of the total Benton County labor force, 2.2 percent of the managerial and professional category, 46 percent of the agricultural workers, and 11.9 percent of the operators, fabricators, and laborers category. In Franklin County, Hispanics make up 28.3 percent of the total labor force, 7.2 percent of the managerial and professional occupational category, 63 percent of the agricultural workers, and 28 percent of the precision production, craft, and repair occupational category.

African Americans, who make up 0.9 percent of the labor force in Benton County, account for 1.4 percent of the managerial and professional category, while in Franklin County they account for 2.1 percent of the labor force and 2 percent of the managerial and professional category. Native Americans account for a slightly larger percentage of the service (1.3 percent); precision production, craft, and repair (1.1 percent); and operators, fabricators, and laborers (1.2 percent) categories in Benton County than their percentage of the total labor force (0.7 percent). In Franklin County, Native Americans account for a larger percentage of the managerial and professional (1.1 percent) and precision production, craft, and repair categories (1.5 percent) than in the total labor force (0.8 percent).

Asians and Pacific Islanders account for 2 percent of the labor force in Benton County and 2.7 percent of the managerial and professional category. The same group accounts for 2 percent of the labor force in Franklin County, but only 1.2 percent of the managerial and professional category. Service occupations show the highest rate of Asian and Pacific Islander representation in both counties.

Women account for 40.4 percent of the labor force in Benton County and 42.7 percent in Franklin County. Women account for 51.5 percent of the managerial and professional category in Benton County and 39.4 percent in Franklin County. In the other occupational categories the representation of women is similar in the two counties.

4.6.3.3 Tax Base

Local government revenues in Benton and Franklin counties come primarily from property taxes and the local share of sales taxes (Serot 1993). In 1993, assessed property values were about $3.8 billion in Benton County and $1.3 billion in Franklin County. These assessed values were $500 million more than 1992 assessments in Benton County (15 percent increase) and $86 million more in Franklin County (7 percent increase).

In 1992, the last year for which complete data are available, taxable retail sales in Benton County were $1,054 million and $400 million in Franklin County (WSDR 1993). This was a 14 percent increase in Benton County over 1991 levels and a 16 percent increase in Franklin County. Between 1988 and 1992, combined taxable retail sales for the two counties increased about 10.5 percent per year.

4.6.3.4 Housing and Real Estate

The growth in employment and population in the Tri-Cities area between 1989 and 1994 created a very tight housing market and rising home prices, which began to soften in early 1995 due to reductions in Hanford Site employment (TAR 1980-95). The tight housing market also was reflected in very low vacancy rates and increasing prices in rental housing, although new construction and Hanford Site employment reductions caused a softening of the rental market in 1995 as well (Sivula 1995). The Hanford Site's environmental restoration and waste management mission also stimulated some new commercial construction.

4.7 LAND USE

This section describes current and future land uses on and adjacent to the Hanford Site. The description focuses on the 200 Areas but includes the remainder of the Hanford Site and the surrounding offsite land-use patterns. Also addressed are the future planning efforts of tribes and Federal, State, and local agencies. Prime and unique farmlands and recreational opportunities also are discussed.

4.7.1 Existing Land-Use Types

4.7.1.1 Hanford Site Development Plan and Comprehensive Land-Use Plan

The Hanford Site Development Plan (DOE 1993e) provides an overview of existing Site land use, infrastructure, and facilities, and presents DOE's vision as of 1993 for future Site land uses and infrastructure as needed by Hanford Site missions. A Draft Comprehensive Land-Use Plan for the Hanford Site was release d for public review and comment in August 1996 (DOE 1996c). DOE invited the affected Tribal Nations , county and city government, and stakeholders to participate in the land-use planning process. Final land-use planning decisions are scheduled for 1997.

The purpose of the Site Development Plan, which is not a comprehensive formal land-use plan and does not mandate specific Federal actions, was to present Site development issues that require a commitment of resources. Until the Comprehensive Land-Use Plan is completed, the Hanford Site Development Plan and its Future Land-Use Map (Figure 4.7.1) represent the most currently available document on DOE's concepts for future Site land uses.

Figure 4.7.1 Future Land-Use Map

Figure 4.7.2 identifies the existing land uses on the Hanford Site. The seven major Hanford Site land-use categories are 1) Reactor Operations; 2) Waste Operations; 3) Operations Support; 4) Administrative Support; 5) Research and Development and Engineering Development; 6) Sensitive Areas (including environmentally or culturally important areas); and 7) Undeveloped Areas (both previously undeveloped or restored).

The largest category of existing Hanford Site land use is the Sensitive Areas. Approximately 665 km^2 (257 mi^2), or nearly half of the Site has been designated as ecological study areas or refuges. This includes the Fitzner Eberhardt Arid Lands Ecology Reserve and the entire Site area north of the Columbia River (the North Slope). Both of these areas are being considered by DOE for release.

Proposals are being considered by DOE to release the Fitzner Eberhardt Arid Lands Ecology Reserve to the Yakama Indian Nation or to another Federal agency such as the Bureau of Land Management.

The North Slope could be designated by Federal legislation as a National Wildlife Refuge, as proposed by the National Park Service (NPS 1994), although other proposals have been made that include some agricultural uses in addition to wildlife areas. A public hearing was held in the summer of 1995 on the Fitzner Eberhardt Arid Lands Ecology Reserve ownership issue, but no final decisions have been made for either area.

The Waste Operations land use is primarily confined to the 200 Areas. The 200 Areas, the focus of proposed TWRS activities, have been used to reprocess irradiated nuclear fuel and to store the resulting waste (including the tank waste). Existing facilities in this area include the PUREX Plant, the Plutonium Finishing Plant, U Plant, the tank farms, the Central Waste Complex, the Waste Sampling and Characterization Facility, and the Waste Encapsulation and Storage Facility. Currently, the PUREX Plant, the Plutonium Finishing Plant, and U Plant are being deactivated.

The Future Land-Use Map from the Hanford Site Development Plan (DOE 1993e) was based on consideration of existing and potential Site missions (Figure 4.7.1). Recommendations of the Hanford Future Site Uses Working Group also were considered (HFSUWG 1992). The Reactor Operations, Sensitive Areas, and Administrative Support areas remain unchanged from the existing land-use map. Of primary importance for the TWRS EIS is the Waste Operations area. The location of the Waste Operations area remains the same, although it has been expanded. This expansion reflects land dedicated to a potential cleanup scenario where Sitewide waste is collected and placed in a central location dedicated to exclusive use as a waste disposal area. This includes relocating waste sites contaminants and associated structures, such as the 100 Area facilities, as well as implementing the proposed TWRS action.

The Hanford Site Development Plan future land-use concept is designed to provide a compatible land-use transition from offsite agricultural uses in Adams, Grant, Franklin, and Benton counties to passive uses onsite in the Fitzner Eberhardt Arid Lands Ecology Reserve and the proposed National Wildlife Refuge and Wild and Scenic River north of and along the Columbia River. The areas of the Hanford

Figure 4.7.2 Hanford Site Existing Land-Use Map

Site nearest to the river are proposed in the Hanford Site Development Plan to remain undeveloped, providing an additional buffer area between sensitive natural areas and more intensely developed Site uses such as on the Central Plateau. The Hanford Site Development Plan accommodates future intensive uses, such as industrial development and research, in the southeast area of the Hanford Site near the urban development of Richland. Although in the Hanford Site Development Plan the Undeveloped Areas were reduced in size to reflect the future release and reuse of portions of the Hanford Site, DOE is working with various government agencies and other organizations to ensure proper preservation, protection, and management of sensitive ecological and cultural resources.

In 1994, the U.S. Department of Interior recommended that Congress designate the Hanford Reach of the Columbia River as a Recreational River under the Wild and Scenic Rivers Act and also designate the area north and east of the river as a National Wildlife Refuge (NPS 1994). This proposal would transfer management of the river and a 0.40-km (0.25-mi) strip of land along both shores of the river, along with approximately 40,000 ha (100,000 ac) of adjacent lands, to the U.S. Fish and Wildlife Service. Development restrictions would be included for the protection of cultural resources, threatened and endangered species, water quality, unique scenic geologic features, and Native American access and use. Benton, Franklin, and Grant county commissioners oppose designation of the Hanford Reach under the Wild and Scenic Rivers Act and have offered an alternative proposal that would leave the Hanford Reach under local government control. Other local groups (e.g., the Lower Columbia Basin Audubon Society) and local residents support the designation. No final decisions have been made on this issue.

The Bureau of Land Management owns land on the Hanford Site that was withdrawn from the public domain for national security use. Currently, the Bureau of Land Management does not own any lands on the Central Plateau because of land exchanges with the Atomic Energy Commission in the 1960's. The Bureau of Land Management owns the land on which the potential Vernita Quarry borrow site is located.

4.7.1.2 Washington State Land Uses

Washington State has several land interests on the Hanford Site. The Washington State Department of Fish and Wildlife currently administers the area of the Hanford Site north and east of the Columbia River known as the Wahluke State Wildlife Recreation Area. This area is considered sensitive ecological upland habitat. Washington State also leases a square parcel in the south central portion of the Hanford Site between State Route 240 and the Route 2 and Route 4 junction. This property is located within the Undeveloped Area of the Site.

4.7.1.3 Tribal Nation Land Uses

The Hanford Site is located on land ceded to the United States by the Confederated Tribes and Bands of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Reservation in the treaties of 1855 (DOI 1992). The Nez Perce Tribe also has retained certain treaty rights to the Columbia River under a separate treaty with the U.S. Government.

4.7.1.4 Local Government Land Uses and Land-Use Plans

The Hanford Site is located within portions of Benton, Franklin, Grant, and Adams counties. Other surrounding local jurisdictions include the cities of Richland, West Richland, Pasco, and Kennewick. Many of the local jurisdictions existing comprehensive plans are incomplete or outdated and updates are either in progress or recently completed.

Both Benton County and the city of Richland are currently involved in land-use planning efforts for the Hanford Site, with the Richland effort focusing only on the southern portions of the Site that are within the city's urban growth boundaries (e.g., the 300 and 1100 Areas).

The majority of the Hanford Site is located within Benton County; the Site makes up 25 percent of the county land. The cities of Richland, West Richland, Kennewick, Prosser, and Benton City are located within Benton County. The unincorporated areas of the county adjacent to the Hanford Site currently have generalized land-use designations for rangeland (largely cattle grazing), undeveloped (primarily open space), and dry agriculture (almost entirely dry land wheat) (BCBCC 1985). Benton County is in the process of updating its comprehensive plan and is expected to release a recommended plan in mid-1996 and make final decisions in late 1996 or early 1997 (Stang 1995a). The plan update will include a separate Hanford Comprehensive Plan that will be consistent with the overall County plan (Walker 1995).

Franklin County, located east of the Hanford Site, includes the city of Pasco. The unincorporated area of the county adjacent to the Hanford Site is rural and sparsely developed. The land-use designation surrounding the Site, as with most of the county, is agriculture. Franklin County adopted an updated comprehensive plan in April 1995. The update does not directly impact land uses at the Hanford Site (German 1995).

Grant County contains the area of the Site north of the Columbia River. The land uses adjacent to the Site are designated as agriculture. Grant County is in the process of updating its comprehensive plan but the expected date for its completion is in 1998 . No changes in the comprehensive plan would affect any areas of the Hanford Site that are south and west of the Columbia River, including any potential TWRS areas (Lambro 1995).

The city of Richland, located immediately adjacent to the Hanford Site, is currently in the process of annexing the Hanford Site's 1100 Area (Milspa 1995). The existing land uses within Richland near the Hanford Site include industrial, agricultural, and public lands. The planned land-use designation within the Richland area adjacent to the Site is identified as industrial, which is compatible with the adjacent Hanford Site use (City of Richland 1988). The city develop ed a set of alternatives for its updated comprehensive plan, which was released for public review in March 1996 . The comprehensive plan itself is expected to be adopted by the city in early 1997 . The updated plan would be expected to call for maintaining and expanding industrial and research and development activities in the area of the city adjacent to the Site (Milspa 199 6).

West Richland is a developing residential community south of the Hanford Site. The West Richland land use near the Site is designated low density residential, which is consistent with the nearby existing Hanford Site land uses (Fitzner Eberhardt Arid Lands Ecology Reserve and Undeveloped Area). The West Richland comprehensive plan was released in June 1996 and is expected to be adopted by the city in September 1996 . There is very little in the plan that would impact Site land-use issues (Corcoran 1996).

The cities of Pasco and Kennewick are also located near the Hanford Site. Pasco is planning major commercial, industrial, office, and residential improvements along the U.S. Interstate 182 corridor to attract businesses. Pasco adopted its updated comprehensive plan in August 1995. There is very little in the update related to Hanford Site land uses (McDonald 1995). Like Pasco, Kennewick is planning additional industrial and office areas to attract businesses. Kennewick adopted its updated comprehensive plan in April 1995. Very little in the plan is related to Site land uses (White 1995).

4.7.1.5 Natural Resources Trustee Council

The Natural Resources Trustee Council is composed of representatives from Washington State and Oregon, Federal agencies (DOE and the Department of Interior), and three affected Tribal Nations (Yakama Indian Nation, Confederated Tribes of the Umatilla Indian Reservation, and Nez Perce Tribe). The primary purpose of the Council is to facilitate the coordination and cooperation of the trustees in their efforts to restore and minimize impacts to natural resources injured as a result of or during cleanup of releases associated with DOEs activities at the Hanford Site. The Councils primary role with respect to TWRS will be to coordinate with DOE during development of the Mitigation Action Plan for impacts identified in the TWRS EIS.

4.7.2 Prime and Unique Farmland

The Farmland Protection Policy Act requires Federal agencies to consider prime or unique farmlands when planning major projects and programs on Federal lands (7 CFR 657.4). Federal agencies are required to use prime and unique farmland criteria developed by the U.S. Department of Agriculture Soil Conservation Service. The Soil Conservation Service has determined that due to low annual precipitation in southeast Washington State, none of the soil occurring on the Hanford Site would meet prime and unique farmland criteria without irrigation (Brincken 1994).

4.7.3 Recreational Resources and the National Environmental Research Park

For the purposes of wildlife management and outdoor recreation, some portions of the Hanford Site are administered by agencies other than DOE. In 1976, the entire Hanford Site was designated by DOE as a National Environmental Research Park aimed at original research into the ecology and natural resources of the area (NPS 1994). Nearly one-half of the Hanford Site is designated for wildlife management use. These wildlife management areas buffer developed areas of the Hanford Site. The area where the Columbia River flows through the Hanford Site is identified as the Hanford Reach and has been proposed as a Recreational River. None of the recreational and wildlife areas are near the TWRS sites in the 200 Areas. They are briefly discussed in the following text and shown on Figure 4.7.3.

Figure 4.7.3 Recreation and Wildlife Areas and the Hanford Reach

- Fitzner Eberhardt Arid Lands Ecology Reserve - Located in the southwest corner of the Hanford Site, the 310-km^2 (120-mi^2) reserve is managed as an ecological research resource for DOE by Pacific Northwest National Laboratory. DOE consider ed a proposal from the Bureau of Land Management to exchange sections of DOE lands on the Reserve for Bureau of Land Management-owned lands elsewhere on the Hanford Site. The Yakama Indian Nation also proposed taking over the Reserve, as did Benton County (Stang 1996a). In July 1996, DOE notified the Yakama Indian Nation, other Federal Agencies, and Benton County of its decision to keep control of the Reserve (O'Leary 1996). The Reserve will continue to function as a buffer zone for on going waste management in the 200 Areas. DOE also announced its intention to negotiate an agreement with the U.S. Fish and Wildlife Service to manage the Reserve while protecting the environmentally sensitive areas and allowing greater public access (Stang 1996c.)

- McNary National Wildlife Refuge - The Refuge's 140-ha (350-ac) Hanford Islands Division contains six islands in the Columbia River (upstream of the city of Richland) which are within the boundaries of the Hanford Site.

- Saddle Mountain National Wildlife Refuge - The U.S. Fish and Wildlife Service manages the Saddle Mountain Refuge, located on the Hanford Site north and west of the Columbia River and a narrow strip of land south and west of the river. Currently, the area is closed to all public use and is dedicated to wildlife management.

- Wahluke Wildlife Recreation Area - Located on the Hanford Site north and east of the Columbia River, the area is managed by the Washington State Department of Fish and Wildlife and is open for public recreation.

- Rattlesnake Slope Wildlife Refuge - The Refuge is located adjoining the Fitzner Eberhardt Arid Lands Ecology Reserve's southern boundary. The Refuge, which is managed by the State of Washington, is outside the boundary of the Hanford Site.

- The Hanford Reach of the Columbia River - The Hanford Reach, which is the last free-flowing segment of the Columbia River in the United States, extends 80 km (50 mi) and includes those portions of the Columbia River within the boundaries of the Hanford Site. Under the National Park Service proposal to designate the Hanford Reach as a Recreational River, the least restrictive designation under the Wild and Scenic Rivers Act, the Hanford Reach boundaries would include a 0.4-km (0.25-mi) strip of land on each side of the river, the Saddle Mountain National Wildlife Refuge, and the Wahluke Wildlife Recreation Area. Under the National Park Service proposal, all public lands within the proposed boundary would be transferred to the U.S. Fish and

Wildlife Service, which would be the administrating agency. Benton, Franklin, and Grant county commissioners oppose this designation and have proposed an approach that leave the Reach under local government control, although there also are local residents and groups (e.g., the Lower Columbia Basin Audubon Society) that support the designation of the Hanford Reach as a Wild and Scenic River (Stang 1996b).

The Hanford Reach and adjacent wildlife refuge and recreation areas provide a variety of recreational activities year-round for local residents and visitors. The most popular activities are sport fishing, boating, and waterfowl hunting. Other popular activities include waterskiing, upland hunting, and nature observation. The heaviest use occurs during September and October, coincident with autumn chinook salmon runs (NPS 1994).

Because of restricted use of the Hanford Site and Saddle Mountain National Wildlife Refuge lands, virtually all land-based recreation occurs on the Wahluke Wildlife Recreation Area. Total recreational use of the Hanford Reach comprises approximately 10,000 land-based visits by hunters, trappers, and nonconsumptive users and approximately 40,000 visits by water-based users (predominantly anglers) per year (NPS 1994).

4.8 VISUAL RESOURCES

The following paragraphs describe the existing visual environment that would be modified by TWRS project implementation.

4.8.1 Landscape Character

The landscape setting within the Hanford Site region is characterized by broad basins and plateaus interspersed with ridges. However, the wide open vistas throughout much of the area are interrupted by over a dozen large industrial facilities (e.g., reactors, processing facilities). Only about 6 percent of the Hanford Site has been disturbed; the remainder of the Hanford Site is undeveloped, including natural areas and abandoned agricultural lands that remain undisturbed because of restricted public access.

The major landscape feature of the Hanford Site is the Columbia River, which flows through the northern part of the Hanford Site and then turning south, forms the eastern Site boundary. Yakima Ridge and Umtanum Ridge form the western boundary of the Site. Two small east-west ridges (Gable Butte and Gable Mountain) rise above the Central Plateau, the large open plateau where TWRS activities would be focused under all EIS alternatives.

The potential Vernita Quarry borrow site is located adjacent to the east of State Route 24 in the northwest of the Hanford Site. The potential McGee Ranch borrow site is located in slightly rolling terrain in the northwest of the Hanford Site just west of State Route 24.

4.8.2 Potential Viewing Areas

For purposes of study, viewing areas are generally divided into four distance zones: the foreground, within 0.8 km (0.5 mi); the middleground, from 0.8 to 8 km (0.5 to 5 mi); the background, from 8 to 24 km (5 to 15 mi); and seldom seen areas that are either beyond 24 km (15 mi) or are unseen because of topography (Figure 4.8.1).

Hanford Site facilities can be seen from elevated locations such as Gable Mountain, Gable Butte, Rattlesnake Mountain, and other portions of the Rattlesnake Hills along the Hanford Site's western perimeter. Gable Mountain, Gable Butte, and Rattlesnake Mountain are used by Native Americans for religious purposes. Site facilities also are visible from offsite locations including State Routes 240 and 24 and the Columbia River. Because of terrain features, distances involved, the size of the Hanford Site, and the size of individual facilities, not all facilities are visible from the highways or the Columbia River.

Facilities in the 200 East Area are in the interior of the Hanford Site and cannot be seen from the Columbia River or State Route 24. Large facilities in the 200 East Area are visible from State Route 240 only as distant background (more than 8 km [5 mi] away). Facilities in the 200 West Area can be seen by travelers on an 11-km (7-mi) segment of State Route 240 south of the Yakima Barricade. For these viewers the facilities are in the visual middleground (0.8 to 8 km [0.5 to 5 mi] away). Facilities in the 200 West Area cannot be seen from the Columbia River. Facilities throughout the 200 Areas are visible from elevated locations such as Gable Mountain and Gable Butte.

The potential Vernita Quarry borrow site is located adjacent to State Route 24 west and north of the Central Plateau. Much of the basalt resources contained in exposed basalt cliffs and past quarry operations are highly visible from the highway. The potential McGee Ranch borrow site activities would be located a short distance from the nearest public highway (State Route 24) in slightly rolling terrain. Borrow activities would be visible from the highway. The potential Pit 30 borrow site is located between the 200 East and 200 West Areas and is only visible from elevated locations.

4.9 NOISE

Noise conditions produced by current, routine operations at the Hanford Site do not violate any Federal or Washington State standards (Washington Administrative Code 173-60). Even near the operating facilities along the Columbia River, measured noise levels are lower than noise experienced in parts of the city of Richland (less than 52 decibels on the A scale (dBA) versus 61 dBA) (dBA is a noise scale used to describe sounds in the frequencies most readily detected by human hearing) (Nuclear Regulatory Commission 1982). Noise levels measured near intake structures at the Columbia River are well within the 60-dBA tolerance levels for daytime residential use. Five kilometers (3 mi) upstream of the intake structures, measured noise levels fall well within levels suited for daytime and nighttime residential use. Moreover, the relative remoteness of population centers from the Hanford Site as a whole (and the TWRS sites in particular) gives the Site a Class C (industrial) classification with a maximum allowable equivalent sound level of 70 dBA in compliance with Washington State and Federal standards (DOE 1991 and Cushing 1992). The equivalent sound level integrates noise levels over time and expresses them as continuous sound levels. Native Americans have expressed the concern that Hanford Site religious locations such as Gable Mountain are near enough to TWRS areas to potentially be impacted by TWRS activities (CTUIR 1996).

Figure 4.8.1 Potential Viewing Areas of 200 East and 200 West Areas

4.10 TRANSPORTATION

The majority of air passenger and freight services in the local area goes through the Tri-Cities Airport, located in Pasco (Cushing 1992). Both Richland and Kennewick have small airports serving general aviation. The ports of Benton, Kennewick, and Pasco use the commercial waterways of the Snake and Columbia rivers to provide access to the deep-water ports of Portland, Oregon and Vancouver, Washington.

Direct rail service is provided to the Tri-Cities area by the Burlington Northern and Union Pacific Railroads. The rail system on the Hanford Site itself consists of approximately 210 km (130 mi) of tracks. It extends from the Richland Junction (at Columbia Center in Kennewick) where it joins the Union Pacific commercial railroad track, to an abandoned commercial right-of-way near the Vernita Bridge in the northwest portion of the Site. There are currently about 1,400 railcar movements annually Sitewide, transporting a wide variety of materials including coal, fuels, hazardous process chemicals, and radioactive materials and equipment. Radioactive waste has been transported on the Site without incident for many years (DOE 1995i).

Regional road transportation is provided by a number of major highways including State Routes 24 and 240 and U.S. Interstate Highways 82 and 182 (Cushing 1992). State Routes 24 and 240 are both two-lane roads that traverse the Hanford Site. State Route 24 is an east-west highway that turns north at the Yakima Barricade in the northern portion of the Site. State Route 240 is a north-south highway that skirts the eastern edge of the Fitzner Eberhardt Arid Lands Ecology Reserve (Figure 4.10.1).

A DOE-maintained road network within the Hanford Site, mostly paved and two-lanes wide, provides access to the various work centers. The primary access roads on the Site are Routes 2, 4, 10, and 11A. Primary access to the 200 Areas is by Route 4 South from Richland. The 200 East Area is also accessed from Route 4 North off Route 11A from the north. July 1994 traffic counts on Route 4 indicated severe congestion west of the Wye Barrier (at the intersection of Routes 10 and 4 South) during Hanford Site shift changes (WHC 1994c). However, completing the State Route 240 Access Highway (Beloit Avenue) linking the 200 Areas with State Route 240 in late 1994 and declining Hanford Site employment have reduced the congestion on Route 4 (Rogers 1995).

Figure 4.10.1 Hanford Site Roadway and Railroad System

Stevens Road at the 1100 Area leading into the Site from Richland (Stevens Road becomes Route 4 South further north onsite) also has experienced severe congestion (BFRC 1993). The 240 Access Highway completion and reduction of Hanford Site employment have reduced this congestion somewhat, although no specific traffic count data are available to quantify this assessment (Rogers 1995).

Access to the 200 West Area is also provided from Route 11A for vehicles entering the Site through the Yakima Barricade and from Route 6 off Route 11A from the north. No congestion problems are reported on these roadways.

Public access to the 200 Areas and interior locations of the Hanford Site has been restricted by manned gates at the Wye Barricade and the Yakima Barricade (at the intersection of State Route 240 and Route 11A).

4.11 RADIOLOGICAL ENVIRONMENT: OVERVIEW AND POTENTIAL RADIATION DOSES FROM 1995 HANFORD SITE OPERATIONS

This section provides a brief introduction to the subject of radioactivity and to some of the common terms used in radiological health evaluation. It also summarizes 1995 data on radiation doses from operations at the Hanford Site and the potential future fatal cancers attributable to exposures.

4.11.1 Introduction to Radioactivity

Radioactivity is a broad term that refers to changes in the nuclei of atoms that release radiation. The radiation is an energetic ray or energetic particle. For ionizing radiation, the ray or particle has enough energy to cause changes in the chemical structure of the materials it strikes. These chemical structure changes are the mechanisms by which radiation can cause biological damage to humans. This means that a human body cell may be damaged if it comes into contact with the energy from a particle or ray released by radioactive decay.

Radiation comes from many sources, some natural and some human-made. People have always been exposed to natural or background radiation. Natural sources of radiation include the sun, and radioactive materials present in the earth's crust, in building materials and in the air, food, and water. Natural radioactivity can even be found within the human body. Some sources of ionizing radiation have been created by people for various uses or as by-products of these activities. These sources include nuclear power generation, medical diagnosis and treatment, and nuclear materials related to nuclear weapons.

Radioactive waste is a result of the use and production of radioactive materials. At the Hanford Site, DOE manages radioactive waste that was generated primarily by the production of plutonium for nuclear weapons. This waste is classified as low-activity, high-level, or transuranic. When radioactive waste is combined with hazardous chemical waste, it is referred to as mixed waste. High-level waste is the most dangerous type of radioactive waste and requires extensive shielding by materials such as lead, water, or concrete and special remote, noncontact handling. Transuranic waste is material contaminated with radioactive elements heavier than uranium. While long lasting, transuranic waste does not require the same degree of isolation as high-level waste. Low-activity waste is generally the least dangerous type of radioactive waste and requires fewer measures to isolate it from people and the environment.

Radioactive waste can be harmful and thus requires isolation for up to hundreds or even thousands of years. Plutonium-contaminated waste will be radioactive for thousands of years. Radioactive cesium, on the other hand, will be virtually gone in 300 years.

4.11.2 Common Terms in Radiological Health Evaluations

Radiation dose to individuals is usually expressed in rem or millirem (mrem), which is one-thousandth of a rem. The rem is a measure of the biological effects of ionizing radiation on people. It is estimated that the average individual in the United States receives an annual dose of about 300 mrem (0.3 rem) from all natural sources. The collective radiation dose to a population, which is calculated by adding up the radioactive dose to each member of the population, is expressed in person-rems.

Any dose of radiation potentially can cause damaging changes to body cells. However, at low levels, such as those received from a medical x-ray, the damage to cells is so slight that the cells can repair themselves or can be replaced by the regeneration of healthy cells. Radiation exposures are often classified as acute (a dose received over a short time), or chronic (a dose received over a long time). Chronic doses are usually less harmful than acute doses because the body has time to repair or replace damaged cells. Nevertheless, even chronic or low doses can have potentially harmful effects.

Impacts from radiation exposure often are expressed using the concept of risk. The most important radiation-related risk is the potential for developing cancers that may cause death in later years. This delayed effect is measured in latent (future) cancer fatalities. The risk of a latent cancer fatality is estimated by converting radiation doses into possible numbers of cancer fatalities. For an entire exposed population group, the latent cancer fatality numerical value is the chance that someone in that group would develop an additional cancer fatality in the future because of the radiation exposure, (i.e., a cancer fatality that otherwise would not occur).

Radiological risk evaluations often refer to the maximally-exposed individual. This is the hypothetical member of the public or a worker who would receive the highest possible dose in a given situation. As a practical matter, the maximally-exposed individual likely would be a person working with radiological or hazardous materials. The Federal government has set a maximum annual exposure limit for workers of 5,000 mrem (5 rem) while DOE has an Administrative Control Limit of 2,000 mrem (2 rem) for occupational exposure. DOE's limit for annual radiological exposures to the public from DOE activities is 100 mrem (0.1 rem).

4.11.3 Potential Radiation Doses and Latent Cancer Fatalities from 1995 Hanford Site Operations

Each year the potential radiation doses to the public from Hanford Site radiation sources are calculated as part of the Hanford Site Environmental Monitoring Program. In particular, the dose to the hypothetical maximally-exposed individual is calculated as described in the Hanford Site Environmental Report for Calendar Year 1995 (PNL 1996). This hypothetical maximally-exposed individual is assumed to live at a location where the radiation dose from airborne releases would be larger than for a resident of any other offsite location. The maximally-exposed individual also is assumed to get drinking water from the Columbia River; eat food grown with Columbia River irrigation water; and use the river extensively for boating, swimming, and fishing (including eating fish from the river). The exposure calculation for this hypothetical individual is based on Hanford Site data from actual reported releases, environmental measurements, and information about operations at Hanford Site facilities.

The calculated dose in 1995 to the maximally-exposed individual near the Hanford Site was a total of 0.02 mrem compared to 0.05 mrem reported for 1994 (PNL 1996) . As indicated previously, the DOE radiation dose limit for a member of the public is 100 mrem. Thus, the 1995 total dose to the maximally-exposed individual was far below the limit. The U.S. Environmental Protection Agency regulations impose a dose limit of 10 mrem to a member of the public from radioactivity released in airborne effluents. The 1995 Hanford Site airborne dose to the maximally-exposed individual of 0.006 mrem was far below the U.S. Environmental Protection Agency limit.

To estimate health effects for radiation protection purposes, it usually is assumed that a collective dose of 2,000 person-rem in the general population will cause one extra latent cancer fatality (ICRP 1991). In these calculations, it does not matter whether 20,000 people each receive an average of 0.1 rem or 2 million people each receive an average of 0.001 rem. In either case the collective dose would equal 2,000 person-mrems and thus one additional latent cancer facility would be expected. The 1995 collective dose to people surrounding the Hanford Site from Hanford Site releases was calculated to be 0.3 person-rems , which is lower than the 0.6 mrem calculated for 1994 . Compared to 2,000 person-rems causing one extra latent cancer fatality, the 0.3 person-rems from the Hanford Site in 1995 is not likely to cause any latent cancer fatalities.

5.0 ENVIRONMENTAL CONSEQUENCES

This section describes the potential impacts to the existing environment (described in Section 4.0 and discussed in further detail in Volume Five, Appendix I) of implementing each of the alternatives described in Section 3.0 and discussed in detail in Volume Two, Appendix B.

This section is divided into 20 subsections. The environmental components studied that would result in potential impacts are presented in Sections 5.1 through 5.12. The environmental components addressed include impacts of each alternative on:

- Geology and soil (Section 5.1);
- Water resources (Section 5.2);
- Air quality (Section 5.3);
- Biological and ecological resources (Section 5.4);
- Cultural resources (Section 5.5);
- Socioeconomics (Section 5.6);
- Land use and land use plans (Section 5.7);
- Visual resources (Section 5.8);
- Noise (Section 5.9);
- Transportation (Section 5.10);
- Human and ecological health effects (Section 5.11); and
- Potential accidents (Section 5.12).

This section also discusses potential cumulative impacts of each alternative when added to impacts from past, present, and reasonably foreseeable actions (Section 5.13), unavoidable adverse impacts (Section 5.14), the relationship between short-term and long-term impacts (Section 5.15), and irreversible and irretrievable commitment of resources (Section 5.16). Conflicts between land use under the alternatives and other land-use plans are discussed in Section 5.17, and pollution prevention measures are discussed in Section 5.18. An analysis of environmental impacts on minority and low-income communities is provided in Section 5.19. Section 5.20 discusses measures that, if implemented, could potentially mitigate the adverse environmental impacts of the alternatives.

Appendices to the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS) have been prepared to support the more complex impact assessments for:

- Human and ecological health (Volume Three, Appendix D, which supports the discussion of health effects in Section 5.11);
- Potential accidents (Volume Four, Appendix E, which supports the discussion of accidents in Section 5.12);
- Groundwater quality (Volume Four, Appendix F, which supports the discussion of groundwater in Section 5.2);
- Air quality (Volume Five, Appendix G, which supports the discussion of air impacts in Section 5.3); and
- Socioeconomics (Volume Five, Appendix H, which supports the discussion of socioeconomics in Section 5.6).

These appendices are provided under separate cover in Volumes Three to Five of the EIS. Each appendix details the data sources, major assumptions, uncertainties, methodology, and results that are summarized in this section.

Also, Section 6.0 of the EIS contains an analysis of the regulatory compliance issues associated with each alternative. Section 6.0 of the EIS provides a summary of all applicable laws and regulations, identifies the environmental permits and approvals required to implement each of the alternatives, and for each alternative discusses impacts that would result in exceedances of standards (e.g., air, water) or would prevent implementation of the alternative due to a potential violation of a Federal or State law.

5.0.1 Comparability of Environmental Consequences

All of the alternatives have been evaluated using the same methods and data, allowing a comparison of all the alternatives on the same basis. For example, all of the alternatives used the common description of the alternatives provided in Section 3.0 and Volume Two, Appendix B and all used the common inventory of tank waste provided in Volume Two, Appendix A. When computer modeling was used to predict the environmental consequences, the same computer model was used for all alternatives.

5.0.2 Approach to Uncertainty and Bounding Analysis of Environmental Impacts

There were several uncertainties involved with calculating the impacts associated with the tank waste alternatives, including characteristics of the waste in the tanks and the specific performance capabilities of waste retrieval and processing technologies. Information needed to more thoroughly determine the characteristics of the tank waste is currently being obtained through waste characterization studies. Studies of the performance of technologies and processes are conducted throughout the process of developing a design for any complex project. The results of these studies were not necessary to develop the environmental consequence analysis in this EIS, but would be necessary to refine the process design for the alternative ultimately selected by the U.S. Department of Energy (DOE). Therefore, the analyses in the following sections are based on identification of bounding waste characterization, retrieval, and processing assumptions and data to bound the impacts of actions that may be undertaken during implementation of the selected alternative. Bounding impacts represent reasonable maximum impacts that are likely to occur.

For each environmental component, where appropriate, uncertainties regarding data, technologies, or processes are identified. Each section includes a discussion of 1) the assumptions used in the impact analysis to ensure that a bounding analysis was performed; 2) implications of the assumptions used; and 3) uncertainties. Because of the uncertainties involved in calculating impacts from operational accidents and long-term human health risks, nominal impacts are also presented. Nominal impacts are based on less conservative assumptions and represent the average impacts that are likely to occur.

5.0.3 Presentation of Remediation and Post-Remediation Analysis

The impacts provided in this section include short-term environmental impacts and the combined impacts of remediation and post-remediation activities, which provide the long-term impacts. To provide an even comparison of the long-term impacts of the alternatives, a representative closure scenario (closure as a landfill) was assumed for all tank waste alternatives. These combined impacts are presented to provide a meaningful comparison of impacts of the total project. The impacts of remediating the cesium and strontium capsules are also provided.

The environmental impacts presented in Sections 5.1 through 5.12 can be understood, in part, by whether the impacts described would be most related to the remedial or post-remedial phase of the alternative. The environmental components analyzed in the EIS that would have their peak impacts during the remedial phase (1996 to 2096, with most impacts from 1996 to 2040) include:

- Geology and soil (except post-remediation changes to topography associated with post remediation actions);
- Air quality (most impacts directly result from routine waste management or treatment emissions);
- Biological and ecological resources (impacts largely related to remediation except post-remediation impacts related to permanent commitment of land to waste disposal);
- Socioeconomics (all impacts associated with the level of remedial activities);
- Visual resources (impacts largely related to remediation except changes to topography associated with post-remediation actions);

Noise (all impacts associated with the level of remedial activities);
- Transportation (all impacts associated with the level of remedial activities);
- Human and ecological health effects (worker health most impacted during remedial activities); and
- Potential accidents (all impacts associated with remedial activities).

Environmental components with peak impacts during the post-remediation phase (2096 to up to 10,000 years in the future) would include:

- Water resources (impacts to groundwater would influence groundwater quality for thousands of years following completion of remediation);
- Human and ecological health effects (health of the general public most impacted by post-remediation groundwater impacts and impacts associated with contact with waste remaining onsite following remediation);
- Land use and land-use plans (permanent commitment of land in the 200 Areas to waste disposal); and
- Cultural resources (impacts would be permanent).

5.0.4 Relationships Among Key Variables and the Results of the Impact Analysis

Three variables are the most important to understanding the relationship between the impacts presented in this section and the comparison of impacts among the alternatives: 1) the amount and type of waste that remained onsite under each alternative; 2) the number of labor hours for construction, operations, and other activities under each alternative; and 3) the amount of previously undisturbed habitat that would be disturbed by each alternative. An understanding of how these variables would influence the impacts presented for each alternative would help to clarify which impacts discriminate among the alternatives and which impacts are either small or do not discriminate among the alternatives.

Amount and Type of Waste That Remains Onsite

A major variable that would influence the post-remediation risks for each alternative would be the amount of waste form remaining in the tanks or on the Hanford Site following remediation. Generally, for post remediation impacts to groundwater (Section 5.2), which would be the major contributor to post-remediation routine health risks (Section 5.11), the larger the volume of waste that remained onsite the more severe the levels of groundwater contamination would be and thus, more adverse health impacts would be expected. The No Action and Long-Term Management alternatives, which would involve no waste retrieval, would result in the highest levels of groundwater contamination and the highest levels of post- remediation health risks. On the other hand, the ex situ alternatives, which would remove an assumed 99 percent of the waste from the tanks, would have much lower levels of impacts to the groundwater and thus, much lower levels of post-remediation risk.

A related important variable would be the type of waste form that remained in the tanks or on the Hanford Site following remediation. Waste that remained onsite and was not immobilized would result in more severe levels of post-remediation groundwater contamination than would waste that was immobilized prior to disposal onsite. Thus, alternatives that would result in larger amounts of untreated waste, such as the No Action, Long-Term Management, and In Situ Fill and Cap alternatives, would result in more severe groundwater impacts and higher levels of post-remediation health risks. The In Situ Vitrification and the ex situ alternatives, which would immobilize most of the waste, would have much lower levels of post-remediation groundwater impacts and lower post-remediation health impacts. The Ex Situ/In Situ Combination 1 and 2 alternatives would have impacts that would fall between the two extremes because a larger amount of the waste by volume would be left in place without treatment, while the remainder of the waste would be retrieved and immobilized.

Number of Labor Hours

Another variable that would influence many of the short-term impacts identified in the EIS would be the number of labor hours associated with each alternative. The number of labor hours for each alternative would directly affect the magnitude of many of the impacts discussed in this section. In other words, the more labor hours worked the higher the level of impact. This relationship would most directly affect the impacts addressed for nonradiological accidents during remediation (Section 5.12), routine worker health risks (Section 5.11), socioeconomics (Section 5.6), and transportation (Section 5.10).

Nonradiological accidents during remediation would include workplace injuries or fatalities associated with constructing or operating the facilities and injuries and fatalities to workers driving to and from work. In each of these cases, the higher the number of labor hours the higher the number of injuries or fatalities. For each of these short-term impacts of the alternatives it is important to note that the accidents and fatalities identified would not be based upon the unique problems associated with working with tank waste. Rather, they would be products of working in a construction or industrial environment or driving to and from work. These same impacts would be associated with any similarly sized construction project or industrial facility operations. The number of fatalities associated with construction provides a good example of this relationship. The number of construction fatalities for each alternative was calculated by multiplying the historic construction fatality rate (0.0032 fatalities per 100 worker years) by the number of worker years estimated for each alternative. If an alternative required 100,000 worker years for construction, the number of expected fatalities would be approximately 3 (100,000 worker years 0.0032 fatalities per 100 worker years = 3.2 fatalities). However, if the alternative required 700,000 worker years, the expected number of worker fatalities would be 22, or about seven times the number of fatalities for 100,000 worker years (700,000 worker years 0.0032 fatalities per 100 worker years = 22.4 fatalities). This same relationship (the more hours worked the higher the impact) would exist for injuries associated with construction and injuries and fatalities associated with operating facilities.

For worker transportation injuries and fatalities, the number of fatalities and injuries is based on the number of kilometers (miles) driven to and from work by the employees. Based on Washington State highway accident reports, for every kilometer driven, there would be 8.98E-09 fatalities. The number of employee transportation fatalities was therefore calculated by multiplying the number of kilometers that the workers would drive to and from work by the historic fatality rate. In this case, a doubling of the number of kilometers driven would result in a doubling of the number of employee transportation fatalities and injuries.

Impacts that would not be directly related to the number of labor hours would tend to be associated with differences in technologies and processes unique to each alternative or the post-remediation amount of waste or waste form remaining onsite. Impacts that would be largely independent of the influence of labor hours worked would include 1) post-remediation health risks (Section 5.11); 2) remediation-phase radiological and chemical accidents (Section 5.12); and 3) the ability of an alternative to comply with environmental regulations such as air quality (Section 5.2), water quality (Section 5.3), and hazardous and radiological waste storage, treatment, and disposal (Section 6.0).

Amount of Habitat Disturbance

Another variable that would influence several of the environmental impacts addressed in this section would be the amount of habitat disturbance associated with the alternatives. The amount of impacts to vegetation and wildlife habitat and archeological and cultural sites would be directly related to the amount of undisturbed land required to implement each alternative. Much of the Hanford Site has been undisturbed by Site activities and the native habitat remains intact. However, in the 200 Areas, where the remediation activities addressed in this EIS would occur, a sizable portion of the land has been previously disturbed by the construction of roads, processing facilities, pipelines, and other facilities and infrastructure associated with the production of plutonium and waste management.

Alternatives such as No Action, Long-Term Management, In Situ Fill and Cap, and In Situ Vitrification, which would focus much of their activities directly at the tank farms, would disturb relatively small amounts of previously undisturbed land and consequently would have low levels of biological and ecological or archeological and cultural site impacts. The ex situ alternatives, which would require the construction of waste treatment facilities and new onsite disposal facilities, would require varying levels of disturbance to previously undisturbed habitat and consequently would have relatively larger biological and ecological and archeological and cultural site impacts. The vast majority of the habitat disturbances would occur in areas close to previously disturbed areas and within the 200 Areas, which have been identified as the area in which DOE should consolidate as much waste management and environmental restoration activities as possible to minimize potential impacts to the remainder of the Hanford Site.

For all in situ and ex situ alternatives, except No Action and Long-Term Management, the post-remediation scenario evaluated (closure of the tank farms by filling the tanks and capping the tanks and onsite disposal facilities) would result in impacts to habitat outside the 200 Areas. These impacts would be associated with securing borrow material (gravel, sand, and stones) to fill the tanks and construct the caps. While the decisions regarding closure would not be supported by this EIS, data regarding impacts associated with closure were presented to permit a balanced comparison of all known and potential impacts associated with each alternative. For all alternatives with substantial habitat impacts, the dominant impacts presented in the EIS were related to potential borrow sites. It is important to note that the final decision regarding closure of the tank farms is many years in the future and that the final closure decision could require substantially less borrow material and have less impacts to borrow sites. Also, borrow materials could be secured from alternative sites that would not involve the same level of adverse impacts to undisturbed habitat.

5.2 WATER RESOURCES

5.2.1 Groundwater

The following is a summary of the potential impacts to groundwater as described in Volume Four, Appendix F. Groundwater would be impacted by all of the EIS alternatives. Groundwater impacts were analyzed by comparing the impacts for each alternative with drinking water standards for key contaminants that have high carcinogenicity, toxicity, and mobility in the groundwater. The environmental impacts of these and other potential groundwater contaminants also were used to analyze human and biological health risk (Section 5.11).

The No Action and Long-Term Management alternatives would result in exceedances of drinking water standards for carbon-14, iodine-129, technetium-99, uranium-238, and nitrate in groundwater. Of all the alternatives, these alternatives would exceed the drinking water standards by the greatest magnitude. The exceedance of the standards in groundwater would occur within a period of 500 years. The In Situ Fill and Cap alternative would exceed the limits of current drinking water standards for the same contaminants with the exception of carbon-14, but most of the exceedances would be delayed for 2,500 years.

The ex situ alternatives and the In Situ Vitrification alternative would include measures to reduce the rate of release of radionuclides, which would result in lower peak concentrations at the water table. These measures would result in groundwater impacts that would occur mostly after 500 years. The ex situ alternatives and the In Situ Vitrification alternative would comply with current drinking water standards for uranium-238. Without considering contamination from the LAW vaults, alternatives that removed waste from the tanks would not meet the limits of current drinking water standards in groundwater. The calculated exceedances mostly would be attributable to the assumption that 1 percent of all tank waste would remain in the tanks after retrieval. There would be no groundwater releases during Phase 1 of the Phased Implementation alternative and hence no groundwater impacts; however, there would be groundwater releases and impacts from the Phased Implementation Total alternative.

The amount and type of waste that would remain in the tanks after retrieval is uncertain. The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1994) set a goal of no more than 1 percent residuals, and the ex situ alternatives have been developed to attempt to achieve that goal. However, achieving this level of tank waste retrieval could require extensive effort and cost, and it may not be practicable to achieve 99 percent retrieval. Conversely, the contaminants that were not recovered would be likely to be insoluble in water, because substantial quantities of water would be used in an attempt to dissolve or suspend the waste during retrieval. Because neither of these issues can be resolved, a conservative assumption was made to bound the impacts of the residual waste. For purposes of this analysis, it was assumed that 99 percent retrieval would be achieved, but that the residual waste in the tanks would contain 1 percent of all the contaminants including the water soluble contaminants. There are a total of 177 million (1.77E+08) curies (Ci) in the tanks (Volume Two, Appendix A). Retrieval of 99 percent of the tank contents as part of the ex situ alternatives would leave 1.77E+06 Ci remaining for potential dissolution by groundwater. Existing groundwater contamination would be in addition to these 1.77E+06 Ci, but is not in the scope of the EIS.

The groundwater assessments provided in this section required several assumptions to address uncertainties. The major assumptions and uncertainties were related to either the natural system (i.e., an understanding and ability to assign vadose zone and aquifer parameter values) or uncertainties inherent to the assessment approach.

The major assumptions and uncertainties were as follows:

- The rates of infiltration into natural ground and through a cap;
- Distribution coefficient (K_d) of contaminants;

- Uncertainty in future groundwater flow direction due to decay of groundwater mounds onsite;
- Uncertainty in future groundwater flow direction due to future land use (e.g., irrigation and groundwater withdrawal);
- Uncertainty in future groundwater flow direction and vadose zone thickness due to climate change;
- Uncertainty in future groundwater flow direction due to changes in land use;
- Uncertainty in vadose zone transport due to use of one-dimensional flow and transport simulation; and
- Uncertainty due to calculation of releases during retrieval.

DOE has a system of monitoring wells called drywells installed in the vicinity of each waste tank. The depth of these drywells varies but they do not extend to the water table of the unconfined aquifer. These drywells were installed as a way of detecting gamma emissions and serve as an indirect means of detecting or confirming waste tank leaks and mobilization of existing contamination in the vadose zone by other water sources such as potable water line leaks. Until recently, the gamma emissions that were detected were indicative of undifferentiated radioisotopes. Such emissions have been detected in many of the drywells at depths ranging from ground surface to up to 38 m (125 ft) belowground surface. Recent improvements in the borehole logging detection equipment have resulted in the identification of specific gamma-emitting radioisotopes. Thus, previously characterized gross gamma contamination is now specifically linked to several radioisotopes. The most prevalent radioisotope detected was cesium-137 while other gamma-emitting radionuclides such as carbon-60, europium-152, and europium-154 were generally found near the surface and are believed to be the result of spills (Brodeur 1996).

The transport of cesium-137 in the vadose zone sediments at the Hanford Site is believed to be greatly retarded due to adsorption. Cesium would not be expected to be found at depths of up to 38 m (125 ft) if it were being transported via interstitial flow through the sediment pore spaces and under ambient conditions that include neutral pH and infiltration rates ranging from 2 mm/yr (5.48E-06 m/day) to 10 cm/yr (2.74E-04 m/day). The detection of cesium-137 at this depth raises several questions concerning the active transport mechanisms. These questions and others are being addressed by DOE in a RCRA Groundwater Assessment of the S and SX Tank Farms (Caggiano 1996). The improved borehole logging detection equipment provides information on the specific contaminant in the vicinity of the drywells, but there is still uncertainty on the lateral distribution of these contaminants within the vadose zone.

The most recent vadose zone characterization information is for the SX Tank Farm. Ten of the 15 tanks in the SX Tank Farm are assumed or verified as leaking as discussed in Volume Five, Appendix K. Ninety-five drywells ranging in depth from 23 to 38 m (75 to 125 ft) from ground surface were logged with the improved logging system in the SX Tank Farm. The most abundant and highest-concentration radionuclide detected was cesium-137, which was detected in virtually every borehole (Brodeur 1996). Cesium-137 was detected in several drywells at the following depths: 23 m (75 ft) in drywells 41-09-03 and 41-08-07; 32 m (105 ft) in 41-09-04; 27 m (90 ft) in 41-11-10, and 38 m (125 ft) in 41-12-02.

Other gamma-emitting radionuclides detected include cobalt-60, europium-152, and europium-154, which were generally found near the surface and are believed to be the result of spills (Brodeur 1996). Cobalt-60 was found in drywell 41-14-06 only. It was detected at a depth of 17 to 23 m (55 to 76 ft) belowground surface. The data were insufficient to conclude whether relatively immobile contaminants such as cesium-137 would be found dispersed laterally within the vadose zone (i.e., at observed concentrations laterally several meters from the drywells) at the depths of over 30 m (100 ft) based on ambient conditions and vadose zone contaminant transport via advective flow in interstitial pore spaces. Vadose zone contaminant transport mechanisms, such as discussed in Volume Five, Section K.4.1.3, in addition to interstitial transport through the pore spaces could be active. The viability of any other potential transport mechanism has not yet been demonstrated but is one of the objectives of the ongoing investigations.

A discussion of these major assumptions and uncertainties is provided in Volume Five, Sections K.4.1 and K.4.2 and results of a limited parameter sensitivity analysis are summarized in Section 5.2.1.3 and provided in Volume Five, Section K.4.2.

Vadose zone, groundwater flow, and contaminant transport were simulated for each alternative with a combined flow and transport model called VAM2D (Huyakorn et al. 1991). The groundwater impact of interest area is shown in Figure 5.2.1. The analysis approach is summarized briefly in the following text and additional details are provided in

Volume Four, Appendix F.

The approach for assessing the impact to the groundwater system is illustrated in Figure 5.2.2. In the source characterization step shown in the top of Figure 5.2.2, the 177 tanks were aggregated to eight source areas, and the contaminants were placed in groups based on their mobility in the vadose zone and unconfined aquifer. The next step, vadose zone modeling shown in the center of the figure, required the development of a conceptual model for each of the source areas. Then, as described in Volume Four, Section F.2.3.1.3, the vadose zone flow field was established based on steady-state flow simulations for an ambient infiltration of 5.0 centimeters (cm)/year (2.0 inches [in.]/year).

Figure 5.2.1 Area of Interest for Groundwater Impact Assessment

Figure 5.2.2 Groundwater Impacts Assessment Approach

Contaminant transport through the vadose zone then was simulated for each source from which results were processed for use by the groundwater model.

The groundwater modeling step, shown in the bottom of Figure 5.2.2, required the development of a conceptual model of the unconfined aquifer. Then a steady-state flow field, which is one of the principal bases for the groundwater impacts assessment, was developed using December 1979 sitewide water level measurements because it was determined (Wurstner-Devary 1993) that this data set was most representative of steady-state conditions. Using this data set also meant that the mounding from U Pond and B Pond would be evident. The mounding was recognized as a present-day condition that could dissipate over the next several decades with changes in the Site waste management practices. With the mounds in place, the vadose zone would be thinner in the 200 West and 200 East Areas and contaminant travel times would be faster to the groundwater. The travel time in the unconfined aquifer to the Columbia River would not be materially affected by the groundwater mounds compared to the vadose zone travel time. The approach based on the December 1979 water level data provides reasonable results for each alternative, especially in light of the uncertainties of land use and waste disposal practices and how these practices would affect the present groundwater mounds. Future land use such as irrigation to the west of the Site and on the Site, uncertainty in the depth of contamination in the unconfined aquifer, and climate change.

The groundwater model then was used to predict contaminant transport given the results from the vadose zone modeling as inputs. The groundwater results then were processed as appropriate for radioactive decay, initial concentration, and aquifer thickness. The final processed data then were plotted in various ways to show contaminant concentration versus time at selected points and contaminant concentration distribution on the Site for selected times in the future (e.g., 300, 500, 2,500, 5,000, and 10,000 years from present).

5.2.1.1 Source Characterization

Source characterization involved: determining the level of analysis for each alternative (screening of alternatives), aggregating the many potential sources into common source areas, grouping contaminants into categories based on their mobility, and developing the source term (i.e., mass flux and fluid flux release as a function of time) for each source area.

Screening of Alternatives and Waste Facilities

Screening was performed to exclude alternatives or waste treatment or storage facilities that had little or no potential for impacting groundwater from rigorous numerical modeling. The following sections provide the rationale for screening each alternative and for inclusion or exclusion of each from detailed groundwater modeling. Vadose zone and groundwater flow and transport simulations were used to analyze the groundwater impacts of those alternatives identified through screening as having the potential to impact groundwater.

No Action Alternative (Tank Waste)

This alternative potentially would impact the groundwater because no remediation would be performed, and all waste would remain in the tanks. During the 100-year institutional control period, tank waste management operations would continue. Waste releases to the vadose zone for both the DSTs and SSTs would occur primarily after the end of the institutional control period.

Long-Term Management Alternative

This alternative potentially would impact groundwater because no remediation would be performed and all waste would remain in the tanks. During the 100-year institutional control period, tank waste management operations would continue and the DSTs would be replaced twice during the 100-year institutional control period. Waste releases to the vadose zone would occur primarily after the end of the institutional control period for the SSTs and 100 years after the end of the institutional control period for the DSTs.

In Situ Fill and Cap Alternative

Under this alternative, the tanks would be filled with gravel, and a Hanford Barrier would be placed over the tanks. Potential releases to the groundwater system that would occur with the In Situ Fill and Cap alternative are associated with the contaminants in the waste tanks. The form of the waste and inventory are identical to the No Action alternative, and the total mass of waste entering the vadose zone and ultimately reaching the groundwater would be the same as for the No Action alternative. However, the release would occur at a slower rate because the Hanford Barrier would reduce the rate of infiltration into the tanks and the rate of migration of the waste downward into the vadose zone. While the gravel fill would structurally stabilize the tanks by supporting the tank domes, it otherwise would not help to reduce infiltration or retard contaminant transport.

In Situ Vitrification Alternative

Under this alternative, all tank waste would be vitrified in situ. A Hanford Barrier then would be placed over the tanks. Potential releases to the groundwater system from dissolution of the vitrified mass would be associated with the contaminants in the waste tanks, but the form of the waste and inventory would differ from the No Action alternative. Materials for making glass would be added to the waste, and the organic and other volatile materials present in the No Action alternative inventory would be destroyed or vaporized.

Ex Situ Intermediate Separations Alternative

Under this alternative, waste would be retrieved from the tanks, high-level waste (HLW) would be separated from the LAW, and both HLW and LAW would be vitrified. The HLW then would be shipped to a potential geologic repository and the LAW would be disposed of onsite in near-surface vaults. A Hanford Barrier would be placed over the tanks and LAW vaults. Potential releases to the groundwater would be associated with releases 1) during retrieval from the waste tanks; 2) from residuals remaining in the tanks; and 3) from the onsite LAW vaults.

Ex Situ No Separations Alternative

Under this alternative, waste would be retrieved from the tanks, vitrified or calcined, and shipped to the potential geologic repository for disposal. A Hanford Barrier would be placed over the tanks. Potential releases to the groundwater system would be associated with releases 1) during retrieval from the waste tanks; and 2) from residuals remaining in the tanks. The vitrified or calcined waste would not have a potential groundwater impact because all waste would be shipped offsite for disposal. The groundwater impacts for this alternative would be the same as those estimated for the retrieval and residual releases for the Ex Situ Intermediate Separations alternative.

Ex Situ Extensive Separations Alternative

This alternative would be similar to the Ex Situ Intermediate Separations alternative, with the difference being that a more extensive separations process would be implemented to remove a greater percentage of the HLW from the LAW waste. Under this alternative, waste would be retrieved from the tanks, HLW would be separated from the LAW, and both HLW and LAW would be vitrified. The extensive separations process would result in a smaller amount of contaminant source in the LAW vaults. A Hanford Barrier would be placed over the tanks and the LAW vaults.

Potential releases to the groundwater system would be associated with releases 1) during retrieval from the waste tanks; 2) from residuals in the tanks; and 3) from the LAW vaults. Groundwater impacts associated with retrieval and residual releases would be similar to the Ex Situ Intermediate Separations alternative. However, the groundwater impacts of releases from the LAW vaults would be lower than those from the Ex Situ Intermediate Separations alternative LAW vaults because the source term is smaller.

Ex Situ/In Situ Combination 1 Alternative

Under this alternative, 107 tanks would be remediated in the manner described for the In Situ Fill and Cap alternative, and 70 tanks (60 SSTs and 10 DSTs) would be remediated in the manner described for the Ex Situ Intermediate Separations alternative. Releases to groundwater associated with the waste remediated under the In Situ Fill and Cap part of the alternative would occur as described previously. These tanks would contain disproportionately large amounts of low-mobility low-solubility contaminants. Tanks selected for waste retrieval and ex situ vitrification would contain approximately 90 percent of the high-mobility, high-solubility, high human health risk contaminants (i.e., technetium-99, carbon-14, iodine-129, and uranium-238).

Ex Situ/In Situ Combination 2 Alternative

Under this alternative, 25 tanks would be selected for retrieval and the remaining 152 tanks would be remediated in situ. The retrieved waste would be separated into LAW and HLW. The LAW would be placed into shallow subsurface LAW burial vaults in the 200 East Area and the HLW would be shipped offsite for disposal at the potential geologic repository. A Hanford Barrier would be placed over the tanks and vaults. This alternative was designed for the ex situ treatment of the largest contributors to long-term risk (i.e., technetium-99, carbon-14, iodine-129, and uranium-238) while limiting the total amount of waste to be retrieved and processed. Approximately 30 percent of the total waste volume in the tanks would be retrieved. The tank waste retrieved would contain approximately 85 percent of the technetium-99, 80 percent of the carbon-14, 50 percent of the uranium-238, and 80 percent of the iodine-129.

Phased Implementation Alternative

Phase 1

Under the first phase of this alternative, waste from the DSTs would be retrieved, vitrified, and stored temporarily onsite. There would be no groundwater impacts under this phase because 1) releases of waste would not occur during retrieval from DSTs; and 2) the storage of the vitrified waste would be temporary and under controlled conditions so there would be no liquid releases.

Phase 2

In the second phase of this alternative, the remainder of the tank waste would be retrieved and treated in the same way as in the Ex Situ Intermediate Separations alternative. Potential releases to the groundwater for Phase 2 of the Phased Implementation alternative would be similar to those calculated for the retrieval from SSTs for the Ex Situ Intermediate Separations alternative.

Effluent Treatment Facility

This facility would be common to all of the alternatives. It potentially would impact groundwater because treated effluent from the Effluent Treatment Facility would be discharged to a State-approved land disposal site located immediately north of the 200 West Area. The Effluent Treatment Facility wastewater originates as process evaporator condensate. All tank alternatives would contribute wastewater to the State-approved land disposal site either through periodic operations of the 242-A Evaporator, DST retanking campaigns, or as liquid effluent collected from the process facility. The State-approved land disposal site consists of a piping manifold used to infiltrate treated effluent into vadose zone soil and deeper groundwater beneath the disposal site. The primary contaminant present in the treated effluent would be tritium, with other organic, inorganic, and radiologic contaminants having been removed during the treatment process (Volume Two, Appendix B). Waste releases to the vadose zone beneath the State-approved land disposal site would occur only during the operations phase of each alternative.

The effects of treated effluent disposal on groundwater were simulated as entering the uppermost aquifer beneath the State-approved land disposal site at a projected rate of 570 liters per minute (L/min) (150 gallons per minute [gal/min]) over an area of 8,350 m^2 (90,000 ft^2). Tritium concentrations in the treated effluent entering the groundwater system were assumed to be 2.1E-05 Ci/L (2.1E+07 pCi/L) with a half-life of 12.3 years. The simulation results indicated that disposal of treated effluent would have little effect on the local direction of groundwater movement beneath the State-approved land disposal site. Groundwater flow directions resume their northeasterly regional flow direction at a point approximately 300 m (980 ft) downgradient of the disposal site. It is estimated that it would take 100 years for tritium in the uppermost aquifer to travel between the disposal site and the Columbia River. Maximum tritium concentrations at the riverbank before dilution in the Columbia River were calculated to be 1.4E-08 Ci/L (1.4E+04 pCi/L), which is below the Federal drinking water standard of 2.0E-08 Ci/L (20,000 pCi/L) (Jacobs 1996). No further groundwater analysis was conducted for the effects of treated effluent disposal.

No Action Alternative (Capsules)

This alternative would not impact groundwater. Cesium and strontium capsules would be maintained and stored temporarily in the Waste Encapsulation and Storage Facility (WESF) basins for a period of approximately 10 years, until further remediation measures have been selected. Therefore, no groundwater analysis was necessary.

Onsite Disposal Alternative

Under this alternative, the capsules would be placed in 0.3-m (1.0-ft) canisters surrounded by a 0.76-m (2.5-ft)-diameter sand backfill. There would be 672 drywells on a 5-m (16-ft) center-to-center spacing with a 30-m (100-ft) buffer around the facility. The drywell depth would be 4.6 m (15 ft) belowground.

Both cesium and strontium are relatively immobile in groundwater systems at the Hanford Site. The result of this immobility would mean that no measurable amount of either cesium or strontium would reach the groundwater within the 10,000-year period of interest. In addition, cesium-137 decays to barium-137, a stable isotope that likewise is immobile in groundwater systems. Strontium-90 decays to zirconium-90, which also is stable and immobile in groundwater systems. No groundwater analysis was conducted for this alternative because no impacts would be expected from the capsule contents or their decay products.

Overpack and Ship Alternative

Under this alternative, capsules would be removed from temporary storage, overpacked, and shipped offsite. No release of liquid would occur. No groundwater assessment was necessary because there would be no release of contaminants to the vadose zone or the groundwater.

Vitrify with Tank Waste Alternative

Under this alternative, capsules would be removed from temporary storage and vitrified with the HLW. Releases of liquid would be accounted for in the ex situ alternatives. No groundwater assessment was necessary because there would be no release of contaminants to the vadose zone or groundwater in excess of those for the ex situ alternatives.

Aggregate Source Areas

The 179 potential sources (i.e., each of the 177 tanks and the proposed LAW disposal vaults) were aggregated into nine discrete source areas based on waste inventory and proximity. The criteria used for these groupings are as follows.

- The proposed LAW disposal facility was considered one source area, though there could be as many as 41 vaults. Vault spacing was assumed to be approximately 30 m (100 ft) over a continuous area of up to 9.4 ha (23 ac). The vaults would be covered with one continuous Hanford Barrier.
- The tank sources were grouped into eight source areas, three in the 200 West Area and five in the 200 East Area.

Contaminant Groups

The tanks contain more than 100 radioactive and nonradioactive contaminants that potentially could impact groundwater. The approach used for this analysis was to group the contaminants based on their mobility in the vadose zone and underlying unconfined aquifer. Contaminant groupings were used rather than the individual mobility of each contaminant primarily because of the uncertainty involved in determining the mobility of individual contaminants. The groups were selected based on relatively narrow ranges of mobility, and contaminants were placed in the more mobile group if there was uncertainty about which group they should be placed in.

Some of the contaminants, such as iodine and technetium, would move at the rate of water whether in the vadose zone or underlying groundwater. The movement of other contaminants in water, such as americium and cesium, would be slowed or retarded by interaction with soil and rock. The VAM2D flow and transport model accounted for the retardation of contaminant movement with the parameter K_d, which is the distribution coefficient (mL/g). This parameter is a measure of sorption and is the ratio of the quantity of the adsorbate adsorbed per gram of solid to the amount of adsorbate remaining in solution (Kaplan et al. 1994). Values of K_d for the contaminants range from 0 mL/g (in which the contaminant's movement in water is not retarded) to more than 100 mL/g (in which the contaminant moves much slower than water).

The waste inventory was grouped and modeled according to each contaminant's reported or assumed K_d. The contaminant groups, based on mobility and examples of common or potential constituents of concern, are described in the following text. A complete listing of tank waste constituents by K_d is provided in Volume Four, Appendix F. The waste inventory groups used for modeling included the following:

- Group 1 - Contaminants were modeled as nonsorbing (i.e., $K_d = 0$). Contaminant movement would be unretarded in water. Contaminant K_d values in this group ranged from 0 to 0.99 mL/g and included all the isotopes of carbon, iodine, technetium, uranium, and nitrate;
- Group 2 - Contaminants were modeled as slightly sorbing (i.e., $K_d = 1$). Contaminant K_d values in this group ranged from 1 to 9.9 mL/g and included all the isotopes of americium, nickel, and chromium;
- Group 3 - Contaminants were modeled as moderately sorbing (i.e., $K_d = 10$). Contaminant K_d values in this group ranged from 10 to 49.9 mL/g and included all the isotopes of lead, plutonium, strontium, and thorium; and
- Group 4 - Contaminants were modeled as strongly sorbing (i.e., $K_d = 50$). Contaminant K_d values in this group were 50 mL/g or greater and included all the isotopes cesium, rubidium, and thallium.

Source Terms

The numerical modeling used to analyze groundwater impacts required understanding and quantifying when, what, and how many (mass or activity) contaminants would be released. The quantification of this information is the source term and includes the water flux into the vadose zone, which results from precipitation infiltrating the waste and mass or activity solubilized from dissolution of waste in the tanks. A detailed description of the source term and the rates of release of contaminants into the groundwater are contained in Volume Four, Appendix F.

5.2.1.2 Results

Groundwater beneath the 200 Areas and in plumes leading from the 200 Areas toward the Columbia River currently is contaminated with hazardous chemicals and radionuclides at levels greatly exceeding Federal drinking water standards. Drinking water standards typically are applied to treated water and are used here for comparison. For radionuclides, the drinking water standard (40 Code of Federal Regulations [CFR] 141.16) is based on a calculated dose equivalent to 4 millirem (mrem)/year to an internal organ, except for uranium that has a standard of 0.02 mg/L based on total uranium (i.e., all isotopes). Hazardous chemical contaminants present at levels exceeding drinking water standards include nitrates, cyanide, fluoride, chromium, chloroform, carbon tetrachloride, trichloroethylene, and techrachloroethylene. Radiological contaminants include iodine-129, tritium, cesium-137, plutonium-239 and 240, and strontium-90.

The groundwater beneath the 200 Areas is severely contaminated at levels that substantially exceed drinking water standards for several constituents. For example, iodine-129 is present at levels that exceed standards by up to 20 times. Groundwater use restrictions have been implemented to prevent use of the contaminated groundwater. Implementing any of the TWRS alternatives would add contaminants to groundwater but in concentrations expected to be less than the current levels of contamination observed in groundwater beneath the 200 Areas. Groundwater impacts calculated for each alternative are described briefly in the following subsections.

No Action Alternative (Tank Waste)

Groundwater impacts would be essentially the same as at present for the remainder of the 100-year period of institutional control, with the exception of slightly increased contaminant levels due to additional SSTs that could develop leaks. The long-term effects of this alternative are discussed below.

Because the waste would remain in the tanks, the No Action alternative eventually would result in the long-term dissolution and release of the total waste inventory from the 177 tanks into the vadose zone. The contaminants ultimately would pass through the vadose zone and reach the groundwater in the underlying unconfined aquifer within the 10,000-year period of analysis. Once in the aquifer, the contaminants would move relatively quickly through the aquifer and discharge to the Columbia River. The calculated contaminant concentrations in the groundwater are described in the following sections.

For the K_d Group 1 (K_d = 0) contaminants (fast-moving contaminants), the vadose simulation results calculated first arrival of contaminants at the vadose zone/groundwater interface from approximately 130 to 150 years from the present for the SSTs and DSTs. Peak concentration at the vadose zone/groundwater interface would be reached approximately 210 to 260 years from the present.

For the K_d Group 2 (K_d = 1), the vadose simulation results calculated contaminant first arrival at the groundwater approximately 1,000 to 1,400 years from the present. The average time of first arrival for the three source areas in the 200 West Area would be approximately 1,300 years from the present, while the average time of first arrival for the five source areas in the 200 East Area would be approximately 1,200 years from the present. The longer average time to first arrival for source areas in the 200 West Area is consistent with the thicker vadose zone in the 200 West Area.

For the K_d Group 3 and 4 (K_d = 10 and 50), first arrival would occur late (i.e., beyond the 10,000-year period of analysis). For this reason, simulation results were not reported for these K_d groups.

Two time frames were selected to illustrate the contaminant distribution in the unconfined aquifer. The calculated nitrate distribution in the groundwater at 300 years from the present is shown in Figure 5.2.3. Nitrate has an assumed K_d equal to zero and thus would move at the same velocity as the groundwater. Figure 5.2.4 provides the calculated distribution of bismuth in the groundwater at 5,000 years from the present. Bismuth is in K_d Group 2 (K_d = 1). Bismuth would move through the groundwater system at a slower velocity than water. Maximum contaminant concentrations for the five indicator contaminants at selected time periods are provided in Table 5.2.1 with the drinking water standards for comparison.

Drinking water standards for carbon-14, iodine-129, technetium-99, nitrate, and uranium-238 all would be exceeded at the 300- and 500-year times. Contaminant concentrations would decrease by 500 years but still would exceed the drinking water standards. By 2,500 years from the present, contaminant levels would be well below applicable drinking water standards as the contaminants are flushed through the system.

Long-Term Management Alternative

Under the Long-Term Management alternative, the first retanking of the DSTs would begin 50 years from the present. As a result, there would be no short-term contaminant releases to the vadose zone and groundwater in addition to those already existing. Groundwater impacts essentially would be the same as at present for the remainder of the 100-year period of institutional control, with the possible exception of slightly increased contaminant levels due to additional

SSTs that begin to develop leaks. Leaks would be very small because saltwell pumping of the SSTs would reduce the amount of liquids available for release and because leaks would not be expected from the outer tanks of the DSTs.

Long-term impacts from the Long-Term Management alternative would be similar to the No Action alternative except impacts from the DSTs would be delayed by up to 100 years. The Long-Term Management alternative would result in the release of the total waste inventory from the 177 tanks into the vadose zone. The contaminants ultimately would pass through the vadose zone and reach the groundwater in the underlying unconfined aquifer within the 10,000-year period of analysis.

Figure 5.2.3 Calculated Nitrate Concentrations in Groundwater at 300 Years for the No Action Alternative

Figure 5.2.4 Predicted Bismuth Concentrations in Groundwater at 5,000 Years for the No Action Alternative

Table 5.2.1 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the No Action Alternative[1]

Once in the aquifer, the contaminants would move quickly through the aquifer and discharge to the Columbia River. The difference between this alternative and the No Action alternative is that the DSTs were assumed to last 100 years longer under the Long-Term Management alternative.

For the K_d Group 1 (K_d = 0) contaminants, the vadose zone simulation results calculated first arrival of contaminants at the vadose zone/groundwater interface approximately 140 to 250 years from present. Peak concentration at the vadose zone/groundwater interface would be reached approximately 210 to 350 years from present.

For the K_d Group 2 (K_d = 1), the vadose simulation results in calculated contaminant first arrival at the groundwater approximately 1,000 to 1,500 years from the present. The average time of first arrival for the three source areas in the 200 West Area would be approximately 1,300 years from the present, while the average time of first arrival for the five source areas in the 200 East Area would be approximately 1,200 years. The longer average time to first arrival for source areas in the 200 West Area is consistent with the thicker vadose zone in the 200 West Area.

For the K_d Group 3 and 4 (K_d = 10 and 50), first arrival would occur late (i.e., beyond the 10,000-year period of analysis). For this reason, simulation results were not reported for these K_d groups.

Two time frames were selected to illustrate the contaminant distribution in the unconfined aquifer. The estimated nitrate distribution in the groundwater at 300 years from the present is shown in Figure 5.2.5. Nitrate has an assumed K_d equal to zero, and thus would move at the velocity of groundwater.

Figure 5.2.6 provides the calculated distribution of bismuth in the groundwater at 5,000 years from the present. Bismuth is in K_d Group 2 (K_d = 1). Bismuth would move through the groundwater system at a much slower velocity than water. Maximum contaminant concentrations for the five indicator contaminants at selected time periods are provided in Table 5.2.2 with drinking water standards for comparison.

Drinking water standards for carbon-14, iodine-129, technetium-99, nitrate, and uranium-238 all would be exceeded at the 300- and 500-year times. Contaminant concentrations would decrease by 500 years but still exceed the drinking water standards. By 2,500 years, contaminant levels would be below current drinking water standards.

In Situ Fill and Cap Alternative

There would be no contaminant losses to the vadose zone and groundwater under the In Situ Fill and Cap alternative during remediation in addition to those already existing, because retrieval of the waste would not be performed; therefore, retrieval activities would not cause increased leaks from the tanks. Groundwater impacts essentially would be the same as for the No Action alternative for the 100-year period of institutional control. The long-term effects of this alternative would commence after the 100-year period of institutional control and are discussed in the following paragraphs.

The waste that remained in the tanks under the In Situ Fill and Cap alternative eventually would result in the long-term dissolution and release of the complete inventory from the 177 tanks into the vadose zone. This complete release was considered to be a bounding condition for the EIS. However, only the most mobile contaminants, those modeled as $K_d = 0$, were calculated to reach the groundwater within the period of analysis. The source would be the same as for the No Action alternative. The major difference between these alternatives is that a Hanford Barrier would be constructed over the tanks, which would result in a lower infiltration rate and lower contaminant release rate to the vadose zone compared to the No Action alternative. For the In Situ Fill and Cap and all other tank waste alternatives, except No Action, Long-Term Management, and Ex Situ/In Situ Combination 1 and 2 alternatives, only the contaminants modeled as $K_d = 0$ would reach the groundwater within the period of analysis. For this reason, simulations were not reported for K_d Groups 2, 3, and 4 for the remaining alternatives except the Ex Situ/In Situ Combination 1 and 2 alternatives.

Figure 5.2.5 Predicted Nitrate Concentrations in Groundwater at 300 Years for the Long-Term Management Alternative

Figure 5.2.6 Predicted Bismuth Concentrations in Groundwater at 5,000 Years for the Long-Term Management Alternative

Table 5.2.2 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the Long-Term Management Alternative [3]

Once in the aquifer, the contaminants would move relatively quickly through the aquifer and discharge to the Columbia River. Contaminant first arrival at the vadose zone/groundwater interface was calculated to occur approximately 2,300 to 3,400 years from the present. Peak groundwater concentrations in the aquifer would be similar to those calculated for the No Action alternative but would occur approximately 4,100 to 6,300 years from present.

The average time to first arrival and peak concentration for the five source areas in the 200 East Area would be approximately 2,500 and 5,200 years, respectively. The average time to first arrival and peak concentration for the three source areas in the 200 West Area would be approximately 3,300 and 5,200 years, respectively.

The calculated peak concentrations for each of the eight areas at the vadose zone/groundwater interface were similar in magnitude to those calculated for the No Action alternative. As with the No Action alternative, contaminant levels would reach or nearly reach steady-state conditions with maximum concentrations near 400,000 g/m^3 for all source areas except one.

The calculated nitrate distribution in the groundwater at 5,000 years from the present is shown in Figure 5.2.7. Nitrate has an assumed K_d equal to zero and thus would move at the velocity of groundwater. Nitrate concentration in the groundwater would reach steady-state conditions at approximately 5,800 years and would continue at those concentration levels for approximately 1,500 years. The nitrate concentrations shown in Figure 5.2.7 were based on an initial source concentration of 360,000 g/m^3 calculated in the upper 6 m (20 ft) of the aquifer.

Maximum contaminant concentrations for the five indicator contaminants at selected time periods are provided in Table 5.2.3 with the drinking water standards for comparison, where available.

Contaminants would not reach groundwater from the sources at earlier time periods during 300 or 500 years from present. Very low levels were calculated for the 2,500-year period. Current drinking water standards exceedances were calculated for iodine-129, uranium, and technetium-99 from 5,000 years through 10,000 years from the present. Nitrate concentrations would exceed drinking water standards at approximately 5,000 years but would decrease to below the standard before 10,000 years.

In Situ Vitrification Alternative

There would be no contaminant losses to the vadose zone and groundwater under the In Situ Vitrification alternative during remediation because the waste would be immobilized by vitrification, and the resulting glass would leach extremely slowly. The long-term effects of this alternative would commence after remediation and are discussed in the following paragraphs.

The In Situ Vitrification alternative would result in the long-term partial release of the tank inventory from the 177 tanks into the vadose zone over the period of interest (10,000 years). Only the most mobile contaminants, those modeled as K_d equal to zero, were calculated to reach the groundwater within the period of analysis. The source would be similar to the alternatives previously described but the release rates would be very low. This would result in a release of contaminants at a constant concentration for several thousand years from each vitrified tank farm.

Contaminant first arrival at the vadose zone/groundwater interface was calculated to occur approximately 2,400 to 3,400 years from the present. Peak concentration at the vadose zone/groundwater interface would reach steady-state conditions with a concentration of 400 mg/L between approximately 6,200 and 7,500 years and remain at that concentration for the remainder of the period of analysis. Compared to the No Action alternative, this alternative would have a much longer calculated time to first arrival and a lower peak concentration at the vadose zone/groundwater interface, primarily because of the lower infiltration rate through the Hanford Barrier and the low solubility of the vitrified waste. The calculated peak concentration for each of the eight source areas at the vadose zone/groundwater interface also would be much lower. The time of first arrival would be affected by the material properties of the strata as well as the distance of travel (vadose zone thickness).

Figure 5.2.7 Predicted Nitrate Concentrations in Groundwater at 5,000 Years for the In Situ Fill and Cap Alternative

Table 5.2.3 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the In Situ Fill and Cap Alternative [3]

Figure 5.2.8 presents the calculated uranium-238 distribution in the groundwater at 5,000 years from the present. Uranium-238 was assumed to have a K_d equal to zero and thus would move at the velocity of groundwater. The uranium-238 concentrations would reach steady-state conditions at approximately 5,000 years and continue at those concentration levels throughout the 10,000-year period of analysis. The uranium-238 concentrations shown in Figure 5.2.8 represent calculated concentrations in the upper 6 m (20 ft) of the aquifer. Maximum contaminant concentrations for the five indicator contaminants at selected time periods are provided in Table 5.2.4 with the drinking water standards for comparison, where available. Calculated contaminant concentrations all would be below drinking water standards for all of the times shown in Table 5.2.4. Iodine-129, nitrate, and carbon-14 were not in the source term because iodine-129 and carbon-14 would be volatilized during the vitrification process, and nitrate would be converted to volatile nitrogen oxides.

Figure 5.2.8 Predicted Uranium-238 Concentrations in Groundwater at 5,000 Years for the In Situ Vitrification Alternative

Table 5.2.4 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the In Situ Vitrification Alternative[2]

Ex Situ Intermediate Separations Alternative

There would be contamination releases to the vadose zone under the Ex Situ Intermediate Separations alternative during remediation that would be caused by releases from the SSTs during retrieval. There would be no contaminant releases from the DSTs. However, the contaminants released by losses during retrieval would travel very slowly in the vadose zone, requiring approximately 1,100 years to reach the groundwater. Groundwater modeling did not distinguish between contaminants from retrieval releases and contaminants from residual waste left in the tank. The net result was that contaminants from retrieval releases would become intermingled with contaminants from residual waste left in the tanks. The modeling results shown in Volume Four, Appendix F show only the arrival of one group of contaminants at the boundary between the vadose zone and the groundwater aquifers. The long-term effects of the Ex Situ Intermediate

Separations alternative are discussed in the following paragraphs.

This alternative would result in the long-term release of contaminants to the vadose zone from 1) waste from the 149 SSTs associated with retrieval operations (retrieval from DSTs do not result in releases); 2) residual waste left in the tanks (for all tanks); and 3) the LAW disposal facility.

Only the most mobile contaminants, those modeled as K_d Group 1 (K_d = 0), were calculated to reach the groundwater within the period of analysis. The contaminants modeled as K_d Group 1 (K_d = 0) would reach the vadose zone/groundwater interface approximately 1,100 to 3,400 years from present. Compared to the No Action alternative, the mass of contaminants that would be released from the tanks would be relatively small (i.e., less than 2 percent of the mass released under the No Action alternative).

Peak contaminant concentrations at the vadose zone/groundwater interface for the tank source areas would be approximately 3,600 to 5,100 years from present. Peak contaminant concentrations at the vadose zone/groundwater interface for the LAW disposal facility would be reached at approximately 6,600 years and would remain at about that concentration for the remainder of the period of analysis. Compared to the No Action alternative, this alternative would have a much longer time to first arrival and peak contaminant concentrations at the vadose zone/groundwater interface, primarily because of the lower infiltration rate through the Hanford Barrier and the lower corrosion rate of the vitrified waste in the LAW disposal facility.

The calculated nitrate concentration in the groundwater from the tank sources at 5,000 years from the present is shown in Figure 5.2.9. The nitrate concentrations shown in Figure 5.2.9 were adjusted for an assumed initial source concentration of 360,000 g/m^3 of nitrate and represent calculated concentrations in the upper 6 m (20 ft) of the aquifer. Figure 5.2.10 presents the calculated uranium-238 concentrations in the groundwater from the tank and LAW disposal facility at 5,000 years from the present. Both nitrate and uranium-238 have an assumed K_d equal to zero and thus would move at the velocity of groundwater. Post processing of the modeling results is explained in Volume Four, Appendix F. There would be an exceedance at the current drinking water standard for uranium-238 at 5,000 years from present. No additional contaminants would exceed current groundwater standards.

Contaminants would not have reached the groundwater from the tank sources at the two earlier time periods of analysis (e.g., 300 and 500 years from the present). At 2,500 years from the present, contaminants would not have yet reached groundwater from the LAW disposal facility. Maximum concentrations for the five indicator contaminants at selected time periods are provided in Table 5.2.5 for comparison with the drinking water standards. The current drinking water standards for any of the indicator contaminants would not be exceeded by releases from the tank sources associated with waste retrieval and residuals nor the LAW disposal source, except for a slight exceedance of uranium at 5,000 years for the tank sources. Because the maximums for tank sources and LAW vaults occur at different locations, they are not additive.

Ex Situ No Separations Alternative

There would be contaminant releases to the vadose zone under the Ex Situ No Separations alternative during remediation that would be caused by releases from the SSTs during retrieval. There would be no contaminant releases from the DSTs. Because the retrieval process is the same as that for the Ex Situ Intermediate Separations alternative, the effects of these retrieval releases also would be the same. The following paragraphs discuss the long-term effects of groundwater contaminants.

Figure 5.2.9 Predicted Nitrate Concentrations in Groundwater at 5,000 Years for the Ex Situ Intermediate Separations Alternative (Tank Sources Only)

Figure 5.2.10 Predicted Uranium-238 Concentrations in Groundwater at 5,000 Years for the Ex Situ Intermediate Separations Alternative (Tank and LAW Sources Combined)

Table 5.2.5 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the Ex Situ Intermediate Separations Alternative

The long-term impact to groundwater associated with the Ex Situ No Separations alternative would be a result of waste retrieval from the SSTs and residual waste remaining in both the SSTs and DSTs. These impacts would be the same as calculated for the Ex Situ Intermediate Separations alternative for the tank sources only, as illustrated in Figures 5.2.9 and 5.2.10. All retrieved waste would be processed and transported to the potential geologic repository. Maximum calculated concentrations for the five indicator contaminants at selected time frames are provided in Table 5.2.6.

Table 5.2.6 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the Ex Situ No Separations Alternative

Contaminants would not reach the groundwater until approximately 1,100 years from the present. Levels of contaminants would remain low. There would be an exceedance of the current drinking water standard for uranium-238 at 5,000 years from the present.

Ex Situ Extensive Separations Alternative

There would be contaminant losses to the vadose zone under the Ex Situ Extensive Separations alternative during remediation that would be caused by losses from the SSTs during retrieval. There would be no contaminant losses from the DSTs. Because the retrieval process would be the same as that for the Ex Situ Intermediate Separations alternative, the effects of these retrieval losses also would be the same. The following paragraphs discuss the long-term effects of the groundwater contaminants.

Long-term groundwater impacts for the Ex Situ Extensive Separations alternative would result from tank sources (waste retrieval releases from SSTs and residual waste releases from SSTs and DSTs) and the LAW disposal vaults. The groundwater impacts associated with the tank sources would be similar to those calculated for the Ex Situ Intermediate Separations alternative (Figures 5.2.9 and 5.2.10). The groundwater impacts associated with releases from the LAW disposal facility would be reduced from those calculated for releases from the LAW disposal vaults under the Ex Situ Intermediate Separations alternative because a greater amount of the HLW would be removed during the separations process. Maximum concentrations in groundwater of the five indicator contaminants from tank sources and of technetium-99 and uranium-238 from the LAW disposal vaults are shown at selected times in Table 5.2.7.

Contaminants would not reach the groundwater until approximately 1,100 years from the present. Levels of contaminants would remain low. There would be a slight exceedance of current drinking water standards for uranium-238 at 5,000 years from the present.

Ex Situ/In Situ Combination 1 Alternative

There would be contaminant losses to the vadose zone under the Ex Situ/In Situ Combination 1 alternative during remediation that would be caused by losses from the SSTs during retrieval. Because the retrieval process would recover waste from 60 SSTs instead of 149, the retrieval losses would be proportionately less. However, the contaminants released by losses during retrieval would travel very slowly in the vadose zone, eventually becoming indistinguishable from the contaminants caused by the residue remaining in the tanks after retrieval. There would be no contaminant losses from the DSTs during remediation. The long-term effects of groundwater contaminants are discussed in the following paragraphs.

The two major components that would result in long-term releases to the vadose zone under this alternative are 1) tank sources from retrieval losses and releases from tanks remediated in situ; and 2) releases from the LAW vault. The scenarios for these components would include all of the assumptions stated for the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives. The residual waste assumed to be 1 percent of the initial inventory, which could be left in the tanks after retrieval, was added to the inventory of tanks that would be remediated in situ. As with both the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives, only the most mobile contaminants, those modeled as K_d equal to zero, were calculated to reach groundwater within the period of analysis.

The objective of this alternative is to reduce the number of tanks in which the waste is processed ex situ and simultaneously achieve low groundwater concentrations of the high-risk contaminants technetium-99, carbon-14, iodine-129, and uranium-238. These contaminants all are mobile and are in K_d Group 1. They, along with the other contaminants in K_d Group 1, were calculated to reach the groundwater of the unconfined aquifer within the period of analysis. The distribution of uranium-238 in groundwater, the most abundant of the uranium isotopes in the tank waste, is presented in this section for 5,000 years from the present. Also, a tabulation of maximum concentrations of indicator contaminants in the unconfined aquifer in K_d Group 1 is provided.

Table 5.2.7 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the Ex Situ Extensive Separations Alternative

Peak contaminant concentrations at the vadose zone/ groundwater interface for the tank source areas would be reached approximately 3,600 to 5,100 years from the present. Peak contaminant concentrations at the vadose zone/groundwater interface for the LAW disposal facility would be reached approximately 6,600 years from the present and would remain at that concentration for the remainder of the period of analysis.

Once in the aquifer, the contaminants would discharge to the Columbia River. Contaminant concentrations in the aquifer would be approximately 10 times lower than those calculated for the No Action alternative, primarily as a result of lower contaminant inventory and a lower infiltration rate due to the Hanford Barrier, which would be constructed over the tanks remediated in situ and the LAW vault.

The calculated uranium-238 concentrations in the groundwater from the tank sources and from the LAW disposal facility at 5,000 years from the present are provided in Figures 5.2.11 and 5.2.12, respectively. These concentrations represent calculated concentrations in the upper 6 m (20 ft) of the aquifer. Maximum concentrations for the five indicator contaminants at selected time periods are provided in Table 5.2.8, with the drinking water standard for comparison for both the tank sources and LAW disposal source. Nitrate, iodine-129, technetium-99, and uranium-238 were calculated to exceed the current drinking water standard at 5,000 years.

Ex Situ/In Situ Combination 2 Alternative

There would be contaminant losses to the vadose zone under the Ex Situ/In Situ Combination 2 alternative from 1) retrieval losses from the 13 SSTs; 2) losses from the residual waste that would remain in the 25 tanks from which waste would be retrieved (13 SSTs and 12 DSTs); 3) releases from the 152 waste tanks that would be remediated in situ with the fill and cap technology; and 4) releases from the LAW vaults. Only the most mobile contaminants, those modeled as K_d equal to zero, were calculated to reach the groundwater within the period of interest. The long-term impacts of these releases on the groundwater are discussed in the following paragraphs.

The calculated groundwater impact from retrieval losses from the 13 SSTs would be proportionally less than the calculated impacts associated with retrieval losses for Ex Situ/In Situ Combination 1 alternative in which the waste from 60 SSTs would be retrieved. To calculate the impact from waste retrieval, the predicted contaminant concentration of each contaminant from the Ex Situ/In Situ Combination 1 alternative was multiplied by the ratio of the mass of this alternative (on a contaminant by contaminant basis) over the mass of that constituent that would be released during retrieval for the Ex Situ/In Situ Combination 1 alternative.

Figure 5.2.11 Predicted Uranium-238 Concentrations in Groundwater at 5,000 Years for the Ex Situ/In Situ Combination 1 Alternative (Tank Sources Only)

Figure 5.2.12 Predicted Uranium-238 Concentrations in Groundwater at 5,000 Years for the Ex Situ/In Situ Combination 1 Alternative (LAW Vault Sources Only)

Table 5.2.8 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the Ex Situ/In Situ Combination 1 Alternative

Simulations of contaminant fate and transport as described for the In Situ Fill and Cap alternative were performed to calculate groundwater impacts from the 152 tanks remediated in situ and as with the retrieval impacts, only the most mobile contaminants would reach groundwater within the period of interest. The calculated groundwater impacts from the LAW vault would also be proportionate to the calculated impacts from the LAW vault in the Ex Situ/In Situ Combination 1 alternative. The impacts were therefore calculated by scaling the results from the Ex Situ/In Situ Combination 1 alternative as described in the previous text.

This alternative would be a variation of the Ex Situ/In Situ Combination 1 alternative. The objective of this alternative would be to reduce the quantity of the long-term risk contributors (i.e., carbon-14, iodine-129, technetium-99 and uranium-238) in tanks remediated in situ while also reducing the amount of overall tank waste that would be retrieved. The contaminants that would be long-term contributors to risk, along with the other in K_d Group 1 (K_d), were calculated to reach the groundwater of the unconfined aquifer within the period of interest. The calculated distribution of uranium-238 in groundwater, the most abundant of the uranium isotopes in the tank waste, is presented in this section for 5,000 years from present for both tank sources and LAW vault sources.

Peak contaminant concentrations at the vadose zone/groundwater interface for the tank releases (both from retrieval releases and releases from tanks remediated in situ) would be reached approximately 3,600 to 5,100 years from the present. Peak contaminant concentrations at the vadose zone/groundwater interface for the LAW disposal facility would be reached at approximately 6,600 years and would remain at that concentration for the remainder of the period of interest.

Once in the aquifer, the contaminants would discharge to the Columbia River. Contaminant concentrations in the aquifer would be approximately 10 times lower than those for the No Action alternative, primarily as a result of lower contaminant inventory and lower infiltration rate due to the Hanford Barrier, which would be constructed over the tanks from which waste would be retrieved, those tanks that would be remediated in situ, and the LAW vault.

The calculated uranium-238 concentrations in the groundwater from tank sources and from the LAW disposal facility at 5,000 years from the present are provided in Figures 5.2.13 and 5.2.14, respectively. These concentrations represent calculated concentrations in the upper 6 m (20 ft) of the unconfined aquifer. Maximum concentrations for the five indicator contaminants at selected time periods are provided in Table 5.2.9, with the drinking water standard for comparison. As with the Ex Situ/In Situ Combination 1 alternative, nitrate, iodine-129, technetium-99, and uranium-238 were calculated to exceed the current drinking water standard at 5,000 years.

Phased Implementation Alternative

Phase 1

There would be no groundwater impacts from the first phase of this alternative. Nearly all of the waste would be retrieved from the DSTs, and there would be no retrieval losses.

Figure 5.2.13 Predicted Uranium-238 Concentrations in Groundwater at 5,000 Years for the Ex Situ/In Situ Combination 2 Alternative (Tank Sources Only)

Figure 5.2.14 Predicted Uranium-238 Concentrations in Groundwater at 5,000 Years for the Ex Situ/In Situ Combination 2 Alternative (LAW Vault Sources Only)

Table 5.2.9 Calculated Maximum Concentrations and Applicable Drinking Water Standards for the Ex Situ/In Situ Combination 2 Alternative

Phase 2

The short-term and long-term groundwater impacts from the second phase of this alternative would be identical to those for the Ex Situ Intermediate Separations alternative. There would be contaminant releases to the vadose zone under the second phase of this alternative during remediation, which would be caused by losses from the SSTs during retrieval. As explained in Volume Four, Appendix F, the impacts of the losses during retrieval would be approximately half of the impacts caused by the residual waste left in the tanks after retrieval. However, the contaminants released by losses during retrieval would travel very slowly in the vadose zone, requiring approximately 1,100 years to reach the groundwater. The net result would be that contaminants from retrieval losses would become intermingled with contaminants from residual waste left in the tanks. Groundwater modeling did not distinguish between the two sources of contaminants. The long-term effects of the second phase of the Phased Implementation alternative would be the same as those discussed for the Ex Situ Intermediate Separations alternative.

Cesium and Strontium Capsules

None of the cesium and strontium capsule alternatives would result in substantive groundwater impacts, as described in Section 5.2.1.1.

5.2.1.3 Parameter Sensitivity

Parameter sensitivity was investigated for the effect of 1) higher glass surface areas for the In Situ Vitrification alternative; 2) changing the performance period of the Hanford Barrier from 1,000 years to 500 years; 3) the eventual decay of the potentiometric head resulting from groundwater mounding related to the discharge to the Hanford Site ponds; 4) the effect of variations in infiltration rate; and 5) the effect of variations in distribution coefficient (K_d). Further information concerning parameter sensitivity is presented in Volume Five, Sections K.4.5.1 and K.4.5.2 .

In Situ Vitrification Surface Area

To investigate the sensitivity of the calculated results to the surface area of the glass produced by in situ vitrification, additional groundwater modeling was performed, based on the assumption that the glass surface area had increased by a factor of two. This would represent the case in which extensive cracking of the waste form had occurred. The additional modeling showed that the calculated contaminant concentrations were indistinguishable from those calculated by the base case analysis.

500-Year Versus 1,000-Year Hanford Barrier

The base case for modeling infiltration through the Hanford Barrier assumed the Barrier would not degrade for 1,000 years. Additional modeling was performed to investigate the situation in which the Hanford Barrier placed over the tanks would degrade 500 years after placement rather than 1,000 years. In the additional modeling, the water flux through the cap was assumed to increase from 0.05 cm/year to 0.1 cm/year (0.02 to 0.04 in./year) after 500 years. A comparison of the calculated nitrate concentrations for the two durations (500 versus 1,000 years) showed that the times of arrival of nitrate in the groundwater and the peak nitrate concentrations were almost identical. A comparison of calculated uranium-238 concentrations in groundwater at 10,000 years from the present indicates that for the 500-year cap, calculated uranium-238 concentrations would be lower by a factor ranging from 5 to 10. This would be due to the higher water flux through the 500-year cap, which would allow uranium-238 to move faster and be flushed from the groundwater system. With the 500-year cap, the contaminants would have already moved through the system. The conclusion is that the maximum contaminant concentrations in groundwater would be nearly unaffected, but the time of contaminant arrival to the groundwater would be proportional to the infiltration rate through the cap.

Groundwater Mounds

To investigate the sensitivity of the calculated contaminant concentrations in the unconfined aquifer, additional modeling for this saturated system was performed, which was based on calculated future groundwater levels where the present-day groundwater mounds associated with Site waste water disposal had dissipated. The additional modeling was conducted using conditions associated with the Ex Situ Intermediate Separations alternative (e.g., source term, infiltration rate, and Hanford Barrier performance). The data indicated that contaminant transport from the waste tanks and LAW vault would be in a slightly more easterly direction compared to that calculated for the base case flow field.

Variations in Infiltration Rate

To investigate the sensitivity of the calculated results to the assumed initial infiltration rate, additional vadose zone modeling was performed based on doubling the initial infiltration to 10 cm/year (4 in./year) from 5 cm/year (2 in./year) for the In Situ Fill and Cap alternative. The additional modeling showed that the calculated contaminant concentrations at the vadose zone/groundwater interface were indistinguishable from those calculated by the base case analysis. The infiltration-limiting effects of the cap was believed to be the controlling factor. Thus, these results would apply to the other alternatives that use a cap.

Variations in K_d

Sensitivity of contaminant travel time through the vadose zone to various K_d values was evaluated by varying K_d and calculating the arrival time for the 1WSS source area and the Ex Situ Intermediate Separations alternative. The additional modeling showed that at this source area and conditions for this alternative, contaminants with K_d values equal to or greater than approximately 0.125 mL/g would not reach the groundwater within the 10,000-year period of interest.

5.2.2 Surface Water

This section describes potential impacts on surface waters from liquid effluent discharges, seeps of contaminated groundwater, and alterations of surface water drainage systems.

5.2.2.1 Water Discharges

Although each tank waste and capsule alternative would generate liquid effluent, the effluent would not be discharged to surface waters, and thus there would be no direct impacts to any surface waters. Liquid currently in the tanks, or added to the tanks for purposes such as diluting waste so it could be pumped, ultimately would be removed to the extent possible under all alternatives. This liquid would be sent to an evaporator. Condensed water from the evaporator would be sent to the Effluent Treatment Facility in the 200 East Area. The water then would be treated in the Effluent Treatment Facility with a variety of systems, including evaporation, to meet applicable regulatory standards, and would ultimately be discharged through the Effluent Treatment Facility to the State-approved land disposal facility site, a subsurface drain field near the north-central part of the 200 West Area.

5.2.2.2 Groundwater Discharges

All of the tank waste alternatives would result in some contaminants being leached into the groundwater beginning in approximately 140 years for the No Action alternative to 3,400 years for the In Situ Vitrification alternative, as described in Section 5.2.1. Previously existing contaminants in the soils and vadose zone beneath the tanks from past tank leaks and spills also would migrate to the groundwater, but these are not in the scope of this EIS. Once contaminants reached the groundwater, they would eventually discharge into the Columbia River through seeps (springs) on the Columbia River bank or into the river through the river bed where the river intersects the unconfined aquifer. The present level of nitrate contamination in the unconfined aquifer (Volume Five, Appendix I) is approximately 20 mg/L at the river east of the 200 Areas. This concentration of nitrate in the unconfined aquifer has resulted in negligible changes in nitrate concentrations in the Columbia River and indicates that impacts to the Columbia River from any of the alternatives would be low. To verify this estimate, a mixing calculation for the water that would enter the Columbia River from the tank waste activities is described in the following text.

The analysis involved dividing the river into segments and then calculating the contaminant concentration in each segment based on inflow from the unconfined aquifer. Segments that were 1 kilometer (km) (0.6 mile [mi]) long were developed, and flow in the Columbia River was adjusted for each segment based on flux from the groundwater model at each node along the river. A water flux to or from the river then was assigned as part of the groundwater model calibration process. Contaminant mass entering the river was calculated from nitrate in groundwater at the 300-year time frame for the Long-Term Management alternative (Figure 5.2.5). This contaminant and alternative were selected because nitrate is the most abundant contaminant in the tank waste, is the contaminant most likely to impact the river, and was calculated to exceed drinking water standards in the unconfined aquifer for the No Action, Long-Term Management, and In Situ Fill and Cap alternatives. The 300-year time frame and the Long-Term Management alternative have the highest calculated nitrate concentrations in the unconfined aquifer at the river.

Columbia River Characteristics

The Columbia River flows through the northern and eastern portions of the Hanford Site for over 100 km (62 mi) and is hydraulically connected to the unconfined aquifer (Figure 5.2.1). This hydraulic connection allows river water to recharge to the unconfined aquifer along some reaches, notably in the vicinity of D Reactor. Groundwater discharges to the river at other locations, such as the reach around B Reactor and east of the Hanford Site. Both the groundwater discharge rate and nitrate concentrations vary along the approximate 105-km (65-mi) length of the Columbia River encompassed within the groundwater model. The minimum 7-day duration mean flow and the median flow rates were used in this analysis to bracket the calculated nitrate concentrations in the Columbia River.

The groundwater model, which encompasses approximately 100 km (62 mi) of the river located within the Hanford Site and a total of approximately 105 km (65 mi) of the river, calculated a net groundwater discharge to the river of approximately 0.51 m^3/sec (18 cubic feet [ft^3]/sec). This represents 0.022 percent of the median river flow.

Water quality information for the Columbia River was obtained from a U.S. Geological Survey water quality monitoring station at the Vernita Bridge, located near the western boundary of the Hanford Site where the Columbia River enters the Site. During the 1994 water year (October 1, 1993 to September 30, 1995), the combined nitrate and nitrite concentrations in the river at that location were less than the analytical detection limit (0.05 mg/L) on three occasions, 0.05 mg/L on one occasion, and 0.06 mg/L on one occasion (USGS 1994). Nitrate typically accounts for all but a small amount of the total nitrate and nitrite concentration.

Impacts Analysis

To determine how concentrations of a contaminant such as nitrate would vary along the river, the river reach was divided into many short segments in which complete mixing of the groundwater discharge with the river flow was assumed to occur. The resultant river concentration after mixing then was assumed to be the concentration for the river influent to the next downstream segment.

For the Long-Term Management alternative, an initial analysis was performed for nitrate, the chemical pollutant identified as having the greatest potential adverse impact, with river flow rates of 594 m^3/sec (21,000 ft^3/sec) (minimum 7-day duration mean flow rate) and 2,300 m^3/sec (81,000 ft^3/sec) (median flow rate). Background nitrate concentrations at the upstream end of the Columbia River Reach through the Hanford Site were assumed to be 0.05 mg/L, which is typical of present concentrations. The results are shown in Figure 5.2.15. Groundwater calculated to be contaminated with nitrate would first enter the river near B Reactor (Figure 5.2.5), and concentrations of nitrate in the river would increase slightly to approximately 0.06 mg/L for the minimum 7-day duration mean flow rate. The nitrate levels would remain at 0.06 mg/L until additional nitrate-contaminated groundwater was calculated to enter the river east of the 200 Areas (where nitrate concentrations ultimately were calculated to reach approximately 0.177 mg/L in the river), which would be approximately 0.12 mg/L above background. Nitrate concentrations in the river were much lower for the median flow rate, reaching a maximum of approximately 0.08 mg/L, which would be 0.03 mg/L above the 0.05 mg/L background nitrate concentrations.

Nitrate is a chemical contaminant belonging to Group 1, where K_d=0. The other members of Group 1 would behave in groundwater in a similar manner, because all of them were considered nonsorbing and their movement in groundwater would be retarded. As discussed in Volume Four, Appendix F, there are other members of Group 1. The radiological constituents in Group 1 include carbon-14, iodine-129, technetium-99, and uranium-238. These radioisotopes would move with nitrate in the groundwater and enter the Columbia River at the same locations. The concentrations of the radioisotopes would be less than that of nitrate in proportion to the amount of radioisotope that is present in the tanks. As is discussed in Volume Four, Appendix F, the tank contents were assumed to be released in proportion to the release of the most abundant tank consistent, which is nitrate.

Figure 5.2.15 Predicted Nitrate Concentration in Columbia River at 300 Years for the Long-Term Management Alternative

Therefore for the Long-Term Management alternative, the calculated concentrations of Group 1 constituents of concern would be as follows: carbon-14=3 .09E-09 g/L; iodine=2.0E-07 g/L; technetium-99=1.0E-06 g/L; and uranium-238=1.0E-03 g/L. These concentrations would be in addition to background concentrations. As explained in Volume Four, Appendix F, these calculated concentrations would be expected at approximately 500 years from the present.

Contaminants entering the Columbia River could be observed from time to time at localized higher concentrations than would be calculated by the mixing model. However, the concentration of pollutants discharged to the river rapidly would become completely mixed with the river flow from several mechanisms. The factors controlling the rate of mixing or length of mixing zone would be: turbulence of the river flow, which depends on velocity of flow; irregularities in the stream channel, including bends; and the width of the river. Secondary currents created by channel irregularities and bends also would result in rapid mixing. These mechanisms would result in the rapid mixing of groundwater discharged from the unconfined aquifer to the Columbia River. Therefore, the contaminants in the groundwater from the tank waste alternatives would be rapidly diluted on discharging into the Columbia River. There would be a slight increase in the contaminant levels, but drinking water standards would not be exceeded.

5.2.2.3 Surface Water Drainage Systems

All facilities would be constructed on relatively flat, semi-arid terrain, which slopes gently to the northeast. No major drainage features are present. While each of the tank waste alternatives would result in slightly altered localized drainage patterns, the area around all temporary structures and all permanent facilities would be designed to conform with the surrounding terrain. Small increases in surface water runoff during heavy precipitation events or rapid snow melt would occur from temporary structures, but there would be no flooding of drainage systems.

The capsule alternatives would not alter surface water drainage systems with the exception of the Onsite Disposal alternative. Under this alternative, 3.8 ha (8.4 ac) of nearly flat and level terrain would be graded almost completely flat and level for the drywell disposal facility. Only enough slope would be provided to allow for runoff during heavy precipitation or rapid snow melt. The facility would be graded to conform with the surrounding terrain. Small decreases in surface water runoff during heavy precipitation or rapid snow melt would occur.

The three potential borrow sites would be constructed on gently sloping semi-arid terrain with no major drainage features. Slightly altered localized drainage patterns would occur during borrow site operations. Small increases in surface water runoff during heavy precipitation events or rapid snow melt would occur from the altered terrain, but there would be no flooding of any drainage system.

Measures would be taken to minimize any increases in runoff during operations of the borrow sites. Following operations, the borrow sites would be recontoured to conform with the surrounding terrain.

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5.3 AIR QUALITY

Air pollutant emissions estimates were developed and air dispersion modeling was performed to analyze air quality impacts from the various TWRS alternatives. A detailed description of the sources of emissions, modeling, and results is contained in Volume Five, Appendix G. The analyses were conducted to compare the calculated impacts of potential criteria pollutant releases against National Ambient Air Quality Standards and Washington State Air Quality Standards, the calculated impacts of emissions of toxic and hazardous air pollutants against applicable Washington State regulations, and the calculated impacts of emissions of radionuclides against applicable Federal and Washington State standards.

The various TWRS alternatives would have the potential to emit air pollutants from several locations and from a variety of sources. These sources were depicted in the air dispersion models as either area or point sources. Where the exact source locations were unknown or were expected to move from time to time, area sources were used to stimulate emissions. Air emissions from the vitrification processes would occur from a vertical stack and were modeled as point sources. Emissions from WESF also were modeled as a point source.

5.3.1 Emission Sources

For each alternative described in Section 3.0, emission sources were identified and analyzed. The emissions sources included tank farms, waste retrieval annexes, concrete batch plants, waste processing facilities construction, and waste processing. Figure 5.3.1 shows the source locations used in the modeling scenarios. Figure 5.3.1 contains a legend that identifies the acronyms used to designate the various point and area sources described in the following text.

Tank Farms

Area sources identified as TF1E through TF11E and TF1W through TF6W were assigned to the tanks.

Waste Retrieval Annex Areas

Waste retrieval annexes identified as TA1E, TA2E, TA1W, TA2W, and TA3W were depicted as area sources in the dispersion models.

Figure 5.3.1 Emission Source Locations

Concrete Batch Plant

A concrete batch plant between the 200 East and 200 West Areas supporting construction activities was modeled as an area source.

In Situ Vitrification Process Stacks

During in situ vitrification operations, off-gases would be treated and released through a stack adjacent to each tank farm. A point source (IS6W) was used to model the highest impact emissions from the process stack.

Borrow Site Excavation

Particulate emissions would result from using heavy equipment to excavate and transport borrow materials from Pit 30 at the same location as the concrete batch plant.

Excavating borrow materials from the Vernita Quarry and McGee Ranch would result in similar particulate matter emissions. Specific emissions estimates and modeling were not performed because particulate matter emissions would be controlled by using wetting procedures and surfactants, resulting in compliance with Federal and State air quality standards.

Processing Facilities Construction

Emissions from constructing the processing facilities for the ex situ alternatives were assigned to an area source (vitrification facility).

Processing Facilities Operations

The majority of the emissions during the processing operation for the ex situ alternatives and the Ex Situ/In Situ Combination 1 and 2 alternatives would occur through processing facility stacks. All stacks were modeled as point sources and are located in the vitrification facility area.

Evaporator

Evaporator emissions during routine operations and waste processing operations were modeled as a point source.

W-314 Project

The anticipated emissions from the W-314 Project were not analyzed because the data available for the project indicated that construction activities would be spread out over various areas and of relatively low intensity compared to construction activities associated with the TWRS alternatives.

Drywell Disposal Facility

The emissions from constructing a drywell disposal facility (DWSF) were represented as an area source.

Capsule Packaging Facility

The emissions from the Overpack and Ship alternative were represented by an area source.

Waste Encapsulation and Storage Facility

Emissions from WESF would occur through a stack and were modeled as a point source.

5.3.2 Emissions Scenarios

The various alternatives would involve emissions from one or more of the emission sources described in Section 5.3.1. Implementing the alternatives would involve an initial period of facility construction, followed by an operating period during which the treatment, transfer, or repackaging processes would occur. Consequently, alternatives would have different phases in which the emissions and calculated impacts were distinctly different. For each alternative, the emissions and calculated impacts from each phase were reported separately. The following sections describe the potential sources of air emissions for each remediation alternative.

5.3.2.1 Tank Waste Alternatives

No Action Alternative (Tank Waste)

The No Action alternative would involve routine radiological and nonradiological emissions from continued operations of the storage tanks and routine operations of the evaporator. Because no remediation or closure activities would occur under this alternative, no change in emissions would occur.

Long-Term Management Alternative

The Long-Term Management alternative would involve routine emissions from the tanks plus emissions from transferring the waste to newly constructed DSTs 50 and 100 years in the future. Because no remediation activities and no closure activities would occur under this alternative, no short-term changes in emissions would occur. Fifty years from the present, new tanks would be constructed in the same location as the area reserved for the process facility for the ex situ alternatives. Construction emissions for new DSTs were modeled by assigning them to the source PROC. Increased emissions from tanks undergoing retrieval were analyzed by assigning the highest emission rate for each pollutant to the TF6W Tank Farm.

In Situ Fill and Cap Alternative

Implementing the In Situ Fill and Cap alternative would involve construction and gravel-filling operations at the tank farm locations and removing gravel from Pit 30. Construction activities were assumed to simultaneously occur with filling operations and routine emissions from the continued operations of the tank farms. The following summarizes the pollutant emitting activities and sources for this alternative.

- Particulate matter emissions were assigned for Pit 30 (BTCH) (an assumed potential borrow site) .
- Construction equipment emissions were assigned to the most conservative location (TF6W).
- Gravel handling operations were assigned to TF5W.
- Increased tank emissions during filling operations were assigned to TF6W for retrieval operations.

No substantial additional emissions would occur under this alternative as a result of closure activities. As explained previously, heavy equipment operating at the borrow sites would have particulate emissions; however, wetting procedures and surfactants used at the borrow sites would result in compliance with Federal and State air quality standards.

In Situ Vitrification Alternative

Implementing this alternative would involve constructing a tank farm confinement facility and an off-gas treatment facility at each tank farm. Constructing one confinement facility would occur while vitrification processes were occurring at another tank farm. For potential air quality impacts, the highest emission location for construction would be TF6W, and impacts were calculated using this location.

Operating this alternative would release a treated gas stream from a vertical stack. The location for this operation producing the highest impacts was shown to be adjacent to TF6W. Although construction and operation activities would not occur at the same time and at the same location, operational emissions were assigned to this location (IS6W) to provide a conservative analysis.

No substantial additional emissions would occur under the In Situ Vitrification alternative as a result of closure activities. As explained previously, emission control measures would result in compliance with Federal and State air quality standards.

Ex Situ Intermediate Separations Alternative

The construction phase would involve emissions from constructing five waste transfer annexes and two waste processing facilities, and constructing and operating a concrete batch plant to support these operations. Additionally, emissions associated with constructing tank waste retrieval equipment at the tank farms would occur simultaneously.

An analysis was conducted that identified the TF5W and TF6W areas as having the highest combined impacts when construction activities occurred simultaneously. This analysis identified the TF5W and TF6W areas as having the highest combined impacts. Accordingly, construction impacts were assessed by assuming simultaneous construction operations at the process facilities, concrete batch plant, five transfer annexes (TA1W, TA2W, TA3W, TA1E, TA2E); and two tank farm locations (TF5W and TF6W).

Operating the Ex Situ Intermediate Separations alternative would include separating the waste into HLW and LAW streams and processing the streams at separate facilities. Additionally, retrieval equipment would operate at various tank farm locations during the course of processing. Therefore, the impacts of the operation phase of the alternative were analyzed by evaluating the simultaneous operations of both processing facilities (ST-L and ST-H) and the two tank farm locations producing the highest impacts (TF5W and TF6W).

For all of the ex situ alternatives (Intermediate Separations, No Separations, and Extensive Separations), no substantial additional emissions would occur as a result of future closure activities. As explained previously, emission control measures used with heavy equipment and at the borrow sites would result in compliance with Federal and State air quality standards.

Ex Situ No Separations Alternative

The emissions for the Ex Situ No Separations alternative would differ from the Ex Situ Intermediate Separations alternative because the tank waste would not be separated into LAW and HLW components, and only one processing plant with one process stack would be operated. Two options, vitrification and calcination, were analyzed for this alternative. With the exception of the emission rates of nitrogen oxides and carbon-14, the sources and emission rates associated with the calcination option would be nearly identical to those of the vitrification alternative.

The construction phase would involve emissions from constructing five waste transfer annexes and process facilities, and constructing and operating a concrete batch plant. Emissions from erecting the retrieval equipment at the tank farms would occur simultaneously. These emissions were assessed in the same manner as those for the construction phase of the Ex Situ Intermediate Separations alternative.

Operating emissions would occur at the main process stack at the vitrification facility. Installing and operating retrieval equipment would occur at two tank farm locations at a time during processing. Therefore, the impacts of the operation phase of this alternative were analyzed by evaluating the simultaneous operations of the process facility and the two tank farm locations producing the highest combined impacts (TF5W and TF6W).

No substantial additional emissions would occur as a result of future closure activities under this ex situ alternative.

Ex Situ Extensive Separations Alternative

The construction phase would involve emissions from constructing five waste transfer annexes, the process facilities, and from constructing and operating a concrete batch plant. Emissions from erecting the retrieval equipment at the tank farms would occur simultaneously. These emissions were assessed in the same manner as those for the construction phase of the Ex Situ Intermediate Separations alternative.

Operating this alternative would include separating the tank waste into HLW and LAW streams and processing the streams at separate facilities. Off-gas emissions from these two processes would be combined in a common stack. Retrieval equipment would be operated at various tank farm locations during processing. Therefore, the impacts of the operation phase of this alternative were analyzed by evaluating the simultaneous operations of the process facilities and the two tank farm locations producing the highest combined impacts (TF5W and TF6W).

No substantial additional emissions would occur as a result of future closure activities under this ex situ alternative.

Ex Situ/In Situ Combination 1 and 2 Alternatives

The in situ portion of these alternatives would involve the same source locations and emissions as described for the In Situ Fill and Cap alternative. These emissions would occur simultaneously with those from the operation phase of the ex situ portion of these alternatives.

The construction phases would involve emissions from constructing waste transfer annexes and process facilities, and from constructing and operating a concrete batch plant. Emissions from erecting the retrieval equipment at the tank farms would occur simultaneously. These emissions were analyzed in the same manner as described for the Ex Situ Intermediate Separations alternative.

Operating the ex situ vitrification portion of these alternatives would include separating the HLW and LAW streams and processing the waste at separate facilities. Retrieval equipment would be expected to operate at various tank farm locations during processing. Therefore, the impacts of the operation phase of these alternatives were analyzed by evaluating the simultaneous operations of both process facilities (ST-L and ST-H) and the two tank farm locations producing the highest impacts (TF5W and TF6W).

These alternatives are a combination of two remediation methods, neither of which would produce substantial additional emissions as a result of future closure activities.

Phased Implementation Alternative

Phase 1

The first phase of the Phased Implementation alternative would involve a period during which two vitrification facilities would be built. Construction on both facilities would occur simultaneously, so construction emissions were assigned to a single source (FCPI).

After the first phase of construction was completed, the two facilities would begin operating. Emissions from the vitrification processes would be released through two stacks. The impacts from operations were analyzed by using peak hourly emission rates from all processes simultaneously.

Phase 2

In the second phase of this alternative, a facility would be constructed to treat the remainder of the tank waste. Emissions would come from constructing the five waste transfer annexes, process facilities, and a concrete batch plant. Emissions from erecting retrieval equipment at the tank farms would occur simultaneously. These emissions were assessed in the same manner as described for the Ex Situ Intermediate Separations alternative.

Impacts from operating the second phase of this alternative were assessed in the same manner as for the Ex Situ Intermediate Separations alternative. This involved the simultaneous operation of two facilities and the two tank farm locations producing the highest impacts.

Total Alternative

For the Phased Implementation alternatives, the total impacts would be the result of operating the first phase simultaneously with the second phase. The emissions would occur from operating the combined LAW and HLW plant and the LAW plant from the first phase; plus the emissions from operating the second phase process facilities, the concrete batch plant, the five transfer annexes, and the two tank farm locations producing the highest impacts.

No substantial additional emissions would occur as a result of future closure activities under this alternative.

5.3.2.2 Capsule Alternatives

No Action Alternative (Capsules)

Routine radiological emissions from maintaining the capsules at WESF were analyzed for this alternative and included in the analysis of all other alternatives. These emissions were modeled as a point source.

Onsite Disposal Alternative

Constructing the drywell disposal facility would cause pollutant emissions from construction equipment; therefore, these emissions were modeled as an area source.

Overpack and Ship Alternative

Construction and operation emissions from a repacking facility were modeled as an area source (CPF).

Vitrify with Tank Waste Alternative

No appreciable emissions above those calculated for the Ex Situ Intermediate Separations alternative would occur, so no additional air quality impacts were included in this alternative.

5.3.3 Air Dispersion Models

Version two of the U.S. Environmental Protection Agency (EPA) Industrial Source Complex Model (ISC2) (EPA 1992a) was used for the air dispersion modeling. ISC2 is capable of simulating emissions from diverse source types. ISC2 is a guideline air quality model (accepted by EPA for regulatory applications) and routinely is recommended for performing screening and refined analyses for remedial actions at Resource Conservation and Recovery Act (RCRA) and Superfund sites. The model requires input of source data, meteorological data, and receptor data.

The short-term version of ISC2 (ISCST2) was used to calculate concentrations with averaging periods ranging from 1 to 24 hours. Annual average concentrations and dose values were calculated with the long-term version of the model (ISCLT2).

Source Data

The primary sources of data used for the emission rates were the Engineering Data Packages for the various TWRS EIS alternatives, which were prepared by the Site Management and Operations contractor (WHC 1995a, b, c, d, e, f, g, h, i, n) and the TWRS EIS contractor (Jacobs 1996). The emission rates for each alternative are provided in tables presented in Volume Five, Appendix G.

Long-Term Meteorological Data

The meteorological data used for the ISCLT2 model consists of wind speed, wind direction, and stability class for individual years 1989 to 1993. The data, provided by the Pacific Northwest National Laboratory, were based on measurements collected at the Hanford Meteorological Station (PNL 1994g).

Short-Term Meteorological Data

For short-term averaging periods, the ISCST2 model was run in a screening mode because it adequately calculates the overall impacts and the differences in air quality among the alternatives. A range of meteorological conditions was applied to the model in a manner consistent with EPA guidance (EPA 1992a).

Receptor Data

A receptor is a location where the model calculates specific air quality impacts. The locations of receptors used in the ISC2 model corresponded to areas where workers and the general public could be exposed.

Compliance with Federal and State ambient air quality standards and levels was analyzed using a total of 614 receptors located along the Columbia River, State Route 240, and the Hanford Site boundaries. Receptors were placed at 500-m (1,650-ft) intervals along sections of State Route 240. Other offsite receptors were placed 2 km (1.2 mi) apart.

Compliance with the Federal standard for radionuclide releases (40 CFR 60) was determined by analyzing the effective dose equivalent at the nearest residence (DOE 1994d). No residences are located within 24 km (15 mi) of the 200 West Area or within 16 km (10 mi) of the 200 East Area. Consequently, a circular set of 72 receptors, centered on the 200 West Area and with a 24-km (15-mi) radius, was established. A rectangular grid of 834 receptors that encompasses the Hanford Site was used to generate isopleths of radionuclide impacts.

5.3.4 Results of Air Emission Modeling

The model output consists of calculated ground-level average concentrations. The ISCST2 model was run to determine the maximum 1-hour average concentrations that could result from a range of meteorological conditions. The 1-hour averages were multiplied by correction factors to calculate longer (3-, 8-, and 24-hour) averaging times. Annual average concentrations were produced with the ISCLT2 model.

The results of the modeling were compared with Washington State air quality standards or emission levels. Washington State standards are listed in the Washington Administrative Code (WAC) and include the following:

- Acceptable Source Impact Levels for toxic air pollutants (WAC 173-460);
- Ambient Air Quality Standards for particulate matter (WAC 173-470);
- Ambient Air Quality Standards for sulfur oxides (WAC 173-474);
- Ambient Air Quality Standards for carbon monoxide, ozone, and nitrogen dioxide (WAC 173-475);
- Ambient Air Quality Standards for radionuclides (WAC 173-480); and
- Ambient Air Quality Standards for fluorides (WAC 173-481).

The results also were compared with national primary and secondary Ambient Air Quality Standards listed in 40 CFR 50. The Washington Ambient Air Quality Standards are equal to or more stringent than the National Ambient Air Quality Standards, and thus compliance with the Washington Ambient Air Quality Standards results in compliance with the National Ambient Air Quality Standards.

The modeling results for select pollutants including sulfur oxides, carbon monoxide, nitrogen dioxide, particulates, and total radionuclides are presented in Table 5.3.1. Complete modeling results and comparison to the National Ambient Air Quality Standards and the Washington Ambient Air Quality Standards are presented in Volume Five, Appendix G. The modeling results for all alternatives show no exceedances of Federal or State air quality standards for criteria pollutants, hazardous air pollutants, or radionuclides. The following pollutants would result in the highest levels of emission compared to Federal or State standards.

Carbon Monoxide -- Impacts, as a percentage of the Federal and State 8-hour standard, would occur during the construction phases of the Ex Situ Extensive Separations, Ex Situ Intermediate Separations, and Ex Situ No Separations alternatives (25 percent, 21 percent, and 17 percent, respectively).

Sulfur Oxides -- Impacts, as a percentage of the State 1-hour standard, would occur during the In Situ Vitrification alternative (10 percent of the standard).

Radionuclides -- Impacts, as a percentage of the State annual standard, would occur during the In Situ Vitrification alternative (75 percent of standard, with primary contributors being carbon-14 and iodine-129).

Impacts, as a percentage of the Federal annual standard, would occur during the In Situ Vitrification alternative (24 percent of standard, with primary contributors being carbon-14 and iodine-129).

Table 5.3.1 Major Pollutant Impacts

5.4 BIOLOGICAL AND ECOLOGICAL RESOURCES

This section describes the impacts of the TWRS EIS alternatives on biological and ecological resources. The impact assessment focused on the biological resources of the specific land areas where activities are proposed under the various EIS alternatives. All of the alternatives would have varying impacts on vegetation and wildlife habitat, especially shrub-steppe habitat. In all cases, the impacts would be less than 1 percent of the total remaining shrub-steppe habitat on the Central Plateau and a fraction of 1 percent of the Hanford Site's remaining shrub-steppe habitat. When considering only the area that would be designated for future waste management uses, the TWRS alternatives would impact up to 6 percent of the undisturbed shrub-steppe within the designated waste management area. For remediation activities impacts would range from 10 ha (25 ac) for the Long-Term Management alternative to 81 ha (200 ac) for the Phased Implementation alternative. Total alternative impacts (remediation and post-remediation closure actions) would add from 40 ha (100 ac) to 80 ha (200 ac) to the impacts from remediation. Most remediation impacts would occur in the 200 Areas, while post-remediation impacts would more heavily impact potential borrow sites, two of which are located outside the Central Plateau of the Hanford Site. All of the alternatives, expect No Action, Long-Term Management, and In Situ Fill and Cap, would result in noise and transportation impacts that would impact wildlife. None of the alternatives would adversely impact Hanford Site aquatic, wetland, or riparian habitats and none would impact Federal or State threatened or endangered species. Potential impacts to other species of concern would be limited to a relatively small portion of the overall habitat.

Following the end of the remedial phase of each alternative, exposure to waste under the No Action and Long-Term Management alternatives likely would be fatal for wildlife. Direct exposure to waste would pose a fatal risk under the In Situ Fill and Cap, In Situ Vitrification, and Ex Situ/In Situ Combination 1 and 2 alternatives; however, the likelihood of exposure would be minimal. Direct exposure under the remaining ex situ alternatives, though considered unlikely, would pose a risk to wildlife. No other exposure scenario (e.g., contaminated groundwater at seeps along the Columbia River) under any of the alternatives would pose a substantial risk to wildlife.

For this analysis, the key issues are 1) whether the land areas proposed for use currently are undisturbed or whether they have been disturbed by past activities; 2) the extent of potential impacts on sensitive shrub-steppe habitat, which is considered a priority habitat by Washington State; and 3) potential impacts on plant and animal species of concern (those listed or candidates for listing by the Federal government or Washington State as threatened, endangered, and sensitive). The section also describes impacts to three potential borrow sites that would be associated with the tank closure scenario included for the comparative analysis of the alternatives.

Activities for all tank waste alternatives except No Action would occur at locations that contain both undisturbed and disturbed land. For example, the tank farms and their immediate surrounding areas currently are heavily disturbed and thus have minimal native vegetative or wildlife habitat. The vitrification facility sites in the 200 East Area associated with the various ex situ alternatives and the Phased Implementation alternative contain currently disturbed land that is of minimal habitat value and undisturbed shrub-steppe that is considered valuable as vegetative and wildlife habitat. The amount and location of the land areas required by each alternative are described in Section 3.0 and Volume Two, Appendix B. The analysis of potential impacts on species of concern focused on plant and animal species found in the Hanford Site's shrub-steppe habitat.

Where TWRS alternatives' activities are proposed in areas that are partly disturbed and partly undisturbed habitat, the alternatives' vegetation and wildlife habitat impacts were calculated proportional to the current percentage of disturbed versus undisturbed land at the particular site. For example, if 30 ha (70 ac) were required at a site that currently is 50 percent disturbed, the habitat impact was calculated to be 15 ha (30 ac) (30 ha [70 ac] times 50 percent). No attempt was made to lay out or configure facilities to either maximize or minimize habitat impacts. Final design, configuration, and layout of facilities for alternatives selected for implementation would incorporate habitat impact avoidance and minimization as part of the development process. However, none of the alternatives are far enough along in the design process for this to have occurred.

5.4.1 Impacts to Vegetation

Virtually all proposed TWRS activities under all EIS alternatives would occur on the Hanford Site's Central Plateau within or between the 200 East and 200 West Areas. All TWRS sites are within shrub-steppe habitat. There are approximately 8,500 ha (21,000 ac) of shrub-steppe on the Central Plateau. This area is approximately 15 percent of the total remaining shrub-steppe habitat of the Hanford Site. All alternatives except No Action would have varying degrees of impact on vegetative habitat (Figure 5.4.1 and Table 5.4.1). In all cases, the affected shrub-steppe area would be less than 1 percent of the total remaining shrub-steppe on the Central Plateau and a small fraction of 1 percent of the Hanford Sites total shrub-steppe habitat.

Table 5.4.1 summarizes the potential shrub-steppe habitat impacts of the TWRS alternatives and identifies the plant species of concern that potentially would be affected. Table 5.4.1 provides a comparison of the potential impacts of each alternative based on where the impacts would occur (200 Areas or at potential borrow sites) and the impacts of the remedial phase of the project compared to impacts of the total alternative (remediation and the post-remediation closure scenario activities). The table also summarizes the total impacts of the alternatives and lists the species (vegetation and wildlife that potentially could be impacted by the alternatives).

Under all alternatives except No Action, approximately 13,000 m (33,000 ft) of replacement underground pipelines would be constructed at various locations in the 200 Areas. All pipelines would be placed in currently disturbed areas adjacent to the existing pipelines. Therefore, there would be no impact on shrub-steppe habitat.

5.4.1.1 Tank Waste Alternatives

No Action Alternative (Tank Waste)

The No Action alternative would involve no additional construction and thus no additional land disturbance. Consequently, there would be no impacts to shrub-steppe habitat.

Long-Term Management Alternative

As shown in Table 5.4.1, the Long-Term Management alternative would impact approximately 10 ha (25 ac) of undisturbed area in the 200 East Area. The undisturbed area that would be affected is shrub-steppe habitat characterized by big sagebrush or gray rabbitbrush, both native plant species typical of the shrub-steppe community. This area would be used for constructing replacement DSTs for existing storage tanks that have reached the end of their design lives, as well as for power lines to provide electrical power to the new tank farms and for a new evaporator. Plant species potentially impacted include the crouching milkvetch, stalked-pod milkvetch, and scilla onion, all Washington State Class 3 monitor species, and Pipers daisy, a species that is listed as sensitive by Washington State.

Figure 5.4.1 Habitat Impacts of Tank Waste and Capsule Alternatives

Table 5.4.1 Shrub-Steppe Habitat and Associated Potential Impacts on Plant and Wildlife Species of Concern of TWRS Alternatives

This alternative also would impact approximately 14 ha (35 ac) of shrub-steppe habitat at the potential Pit 30 borrow site. No Federally listed plant species would be affected, but the stalked-pod milkvetch, a Washington State Class 3 monitor species, and Pipers daisy, a State sensitive species, have been observed there and would be affected (Duranceau 1995).

In Situ Fill and Cap Alternative

The In Situ Fill and Cap alternative would affect no undisturbed vegetative habitat in the 200 Areas. However, because remediation would involve filling all 177 tanks with gravel from the potential Pit 30 borrow site , 23 ha (57 ac) of vegetation would be disturbed at Pit 30 (located on the Central Plateau between the 200 East Area and the 200 West

Area).

During closure activities, approximately 17 ha (42 ac) of shrub-steppe would be disturbed at the potential Vernita Quarry borrow site. The area that would be affected is undisturbed shrub-steppe habitat with varying degrees of shrub coverage, primarily big sagebrush, rigid sagebrush, and some spiny hopsage, as well as grasses such as Sandbergs bluegrass and bluebunch wheatgrass. No Federally-listed threatened or endangered species would be affected. Two plant species classified as Class 3 monitor species by Washington State were observed in 1993 biological surveys and would be affected. These are the stalked-pod milkvetch and crouching milkvetch (Duranceau 1995).

This alternative also would disturb approximately 12 ha (30 ac) of shrub-steppe at the potential McGee Ranch borrow site and 13 ha (32 ac) at the potential Pit 30 borrow site during closure activities. No Federally-listed threatened or endangered species would be affected at McGee Ranch, although the crouching milkvetch and the scilla onion, two Washington State Class 3 monitor species, were identified there in 1993 biological surveys and would be impacted (Landeen et al. 1994). No Federally-listed threatened or endangered plant species would be impacted at Pit 30, although the stalked-pod milkvetch, a Washington State Class 3 monitor species, and Pipers daisy, a State sensitive species, have been observed there (Duranceau 1995).

In Situ Vitrification Alternative

The In Situ Vitrification alternative would disturb 23 ha (57 ac) of undisturbed shrub-steppe habitat by constructing 115-kilovolt (kV) transmission lines to the tank farms in the 200 Areas where the in situ vitrification activities would occur (Figure 5.4.1). The acreage at and around the tank farms where the vitrification facilities would be developed currently is disturbed. An additional 18 ha (44 ac) would be disturbed at the potential Pit 30 borrow site during remediation activities.

During closure activities, the In Situ Vitrification alternative also would disturb approximately 42 ha (100 ac) of shrub-steppe at the three potential borrow sites (17 ha [42 ac] at Vernita Quarry, 12 ha [30 ac] at McGee Ranch, and 13 ha [32 ac] at Pit 30). Impacts would be similar to the In Situ Fill and Cap alternative.

Ex Situ Intermediate Separations Alternative

During tank waste remediation, this alternative would impact about 59 ha (150 ac) of shrub-steppe habitat in the 200 East Area and 33 ha (82 ac) at the potential Pit 30 borrow site. During closure activities, this alternative would impact an additional 77 ha (220 ac) of shrub-steppe at the three potential borrow sites (23 ha [62 ac] at Vernita Quarry, 13 ha [47 ac] at McGee Ranch, and 41 ha [110 ac] at Pit 30). The same impacts described for the Long-Term Management and In Situ Fill and Cap alternatives would be impacted under this alternative.

Ex Situ No Separations Alternative

This alternative would have similar vegetation impacts to the Ex Situ Intermediate Separations alternative. However, during remediation, the Ex Situ No Separations alternative would impact more shrub-steppe in the 200 Area (approximately 89 ha [220 ac]) than the Ex Situ Intermediate Separations alternative (approximately 33 ha [82 ac]) because of the need for interim storage of large quantities of vitrified waste before offsite shipment to the potential geologic repository. During closure, less borrow material, and therefore less habitat disturbance, would be required at the potential borrow sites for this alternative than for the Ex Situ Intermediate Separations alternative (Table 5.4.1).

Ex Situ Extensive Separations Alternative

During remediation, similar activities would take place at the same proposed waste processing site and for closure at the same potential borrow sites, as discussed for the other ex situ alternatives. The Ex Situ Extensive Separations alternative would disturb the same amount of shrub-steppe habitat as the Ex Situ Intermediate Separations alternative (Table 5.4.1).

Ex Situ/In Situ Combination 1 Alternative

During remediation, this alternative would impact about 56 ha (140 ac) of shrub-steppe habitat in the 200 East Area and 32 ha (79 ac) at Pit 30. For closure activities, a total of 58 ha (140 ac) of additional shrub-steppe habitat would be impacted at the three potential borrow sites ; (21 ha [52 ac] at Vernita Quarry, 12 ha [30 ac] at McGee Ranch, and 25 ha [62 ac] at Pit 30).

Ex Situ/In Situ Combination 2 Alternative

This alternative would impact 40 ha (100 ac) of shrub-steppe habitat in the 200 Areas during remediation as well as 30 ha (75 ac) at Pit 30. For closure activities, an additional 48 ha (120 ac) of shrub-steppe would be affected at the three potential borrow sites; 19 ha (47 ac) at Vernita Quarry, 11 ha (27 ac) at McGee Ranch, and 18 ha (44 ac) at Pit 30.

Phased Implementation Alternative

Phase 1

Phase 1 of the Phased Implementation alternative would disturb about 21 ha (52 ac) of shrub-steppe vegetation in the easternmost section of the 200 East Area. Approximately 1 ha (2 ac) of shrub-steppe would also be disturbed at the potential Pit 30 borrow site to support remediation activities. The same kind of plant species identified for the other alternatives would be impacted by this alternative.

Total Alternative

The Phased Implementation alternative, when fully implemented, would result in a total disturbance that would include the impacts identified for Phase 1, as well as impacts associated with implementing Phase 2 construction, retrieval, operations, and post remediation for the entire alternative. The total impacts would include 99 ha (240 ac) of shrub-steppe habitat in the 200 Areas and 37 ha (49 ac) in the potential Pit 30 borrow site associated with remediation activities. An additional 81 ha (200 ac) of shrub-steppe habitat would be disturbed at the three potential borrow sites resulting from closure activities. The same kind of plant species impacted under the other alternatives would be impacted by this alternative.

5.4.1.2 Capsule Alternatives

The No Action alternative essentially would have no vegetation impacts because no new land disturbance would occur. All other cesium and strontium capsule alternatives would have minor impacts on vegetation. The Onsite Disposal alternative would involve constructing a disposal facility on the Central Plateau just west of the 200 East Area, which would impact approximately 1.5 ha (3.7 ac) of shrub-steppe. The Overpack and Ship and the Vitrify with Tank Waste alternatives would involve additional minor facility development within areas that would be disturbed by the vitrification complex proposed in the 200 East Area for the Ex Situ Intermediate Separations alternative. Thus, no additional vegetation disturbance would be associated with these capsule alternatives.

5.4.2 Wildlife

Under all tank waste alternatives except No Action, some loss of individual members of wildlife species would occur. However, when considering the total Hanford Site population of the affected species, the number of individual members lost is not expected to be large enough to have substantial impact on any species as a whole. As described previously, activities in currently undisturbed areas would affect wildlife habitat, while activities in currently disturbed areas would not affect wildlife habitat. The impact analysis focused on impacts in undisturbed wildlife habitat areas.

The EIS alternatives would impact wildlife by directly disturbing habitat areas at proposed facility sites. Rodent and rabbit populations of the disturbed areas would be destroyed or displaced. This would impact raptor species (birds of prey such as harriers, kestrels, hawks, and owls) and mammals (such as coyotes, badgers, mule deer) of the Central Plateau and vicinity. Predator food supplies would decrease, which would in turn increase competition and decrease predator species productivity. Eventually, this would result in a local reduction in the predator population of the Central Plateau as individual species members died or were displaced. Common bird species (e.g., larks and finches) would be displaced and ground nesting birds such as the killdeer and mourning dove could be affected by the destruction of nests. Impacts would affect only individual members of the species; they would not be of a scale to affect the Sitewide populations of either the predator species or nonpredator species.

In addition to direct impacts from habitat loss, the increased levels of human activity and associated noise for all tank waste alternatives (except No Action) would displace wildlife species, particularly raptors and predatory mammals. The noise impacts would occur primarily from using heavy equipment during facilities construction and at borrow sites, although the general disturbance caused by increased human presence would continue throughout facility operations. Predators would likely move out of the immediate area, which would further contribute to competition for food and living space in adjacent areas. Construction noise levels would approach background levels at distances greater than 600 m (2,000 ft), and the zone of indirect impact would vary by species. However, the overall zone of impact for some species could extend to a radius of up to 800 m (2,700 ft) from the construction site (Section 5.9).

Increased vehicular traffic associated with the various alternatives also could lead to occasional collisions between vehicles and wildlife. This could lead to a slight increase in mortality of various wildlife species, including large mammals such as mule deer. The levels of increased mortality would be directly proportional to the employment levels and associated traffic volumes for each alternative (Section 5.10).

The nesting period is a critical time period for most bird species. Disturbances, including noise, could result in nest abandonment and declines in productivity. Nesting disturbances of raptors such as the ferruginous hawk, swainsons hawk, red-tailed hawk, and prairie falcon could occur at distances greater than 800 m (2,700 ft). For example, the Pacific Northwest National Laboratory recommends confining human activity to the nonnesting season or avoiding alteration or disturbance within 1.0 km (0.6 mi) of red-tailed hawk nests, 1.6 km (1.0 mi) of ferruginous hawk nests, and 1.5 km (0.9 mi) of swainsons hawk nests (PNL 1994e). The only likely potential raptor nesting site in the 200 Areas would be on power transmission facilities. Construction of new power lines for the alternatives could provide additional raptor nesting sites. Passerine (songbird) species such as the sage sparrow also could be adversely affected by disturbance during the breeding season. Avoiding activities such as Site clearing during breeding or avoiding disturbance near songbird nesting areas would reduce these impacts.

Under all tank waste alternatives except No Action, there would be approximately 13,000 m (33,000 ft) of replacement underground pipelines placed in currently disturbed portions of the 200 Areas. As these pipelines would be placed in currently disturbed areas adjacent to the existing pipelines, no wildlife impacts would be expected.

Impacts associated with the closure phase of the alternatives would 1) include habitat loss at the potential McGee Ranch borrow site, which would be used under all tank waste alternatives except No Action and Long-Term Management; and 2) adversely affect an important wildlife corridor between the Hanford Site and the Yakima Training Center, which are the two largest remaining shrub-steppe habitat areas in Washington State. Disturbing this corridor would contribute to fragmenting the region's shrub-steppe habitat. The corridor potentially is of importance to medium-to-large mammals, such as coyote, deer, and elk, and to other species using relatively undisturbed shrub-steppe. The corridor is generally important from the standpoint of species proliferation and maintaining genetic diversity. The corridor also has the potential for serving as a conduit for the reintroduction to the Hanford Site of sage grouse, a State and Federal candidate species. Sage grouse were displaced from the Site by a major wildfire in 1984. The nearest population of sage grouse is at the Yakima Training Center, and the McGee Ranch provides the most direct, relatively undisturbed corridor between the Site and the Yakima Training Center.

Table 5.4.1 summarizes the shrub-steppe habitat impacts of the TWRS alternatives and identifies wildlife species of concern that potentially may be affected.

5.4.2.1 Tank Waste Alternatives

No Action Alternative (Tank Waste)

The No Action alternative would involve no additional land disturbance and thus would have no impacts on wildlife resources.

Long-Term Management Alternative

The Long-Term Management alternative would disturb approximately 10 ha (25 ac) of shrub-steppe wildlife habitat in the 200 East Area from retanking the DSTs. An additional 14 ha (35 ac) of shrub-steppe habitat would be affected at the potential Pit 30 borrow site. Potentially affected species would include the horned lark, western meadowlark, common raven, red-tailed hawk, ferruginous hawk, violet green swallow, great basin pocket mouse, and northern pocket gopher. Impacts, which would be limited to individual members of species, would be small when considering the Hanford Site as a whole.

Two species of concern are found at the potential Pit 30 borrow site in addition to the species identified in the 200 East Area. These are the loggerhead shrike (Federal and State candidate species) and the sage sparrow (State candidate species). Both species nest and raise their young in shrub-steppe, and the habitat disturbance would adversely impact both the shrike and sparrow.

In Situ Fill and Cap Alternative

During remediation, the In Situ Fill and Cap alternative would affect only currently disturbed lands in the 200 Areas (Table 5.4.1). These areas at and near the tank farms are of little wildlife habitat value. During remediation, there would be 23 ha (57 ac) impacted at the potential Pit 30 borrow site.

During closure, activities at the potential Vernita Quarry borrow site would affect wildlife by disturbing about 17 ha (42 ac) of shrub-steppe habitat. Potentially affected species and impacts would be those identified for the Long-Term Management alternative, as well as mule deer, coyote, and badger, which all are found in the vicinity. A pair of red-tailed hawks was observed nesting on the basalt cliff face at Vernita Quarry during a 1994 biological survey. Such nesting activity would be disrupted if the hawks were present during the post-remediation Hanford Barrier construction phase of the project (Duranceau 1995).

Similar bird and mammal species would be affected at the potential McGee Ranch borrow site where 12 ha (30 ac) of shrub-steppe wildlife habitat would be disturbed. Individual species members would be lost or replaced, but only small impacts would occur on the species as a whole. However, the McGee Ranch area is an important corridor between the Hanford Site and the Yakima Training Center. Two species of concern found at McGee Ranch would be affected: the loggerhead shrike (Federal and State candidate species) and the sage sparrow (State candidate species). Moreover, the reintroduction to the Hanford Site of the sage grouse, a Federal and State candidate species, could be adversely affected.

During closure activities, wildlife impacts would be similar at the potential Pit 30 borrow site to those at the potential McGee Ranch and Vernita Quarry borrow sites. This is because essentially the same bird and mammal species are found in the shrub-steppe at Pit 30, although Pit 30 does not have the same importance as a wildlife corridor as McGee Ranch. However, the same adverse impacts on the sage sparrow and loggerhead shrike (Federal and State candidate species) would occur at Pit 30 as at McGee Ranch. Approximately 13 ha (32 ac) of additional shrub-steppe wildlife habitat would be impacted at Pit 30 during closure activities.

In Situ Vitrification Alternative

During remediation activities, this alternative would disturb approximately 23 ha (57 ac) of shrub-steppe habitat by constructing power lines to the tank farms in the 200 Areas and 21 ha (52 ac) of shrub-steppe habitat at the potential Pit 30 borrow site (Table 5.4.1). During closure, an additional 42 ha (100 ac) of shrub-steppe habitat would be disturbed at all three potential borrow sites (Table 5.4.1). Wildlife impacts at the potential borrow sites would be the same as described for the In Situ Fill and Cap alternative.

Ex Situ Intermediate Separations Alternative

During remediation, this alternative would disturb 57 ha (150 ac) of shrub-steppe wildlife habitat in the 200 East Area and 33 ha (59 ac) of shrub-steppe habitat in the potential Pit 30 borrow site. For closure activities, an additional 77 ha

(220 ac) would be disturbed at the three potential borrow sites. Impacts would be the same as described for the In Situ Fill and Cap alternative.

Ex Situ No Separations Alternative

This alternative would involve wildlife impacts similar to the Ex Situ Intermediate Separations alternative. There would be more shrub-steppe wildlife habitat (96 ha [240 ac]) disturbed than for the Ex Situ Intermediate Separations alternative in the 200 Areas and at Pit 30 during remediation, with 89 ha (220 ac) of the disturbance occurring at Pit 30 (Table 5.4.1). There would be less disturbance at potential borrow sites during closure for this alternative than for the Ex Situ Intermediate Separations alternative because there would be no LAW vaults (64 ha [160 ac]).

Ex Situ Extensive Separations Alternative

This alternative would have impacts similar to the Ex Situ Intermediate Separations alternative because the same activities would occur at the same sites. The wildlife habitat acreage impacted would be less than for the Ex Situ Intermediate Separations alternative (Table 5.4.1).

Ex Situ/In Situ Combination 1 Alternative

During remediation activities, this alternative would disturb approximately 56 ha (140 ac) of shrub-steppe wildlife habitat in the 200 East Area and 32 ha (77 ac) of shrub-steppe habitat at the potential Pit 30 borrow site. An additional 58 ha (160 ac) of shrub-steppe habitat would be disturbed at the three potential borrow sites (21 ha [52 ac] at Vernita Quarry, 12 ha [30 ac] at McGee Ranch, and 25 ha [64 ac] at Pit 30) to support closure of the tank farms and LAW vaults. Impacts would be similar to those described for the Ex Situ Intermediate Separations alternative.

Ex Situ/In Situ Combination 2 Alternative

During remediation, this alternative would disturb 40 ha (99 ac) of shrub-steppe habitat in the 200 East Area and 30 ha (74 ac) at the potential Pit 30 borrow site. During closure, an additional 48 ha (120 ac) would be disturbed at the three potential borrow sites; 19 ha (47 ac) at Vernita Quarry, 11 ha (27 ac) at McGee Ranch, and 18 ha (44 ac) at Pit 30. Impacts would be similar to those described for the Ex Situ Intermediate Separations alternative.

Phased Implementation Alternative

Phase 1

Phase 1 of the Phased Implementation alternative would disturb approximately 21 ha (49 ac) of shrub-steppe wildlife habitat, all but 1 ha (2.5 ac) of which would be in the 200 East Area. Impacts similar to those described for the Ex Situ Intermediate Separations alternative would be expected.

Total Alternative

The Phased Implementation alternative, when fully implemented, would result in a total disturbance that would include the disturbances identified for Phase 1, as well as disturbances associated with implementing Phase 2. The total disturbances would include 79 ha (150 ac) of shrub-steppe habitat in the 200 Areas and 37 ha (91 ac) at the potential Pit 30 borrow site would be associated with remediation activities. An additional 81 ha (200 ac) at the three potential borrow sites would be associated with closure activities. Impacts to wildlife similar to those described for the Ex Situ Intermediate Separations alternative would be expected.

5.4.2.2 Capsule Alternatives

Wildlife impacts from all capsule alternatives would be negligible. The No Action (Capsules) alternative would disturb no additional wildlife habitat. The Onsite Disposal alternative would involve an area currently partly disturbed, and only 1.5 ha (3.5 ac) of wildlife habitat would be affected. Both of the other capsule alternatives would involve developing small facilities within the proposed complex for vitrifying tank waste. Thus, no additional wildlife habitat areas would be disturbed, and no incremental impacts would occur.

5.4.3 Aquatic, Wetlands, and Riparian Habitats

The aquatic habitats on the Hanford Site include the Columbia River, two small spring-fed streams on the Fitzner Eberhardt Arid Lands Ecology Reserve, and artificial ponds and ditches located in or near the 200 Areas. The primary wetlands on the Hanford Site are the riparian areas along the Columbia River. There also are human-made wetlands near the 200 East Area. None of the aquatic habitats, riparian areas, or wetlands would be directly or indirectly adversely affected by any EIS alternative.

5.4.4 Species of Concern and Critical Habitats

Impacts of all EIS alternatives on plant and animal species of concern were directly related to the amount of disturbance of shrub-steppe habitat associated with each alternative (Table 5.4.1). Species of concern are defined as those species 1) listed as threatened or endangered by the Federal government or Washington State; 2) identified as candidates for listing by the Federal government; or 3) identified as candidate, monitor, or sensitive species by Washington State. Critical habitats are habitat types that are of high value to wildlife, declining in abundance, or both.

No Federal- or State-listed species would be impacted by any EIS alternative. The following Federal candidate species or Washington State candidate, monitor, or sensitive species either were observed in TWRS EIS biological surveys or are known to exist in shrub-steppe habitat, and thus should be considered potentially impacted:

- Plant species - Crouching milkvetch, stalked-pod milkvetch, scilla onion, and Pipers daisy;
- Bird species - Loggerhead shrike, sage sparrow, ferruginous hawk, swainsons hawk, sage thrasher, long-billed curlew, prairie falcon, golden eagle, and burrowing owl;
- Mammal species - Pygmy rabbit; and
- Reptile species - Northern sagebrush lizard, striped whipsnake, and desert night snake.

Washington State considers shrub-steppe a priority habitat because of its value to many wildlife species and because it is a diminishing resource that is relatively scarce in the state. It is DOE policy at the Hanford Site to mitigate losses of mature sagebrush in shrub-steppe habitat areas. Section 5.20 contains additional details on mitigation of impacts to shrub-steppe habitat.

The western sage grouse, a Federal and State-listed threatened species, was found on the Site until the local population was displaced by a major wildfire in 1984. The bald eagle, also listed as threatened by the Federal government and Washington State, winters along the Hanford Reach. The bald eagle forages on fish and wildlife along the river. Eagles are not known to use the Central Plateau of the Site, which is 10 km (6 mi) or more from the river. Although the bald eagle potentially could consume fish from areas of the river that received groundwater contaminated under TWRS EIS alternatives, contaminant exposures to the bald eagle would be expected to be below levels of concern (Section 5.4.6). Thus, no direct or indirect impacts would be expected under any TWRS EIS alternative.

5.4.5 Biodiversity

The destruction or degradation of the shrub-steppe habitat on the Hanford Site would impact the area's unique biodiversity. None of the EIS alternatives would affect more than a fraction of 1 percent of the Hanford Site's total shrub-steppe area. However, impacts on the McGee Ranch area, a potential borrow site under all tank waste alternatives except No Action and Long-Term Management, would impact a wildlife corridor that is important for species migration, proliferation, and genetic diversity. Historic evidence at the Hanford Site indicates that disturbing shrub-steppe habitat leads to the incursion of exotic species that replace or compete with the native species. These new species tend to simplify the ecosystem, thereby reducing diversity and changing the ecological character of the Hanford Site. The impacts of EIS alternatives would be directly related to the amount of shrub-steppe they would disturb. Table 5.4.1 lists the differences in impacts among alternatives.

There are a variety of other ecosystems on the Hanford Site such as wetlands, riparian areas, and bluffs. These support unique plant and animal communities and contribute to the Hanford Site's biodiversity. None of the EIS alternatives would adversely affect any of the other Hanford Site ecosystems.

5.4.6 Radiological and Chemical Impacts to Biological and Ecological Resources

This section describes risk to plant and animal species from possible exposures to radionuclides and hazardous chemicals under the various EIS alternatives. Radiation doses and chemical hazards were assessed for a generic plant, several mammals (great basin pocket mouse, coyote, and mule deer), and two bird species (red-tailed hawk and loggerhead shrike). The methodology for this assessment is described in Volume Three, Appendix D. Calculation methods used were for the analysis similar to those described in the Hanford Baseline Risk Assessment Methodology (DOE 1995c). The equations were modified to follow the unit risk factor approach used for the human health assessment (Section 5.11).

5.4.6.1 Tank Waste Alternatives

No Action Alternative (Tank Waste) and Long-Term Management Alternative

Direct contact with stored waste is unlikely as long as institutional controls are present, but would be possible after the 100-year institutional control period. If direct contact with the waste occurred under the No Action and Long-Term Management alternatives, that exposure would be estimated to lead to potential radiation doses ranging from 16 to several million radiation absorbed doses (rad)/day, which most likely would be lethal to wildlife in a short time. The chemical hazards of direct exposure would range as high as several hundreds of times higher than the 1.0 hazard index that is the benchmark for potential adverse ecological impacts (e.g., a hazard index greater than 1.0 indicates adverse effects in ecological receptors of concern). The mechanism by which direct contact could occur many years in the future (after institutional control has been lost) would involve the eventual collapse of the top of an underground tank. This would allow species to fall into the exposed tank and suffer trauma from the fall as well as radioactive and chemical exposures. Birds would be the most likely animal to be impacted.

Exposure to routine air emissions under this alternative is estimated to result in radiation exposures of less than 1.0E-06 rad/day. Routine air emissions would occur only during the period of institutional control. This exposure level is far below background levels and would be expected to have no detectable effects on exposed species.

Exposure to contaminated groundwater reaching the Columbia River would result in low radiological exposure levels. Radiation doses would not approach the International Atomic Energy Agency 0.1-rad/day benchmark for terrestrial organisms or the National Council on Radiation Protection and Measurement 1.0-rad/day benchmark for aquatic organisms (IAEA 1992 and NCRP 1991).

The No Action and Long-Term Management alternatives are the most conservative of the alternatives evaluated and represent the greatest potential impact to groundwater and the Columbia River. This is because no remediation would be performed, and all the waste would remain in the tanks and be available for migration to groundwater following tank failure.

Under these alternatives, maximum chemical concentrations calculated to reach the Columbia River 300, 500, 2,500, 5,000, or 10,000 years in the future would result in maximum hazard indices well below the hazard index criterion of 1.0 for the indicator species (coyote, mule deer, red-tailed hawk, and loggerhead shrike). The ecological hazards were based on a conservative scenario involving consumption of groundwater contaminants at the point where groundwater reaches the surface on the Columbia River bank (e.g., springs or seeps) and assume no dilution of the groundwater contaminants by the river before access by the receptors. This scenario conservatively assumes that a terrestrial receptor would obtain all its water from a spring where maximum contaminant concentrations are calculated to occur. Further, this receptor is assumed to spend its entire lifetime drinking water from this single, maximum exposure location and nowhere else. In reality, all indicator species used to evaluate potential groundwater consumption are highly mobile and have relatively large home ranges, such that they would drink water at numerous locations both onsite and offsite. Based on the conservative nature of the exposure scenarios, the estimated hazards for the representative species indicate that no adverse effects would be expected for any terrestrial or aquatic receptor consuming groundwater in the future.

In Situ Fill and Cap Alternative

Under the In Situ Fill and Cap alternative, all of the tank waste would remain in place. As long as institutional controls were present, it is unlikely that ecological receptors would have direct contact with the tank waste. Following the loss of institutional controls, if direct contact with the waste occurred, that exposure would lead to potential radiation doses that most likely would be lethal to ecological receptors. Doses would be similar to those calculated for the No Action and Long-Term Management alternatives. The chemical hazards of direct exposure would range as high as several hundred times above the 1.0 benchmark for potential adverse ecological impacts.

For the In Situ Fill and Cap alternative, closure would entail placing a multi-layered Hanford Barrier over each tank farm. This 4.5-m (15-ft)-thick barrier would be designed to inhibit intrusion by burrowing animals. Consequently, direct contact with tank waste would be unlikely following closure.

Potential radiation doses as a result of radiological releases to air from routine operations would be below the 0.1-rad/day benchmark. Radiation doses from contaminated groundwater also would be below the 0.1-rad/day and 1.0-rad/day benchmarks for terrestrial and aquatic organisms, respectively. The maximum chemical concentrations calculated to reach the Columbia River under the No Action alternative represent the highest potential concentrations of groundwater contaminants for any of the alternatives. As described previously for the No Action alternative, maximum calculated contaminant concentrations in groundwater would result in hazard indices well below the hazard index criterion of 1.0 for all indicator species (coyote, mule deer, red-tailed hawk, and loggerhead shrike). Because chemical concentrations that would reach the Columbia River would be approximately 10 times lower under the In Situ Fill and Cap alternative than under the No Action alternative, potential chemical exposures would not pose a threat to terrestrial or aquatic receptors under the In Situ Fill and Cap alternative.

In Situ Vitrification Alternative

Under the In Situ Vitrification alternative, direct contact with the stabilized waste-containing material would result in radiation doses that most likely would produce lethal effects in ecological receptors. Following closure and construction of a Hanford Barrier over each tank farm, direct contact with the stabilized waste would be unlikely because this barrier is intended to prevent penetration by burrowing animals.

Estimated radiation doses resulting from routine air emissions would not exceed the 0.1-rad/day benchmark of concern (IAEA 1992). Exposure to contaminated groundwater reaching the Columbia River would be well below the 0.1-rad/day and 1.0-rad/day benchmarks for terrestrial and aquatic species, respectively. As described previously, maximum chemical concentrations calculated to reach the Columbia River under the No Action alternative would represent the highest potential concentrations of groundwater contaminants for any of the alternatives. Because the maximum hazard indices under the No Action alternative would be below the hazard index benchmark value of 1.0, chemical concentrations that would reach the Columbia River under the In Situ Vitrification alternative would not pose a threat to terrestrial or aquatic receptors.

Ex Situ Intermediate Separations Alternative

Under the Ex Situ Intermediate Separations alternative, 1 percent of the tank waste would remain as residual contamination. Direct contact with this residual tank waste would result in radiation doses that would pose a threat to ecological receptors, including potential lethal effects. Following closure and construction of a Hanford Barrier, direct contact with the 1 percent residual waste would be unlikely because this barrier is intended to prevent penetration of burrowing animals.

The maximum estimated radiation exposure from air releases during routine operations would exceed the 0.1-rad/day benchmark of concern under conservative assumptions. Exposures would range from 1.0 rad/day for the mule deer to 48 rad/day for the pocket mouse, primarily due to releases of carbon-14, cesium-137, and strontium-90. However, this estimate assumes year-long exposure at the location of maximum radionuclide concentrations. At other locations, radionuclide concentrations would be lower, and thus exposures would be lower. Species exposure to harmful levels of airborne radiation from routine releases would be unlikely unless an animal spent its entire life at the point of maximum exposure.

As described previously, maximum contaminant concentrations calculated to reach the Columbia River under the No Action alternative would represent the highest potential concentrations of groundwater contaminants of any of the alternatives. Because the maximum hazard indices and radiation doses under the No Action alternative were below their respective benchmark values (e.g., a hazard index of 1.0, 0.1 rad/day for terrestrial species, and 1.0 rad/day for aquatic species), groundwater contaminant concentrations that would reach the Columbia River under the Ex Situ Intermediate Separations alternative would not pose a threat to terrestrial or aquatic receptors.

Ex Situ No Separations Alternative

Radiological and chemical hazards to animal species for this alternative would be similar to those described for the Ex Situ Intermediate Separations alternative. However, direct contact radiological risk would be lower than for the Ex Situ Intermediate Separations alternative because there would be no long-term onsite storage of LAW. Maximum estimated radiation doses resulting from routine releases would be expected to exceed the 0.1-rad/day benchmark for terrestrial receptors. Given the conservative nature of this exposure scenario (i.e., year-long exposure at the point of maximum radionuclide concentration), it is unlikely that ecological receptors would be exposed to harmful levels of airborne radiation from routine releases under the Ex Situ No Separations alternative.

As described previously, maximum contaminant concentrations calculated to reach the Columbia River under the No Action alternative would represent the highest potential concentrations of groundwater contaminants of any of the alternatives. Because the maximum hazard indices and radiation doses under the No Action alternative would be below their respective benchmark values (a hazard index of 1.0, 0.1 rad/day for terrestrial species, and 1.0 rad/day for aquatic species), groundwater contaminant concentrations that would reach the Columbia River under the Ex Situ No Separations alternative would not pose a threat to terrestrial or aquatic receptors.

Ex Situ Extensive Separations Alternative

Radiological and chemical risk to animal species would be similar to those described for the Ex Situ Intermediate Separations alternative. Exposure mechanisms would be similar to the Ex Situ Intermediate Separations alternative but there would be less risk from LAW vaults because the concentration of radionuclides would be less in the LAW disposed of onsite. Maximum estimated radiation doses resulting from routine releases would be expected to exceed the 0.1-rad/day benchmark for terrestrial receptors. Given the conservative nature of this exposure scenario (i.e., year-long exposure at the point of maximum radionuclide concentration), it is unlikely that ecological receptors would be exposed to harmful levels of airborne radiation from routine releases under the Ex Situ Extensive Separations alternative.

As described previously, maximum contaminant concentrations calculated to reach the Columbia River under the No Action alternative would represent the highest potential concentrations of groundwater contaminants for any of the alternatives. Because the maximum hazard indices and radiation doses under the No Action alternative would be below their respective benchmark values (a hazard index of 1.0, 0.1 rad/day for terrestrial species, and 1.0 rad/day for aquatic species), groundwater contaminant concentrations that would reach the Columbia River under the Ex Situ Extensive Separations alternative would not pose a threat to terrestrial or aquatic receptors.

Ex Situ/In Situ Combination 1 and 2 Alternatives

These alternative s would be combination s of the In Situ Fill and Cap alternative for those tanks left in place and the Ex Situ Intermediate Separations alternative for the tank waste retrieved. The radiological and chemical constituents and concentrations released during operations would be similar to the In Situ Fill and Cap and the Ex Situ Intermediate Separations alternatives.

Under the conservative maximum exposure scenario, the maximum estimated radiation doses from air releases during routine operations would not exceed the 0.1-rad/day benchmark for terrestrial receptors.

As described previously, maximum contaminant concentrations calculated to reach the Columbia River under the No Action alternative would represent the highest potential concentrations of groundwater contaminants of any of the alternatives. Because the maximum hazard indices and radiation doses under the No Action alternative would be below their respective benchmark values (a hazard index of 1.0, 0.1 rad/day for terrestrial species, and 1.0 rad/day for aquatic species), groundwater contaminant concentrations that would reach the Columbia River under the Ex Situ/In Situ Combination 1 and 2 alternative s are not expected to pose a threat to terrestrial or aquatic receptors.

Phased Implementation Alternative

Phase 1

Phase 1 of the Phased Implementation alternative would include constructing one LAW processing plant and one combined LAW and HLW facility to process a portion of the tank waste. The chemical and radiological constituents and concentrations released during operations of this alternative would be similar to the Ex Situ Intermediate Separations alternative, and the associated impacts would be similar to operations. This phase of the alternative would not include disposal, so no post-remediation impacts would occur.

Total Alternative

The Phased Implementation alternative would result in chemical and radiological releases during operation, as described previously for Phase 1, and during operations associated with implementing Phase 2. The total chemical and radiological releases during operations and post remediation would be similar to those of the Ex Situ Intermediate Separations alternative.

5.4.6.2 Capsules Alternatives

Radiological and chemical risk to animal species would be small for all capsule alternatives. Neither the No Action alternative nor the Onsite Disposal alternative would involve waste treatment activities, and thus no radiological or chemical hazards would occur. Furthermore, no airborne releases would be expected from routine operations. Groundwater risk would be small because of the radioactive decay of the cesium and strontium capsule contents. By the time any releases could reach groundwater, only stable progeny isotopes (i.e., barium-137 and zirconium-90) would remain. The concentrations of these progeny in the groundwater would result in doses below the levels that would cause toxic effects in animal species.

It is conceivable that burrowing animals could be affected under the Onsite Disposal alternative after institutional controls were lost in the future. For example, pocket mice and burrowing owls could be stressed as a result of the heat generated from the capsules. Direct contact with the capsule contents also could occur following failure of the capsules. However, some radioactive decay of the cesium and strontium capsules likely would have occurred by the time of possible direct contact. Potential heat stress or direct contact impacts would affect a small number of individual species members and would have no impact on the total species population of the Site as a whole.

The Overpack and Ship alternative would involve no waste treatment and no long-term onsite storage of the capsules. No chemical or radiological risk to species would be expected.

The Vitrify with Tank Waste alternative would involve low risk to species. Capsule contents would be processed together with the tank waste in the same manner and at the same facility as described for the Ex Situ Intermediate Separations alternative. The vitrified capsule contents would be shipped offsite for disposal as HLW, and thus there would be no long-term onsite capsule waste storage.

5.5 CULTURAL RESOURCES

This section describes the impacts of the EIS alternatives on prehistoric and historic sites. The approach used was to 1) define specific land areas that would be disturbed by construction and operation; and 2) identify any prehistoric or historic materials or sites at those locations that might be adversely impacted. Table 5.5.1 summarizes these impacts and identifies the areas that potentially would be impacted. Issues of potential concern to Native Americans, such as land use and access, are presented in Section 5.5.3 and also are discussed in Section 5.19 (Environmental Justice).

Table 5.5.1 Prehistoric and Historic Impacts of TWRS Alternatives

Cultural resources surveys conducted in 1994 for this EIS and previous cultural resources surveys indicated existing ground disturbance at portions of the sites proposed for TWRS facilities in the 200 East Area proposed under the various ex situ alternatives and the Ex Situ/In Situ Combination 1 and 2 alternatives (PNL 1994a, b, c). This disturbance has resulted from past and ongoing Hanford Site activities. However, it is possible that the disturbed areas may contain cultural resources that were not identified in past surveys. Thus, additional cultural resource surveys would be conducted and TWRS construction would include procedures and monitoring activities to protect cultural resources encountered during construction.

Survey work in the 200 East Area has recorded two historic isolated artifacts within the proposed TWRS sites. These items, a flat-bottomed, crimped tin can and a double-soldered tin can, are considered of little importance as they probably do not meet National Register of Historic Places eligibility criteria because they lack physical integrity. Surveys of the proposed Phased Implementation (Phase 1) alternative site in the 200 East Area identified no archaeological sites (Cadoret 1995). Surveys of the 200 West Area also have identified very few archaeological sites (Section 4.5).

Under all tank waste alternatives except No Action, approximately 13,000 m (33,000 ft) of replacement underground pipelines would be placed at various locations in the 200 East and 200 West Areas. These pipelines would be placed adjacent to and replace the existing pipelines. Thus, no currently undisturbed land would be impacted, and no prehistoric or historic sites would be impacted by the activities under any EIS alternative.

Archaeological surveys of the three potential borrow sites have identified a variety of prehistoric or historic artifacts and sites at the Vernita Quarry and McGee Ranch. The likelihood of disturbing additional archaeological sites in these areas is considered high. The McGee Ranch site is part of the proposed McGee Ranch/Cold Creek Archaeological District, which has been deemed eligible for nomination to the National Register of Historic Places. The potential of disturbing archaeological sites at Pit 30 is considered low because of its location between the 200 West and 200 East Areas, a vicinity where few prehistoric or historic sites have been identified (Duranceau 1995).

5.5.1 Prehistoric Sites Impacts

5.5.1.1 Tank Waste Alternatives

No Action Alternative

The No Action alternative would involve no new construction, and thus no impacts to prehistoric archaeological sites would occur.

Long-Term Management Alternative

This alternative would disturb 50 ha (124 ac) in the 200 East Area and 16 ha (40 ac) at the potential Pit 30 borrow site for the construction of two new tank farms. This disturbance in the 200 East Area would occur in the same area proposed for the waste treatment facilities under the various ex situ alternatives. Because no important prehistoric sites were found in surveys of this area, no impacts would be expected. It is unlikely that activities at the potential Pit 30 borrow site would encounter any prehistoric sites.

In Situ Fill and Cap Alternative

During remediation activities, there would be minimal new disturbances (0.1 ha [0.5 ac]) in the 200 Areas near the tank farms. There would be approximately 25 ha (62 ac) disturbed at the potential Pit 30 borrow site where it is unlikely that activities would encounter prehistoric sites.

The remediation and closure activities under the In Situ Fill and Cap alternative would involve disturbing areas within and adjacent to the tank farms and at the potential borrow sites. Activities at and near the tank farms would have low impact potential. Disturbance of about 37 ha (91 ac) by construction activities at the potential Vernita Quarry and McGee Ranch borrow sites would have a high likelihood of impacting prehistoric sites because past surveys have found prehistoric materials in both areas. However, it is unlikely that activities at the potential Pit 30 borrow site would encounter any prehistoric sites.

In Situ Vitrification Alternative

During remediation, the in situ vitrification activities would occur in disturbed areas within and immediately adjacent to the various tank farms in the 200 Areas, and thus impacts to archaeological sites were considered unlikely. The In Situ Vitrification alternative would involve constructing a new substation and new power transmission lines in the 200 Areas to bring power to the in situ vitrification activities at the tank farms. The new substation would be located in currently disturbed areas, and it is likely that no impacts to prehistoric archaeological sites would occur. Constructing the new power lines would affect approximately 70 ha (170 ac) of land in approximately 17,000-m (57,000-ft) by 15-m (50-ft)-wide corridors. The bulk of this area, about 47 ha (115 ac), is currently disturbed, and thus it is unlikely that any new impacts to archaeological sites would occur. The remaining 23 ha (57 ac) are undisturbed. A cultural resources field survey of these power line routes would be performed before any final power line alignment would be selected. During remediation, 23 ha (57 ac) of currently undisturbed land would be impacted at the potential Pit 30 borrow site. However, activities would not likely encounter prehistoric sites.

During closure activities, this alternative would disturb land at the potential Vernita Quarry, McGee Ranch, and Pit 30 borrow sites. The likelihood of impacting prehistoric archaeological sites would be high at Vernita Quarry and McGee Ranch because prehistoric materials have been recorded there in past cultural resource surveys. Approximately 37 ha (91 ac) would be disturbed at these two potential borrow sites. Impact potential is considered low at the potential Pit 30 borrow site because prehistoric sites are scarce in and around the arid 200 Areas.

Ex Situ Intermediate Separations Alternative

As indicated previously, field investigations have indicated no important archaeological sites at the proposed 200 East Area site for the remediation activities under the Ex Situ Intermediate Separations alternative. Thus, no impacts on prehistoric sites would be expected.

During closure activities, the alternative would disturb land at all three potential borrow sites. The potential for impacts on prehistoric archaeological sites would be similar to those described previously, (i.e., high at the potential Vernita Quarry and McGee Ranch borrow sites and low at the potential Pit 30 borrow site).

Ex Situ No Separations Alternative

The prehistoric archaeological site impact potential during remediation activities would be very low at the proposed 200 East Area waste treatment site and the potential Pit 30 borrow site. During closure activities, there would be a high potential for impacts at the Vernita Quarry and McGee Ranch borrow sites.

Ex Situ Extensive Separations Alternative

The prehistoric archaeological site impact potential during remediation activities would be the same as described for the Ex Situ Intermediate Separations alternative. During closure activities, the same amount of land disturbance would occur at the primary areas of potential impact (the potential McGee Ranch and Vernita Quarry borrow sites).

Ex Situ/In Situ Combination 1 Alternative

During remediation, this alternative would involve activities at the proposed waste processing site in the 200 East Area and in currently disturbed areas in and around the tank farms. Impact potential would be the same as for the Ex Situ Intermediate Separations alternative. During closure activities, a total of 42 ha (100 ac) of land would be disturbed at the potential McGee Ranch and Vernita Quarry borrow sites.

Ex Situ/In Situ Combination 2 Alternative

During remediation, this alternative would involve activities at the same locations as for the Ex Situ/ In Situ Combination 1 alternative, but would disturb a somewhat smaller total area. Impact potential would be the same as for the Ex Situ Intermediate Separations alternative. During closure activities, a total of 38 ha (94 ac) would be disturbed at the potential McGee Ranch and Vernita Quarry borrow sites.

Phased Implementation Alternative

Phase 1

Past surveys of the proposed Phased Implementation alternative facility sites that would be used during Phase 1 in the 200 East Area revealed no prehistoric materials or sites (Cadoret 1995). Thus, no impacts would be expected. Borrow material used during remediation activities would be obtained from the potential Pit 30 borrow site so there would be a low probability of impacting archaeological sites.

Total Alternative

The Phased Implementation alternative would have the same potential impacts on prehistoric sites as were described for the Ex Situ Intermediate Separations alternative.

5.5.1.2 Capsule Alternatives

The capsule No Action alternative would involve no additional ground disturbance, and therefore no impacts to prehistoric archaeological sites would occur. The Onsite Disposal alternative would involve ground disturbance at a site adjacent to the 200 East Area that is mostly disturbed, and thus no new impacts to archaeological sites are likely. The Overpack and Ship and Vitrify with Tank Waste alternatives would involve using small amounts of land at the waste treatment site in the 200 East Area proposed under the various ex situ alternatives. As described previously, because site surveys revealed no important archaeological sites, no impacts would be expected from these capsule alternatives.

5.5.2 Historic Site Impacts

Except for within the tank farms, there would be no facilities constructed in areas that contained historic structures (i.e., structures that were occupied or used after written records became available) under all tank waste and capsule alternatives. In addition, no new construction activities would occur adjacent to existing historic buildings or structures. No existing buildings or structures would be modified other than possibly the waste storage tanks and other structures at the tank farms (WHC 1995a, c, e, f, g, h, j, n). Under the In Situ Vitrification and the various ex situ alternatives, facilities within the tank farms (e.g., buildings and water tanks) could be modified or destroyed.

The waste storage tanks could be considered of potential historical importance because they represent activities of the World War II and Cold War periods. Under all alternatives involving ex situ treatment, the waste contents of the tanks would be retrieved by hydraulic or mechanical means or both. Waste retrieval might require modifications to the existing tank structures to allow waste content removal. Under the In Situ Vitrification alternative, the waste tanks would be melted into glass with their waste contents. Typically, contaminated structures of historical value would have their history and use documented but would not be preserved intact. DOE has received an exemption that would allow documenting of only one SST, one DST, and one inactive miscellaneous underground storage tank, rather than documenting each tank individually (DOE 1996e).

The former White Bluffs Freight Road crosses diagonally through the 200 West Area from the northeast to the southwest and would be intersected in two places by the new power transmission corridors under the In Situ Vitrification alternative. What is now known as the White Bluffs Freight Road has been in continuous use since prehistoric times. It has played a role in Euro-American immigration in the nineteenth century, in agriculture, and in Hanford Site operations (Cushing 1994). Nomination of this property to the National Register of Historic Places is pending, and a 100-m (330-ft) easement exists to protect the road from uncontrolled disturbance. However, the road segment that passes through the 200 West Area is not an important element in the National Register nomination largely because it has been disturbed in places by past Hanford Site activities (Cadoret 1995). Affected Tribal Nations indicate that although the White Bluffs Freight Road has been fragmented by past contemporary activities, it remains just as important to the affected Tribes as any other cultural site within the Pasco Basin (CTUIR 1996).

Historic sites have been recorded at the potential McGee Ranch and Vernita Quarry borrow sites. These sites are representative of Euro-American settlement activities from the turn of the century to the 1940's. One structure from the pre-Hanford Site homesteading period is known to exist at the potential Pit 30 borrow site. Impact potential is considered high for historic sites at both the potential McGee Ranch and Vernita Quarry borrow sites . At McGee Ranch, the historic sites are the primary basis for its being judged eligible for nomination to the National Register of Historic Places (Cadoret 1995). The historic structure at the potential Pit 30 borrow site has not yet been evaluated for its historic importance, but the overall historic site impact potential is considered low.

5.5.3 Issues of Potential Concern to Native Americans

As described in Section 4.5, the Hanford Site as a whole has special importance for Native Americans. By treaty, the Hanford Site was ceded by the Confederated Tribes and Bands of the Yakama Indian Nation and Confederated Tribes of the Umatilla Indian Reservation to the United States. There are Native American remains and other specific sites of religious and cultural importance at various locations around the Hanford Site, approximately 94 percent of which has not been disturbed by past activities and currently is unused. The Native American perspective on resources is different in many ways from the perspective of Euro-Americans (Harper 1995).

Development of the Hanford Site has altered substantially the natural landscape. Buildings have been erected, soil and water has been disturbed, and the distribution of plants and animals has been altered. Environmental cleanup and restoration activities will further alter the visual landscape, disrupt wildlife, and alter plant communities, leaving the Site less natural than it once was. Such changes affect the relationship between the Native Americans and the native lands.

Access to the Hanford Site by Native Americans, as well as all members of the public, has been restricted since the Hanford Site was established as a national defense facility in 1943. However, Tribal Nations have continued to express the desire to access and use Hanford Site areas. The various alternatives would have different long-term impacts on Native American land access and use. However, access to and use of the 200 Areas would be restricted regardless of which EIS alternative is selected because of environmental contamination of areas surrounding the tank farms (e.g., the existing processing facilities).

For remediation activities, the tank waste No Action and Long-Term Management alternatives would leave the tank waste intact in its current location and form indefinitely, thereby restricting access and use of land associated with the tank farms. All other tank waste alternatives also would leave various amounts of residual waste in the tanks but with less potential health hazard than No Action or Long-Term Management. For post-remediation activities associated with the closure scenario, all the alternatives except No Action and Long-Term Management would result in areas covered by the Hanford Barriers that would be restricted from alternative uses and access. To support closure activities, all tank waste alternatives except No Action and Long-Term Management would change the land forms and land uses at the three potential borrow sites (i.e., Vernita Quarry, McGee Ranch, and Pit 30).

During remediation, the In Situ Vitrification alternative would involve additional power transmission corridor development that would limit uses of the corridor during the alternative's construction and operation phases. The Ex Situ Intermediate Separations, Ex Situ Extensive Separations, Phased Implementation (total alternative), and the Ex Situ/In Situ Combination 1 and 2 alternatives would involve permanent onsite disposal of LAW, which would require restricting future use of this area. The Ex Situ No Separations alternative would involve no onsite LAW storage.

The cesium and strontium capsule Onsite Disposal alternative would maintain access restrictions for 100 years for the drywell disposal location. Alternative uses and access would be precluded at least for that time frame. The Overpack and Ship alternative would remove all waste from the Hanford Site, as would the capsule Vitrify with Tank Waste alternative. Consequently, these alternatives would have no impact on future Native American land use or access.

5.6 SOCIOECONOMICS

The following is a summary of the potential impacts to the socioeconomic environment associated with each of the alternatives. To support a comparison of the relative impacts of each alternative, the impact analysis focused on key indicators of the potentially impacted area including Hanford Site employment and the effects of Site employment levels on employment, population, taxable retail sales, and housing prices in the surrounding area. These impacts are addressed in more detail in Volume Five, Appendix H. Based on the results of the socioeconomic modeling of the key indicators of socioeconomic impacts, analyses of potential impacts to public services and facilities (schools, police and fire protection, medical services, sanitary and solid waste disposal, and electricity, natural gas, and fuel oil) were completed. The socioeconomic analysis did not address the possible economic impacts of TWRS accidents. Impacts resulting from accidents are presented in Section 5.12 and Volume Four, Appendix E. Impacts to the transportation system are addressed separate from this section (Section 5.10).

All of the tank waste alternatives, except No Action, would create new jobs at the Hanford Site and in the surrounding community. Peak year new employment typically would occur during the construction phase for each alternative with peak construction ranging from 150 jobs under the In Situ Fill and Cap alternative to approximately 6,700 jobs under the Ex Situ Intermediate Separations and Phased Implementation alternatives. For capsule alternatives, peak year employment would range from none under the No Action alternative to 47 under the Overpack and Ship and Vitrify with Tank Waste alternatives. New jobs created under each alternative would have impacts on the Tri-Cities economy based on the number of jobs created. These impacts would include increased total population, retail sales, housing prices, and increased demands for housing and public facilities and services. The level of impacts would be directly related to the level of new jobs created, and in each case, the impacts would be greatest in the years closest to the year of peak employment. A large number of jobs would be created over a short period of time under some of the alternatives, resulting in the Tri-Cities economy experiencing a boom-bust cycle that could adversely impact the local economy.

This socioeconomic analysis was limited to the Richland-Kennewick- Pasco Metropolitan Statistical Area, also known as the Tri-Cities area, which encompasses all of Benton and Franklin counties. The analysis did not address impacts on other areas in the region because there are too few Hanford Site employees in surrounding counties for changes in Hanford Site employment to cause any measurable economic impacts. Historically, Hanford Site employees that live outside Benton and Franklin counties constitute approximately 7 percent of the total Hanford Site labor force (Cushing 1995). Most of these employees live in Yakima County, which has a total nonfarm employment of over 65,000 (WSDES 1993b). Hanford Site employees represent approximately 1 percent of the total Yakima County nonfarm employment. Thus, outside of Benton and Franklin counties, the economic impacts of EIS alternatives would be too small to warrant detailed analysis (Serot 1995a).

The socioeconomic modeling summarized in this section focused on total numbers of jobs and did not address the possible economic effects of differences in wage and salary levels (and thus total Tri-Cities gross income) of new jobs created compared to wages and salaries of jobs lost as Hanford Site employment declines over time. Historically, Hanford Site-related jobs have been higher paying than non-Site jobs in the area, and new jobs created in the Tri-Cities might not match the total income generated by jobs that previously existed at the Hanford Site. The projections of nonfarm employment and population were used to assess the impacts of each alternative on public services and facilities (e.g., schools, police and fire services, and public utilities). Development of the calculational baseline projection and use of the economic forecasting model are described in more detail in Volume Five, Appendix H.

Economic forecasts that attempt to calculate conditions many years into the future are inherently limited in their accuracy. Because of the uncertainties in calculating Federal funding, and thus future employment levels, the economic forecasting model may provide optimistic calculations of several economic indicators. This socioeconomic impact analysis is not a definitive description of the future of the Tri-Cities area. Rather, the information is presented to identify the differences in socioeconomic impacts among the various EIS alternatives. To use the analysis for any other purpose assumes a validity and usefulness not intended.

Currently, the Tri-Cities area is in a transitional period as the Hanford Site, historically the dominant local employer, downsizes. There is as yet limited evidence of how the area's economy will adapt to this change. For example, it is not yet known how successful the ongoing attempts will be to diversify the economy by using the Site's technology and skilled employee base. The Tri-Cities economy of the mid-1990's is considerably larger and more diversified than it was during Site downturns in past decades. This would tend to lessen the overall effect on the Tri-Cities of changes in employment and spending at the Site.

Emerging data indicate that the negative effect to the Tri-Cities economy of the recent declines in Hanford Site employment have been less severe than commonly assumed. For example, average Hanford Site employment in 1995 declined from 18,388 in 1994 to 15,767, a reduction of over 2,600 jobs. Over the same time frame, total nonfarm employment in the Tri-Cities area declined from 73,800 to 72,200, a reduction of 1,600 jobs (Table 4.6.1). Analyses of the Tri-Cities economy based on historical data indicate that each additional job created at the Hanford Site would in turn lead to the creation of more than one additional job locally (i.e., a multiplier effect of more than 2). If this same multiplier worked in reverse, each job lost at the Site should lead to a reduction in total nonfarm employment of two jobs or more. However, the data indicate that this has not occurred, or at least has not yet occurred.

It is too early to determine why Site job losses have not led to greater immediate declines in total Tri-Cities employment, and it would be inappropriate to suggest that the data mean that total Tri-Cities employment is unaffected by Hanford Site job reductions. Future data on total nonfarm employment may show a sharper decline, which could indicate that there is a time lag between Site job reductions and the time when these reductions would be reflected in the data about the Tri-Cities area's economy as a whole. However, it also is possible that because of the increasing diversification of the area's economy, the effects of changes in Site employment on the area's economy may not be as great as in the past, particularly when Site employment declines (i.e., as in 1995), compared to when it increases (i.e., as it did in the early 1990's) (Serot 1996).

If future data indicate that changes in Hanford Site employment have a smaller impact on total nonfarm employment and other socioeconomic aspects of the Tri-Cities area than would result from the 2.4 employment multiplier for Site employment used in this EIS, then the impacts of the TWRS alternatives on total Tri-Cities nonfarm employment, population, taxable retail sales, housing prices, and public services and facilities would be less than estimated in this EIS.

5.6.1 Economy and Employment

The socioeconomic impacts of each TWRS alternative were measured in terms of changes from a baseline projection of economic activity, population, and housing in the Tri-Cities area. The projection assumed the successful completion of the scheduled milestones for Hanford Site cleanup and environmental restoration under the Tri-Party Agreement (Ecology et al. 1994). This baseline projection was developed for impact analysis purposes only and should be considered a calculational baseline. Developing this calculational baseline began with the most current available projection of long-term overall Hanford Site employment including DOE employees, contractors, and major subcontractors (Daly 1995). The overall Hanford Site employment projection included the proposed TWRS activities as defined in the Tri-Party Agreement (Ecology et al. 1994).

The calculational baseline for the EIS socioeconomic impact analysis removed the proposed TWRS component from the overall Hanford Site employment projection. This provided a consistent base from which to add the estimated labor requirements for each TWRS alternative (WHC 1995a, c, e, f, g, h, j, n and Jacobs 1996). Figure 5.6.1 shows the projection of Hanford Site employment including the TWRS program as defined in the Tri-Party Agreement and the calculational baseline used for this socioeconomic analysis. An economic forecasting model then was used to project the effects of the calculational baseline of Hanford Site employment under each alternative on the Tri-Cities area nonfarm employment, taxable retail sales, population, and housing prices.

The current projection of long-term, overall Hanford Site employment showed a decline from a peak of about 19,000 in 1994 to 15,000 in 1996 (Daly 1995). From 1996 to 2001, the current projection showed staffing at 15,000. From 2001 to 2030, the projection showed a steady decline in employment, reaching a level of 8,000 by 2030. For this analysis, the same rate of decline was continued through 2040, which was the end of the forecast period for the EIS socioeconomic impact analysis. Figure 5.6.2 shows the current Hanford Site employment projection and a projection of Tri-Cities area nonfarm employment based on that forecast of Hanford Site employment.

Recent data show that the Site employment in mid-1996 was 14,100, which was lower than the 15,000 that was used in the EIS baseline forecast for this year. However, because the same future baseline forecast was used to assess the impacts of all TWRS alternatives on Tri-Cites total nonfarm employment, population, taxable retail sales, and housing prices, the comparison of impacts among the TWRS alternatives would yield the same relative results. This means that the alternatives with the largest impacts on Site employment, total nonfarm employment, and population would still have the largest impacts even if a new baseline Site employment forecast were used. Likewise, the alternatives with the smallest impacts on local socioeconomic conditions under the previous baseline forecast would have the smallest impacts under a new baseline forecast.

Revisions in the descriptions and schedules of the TWRS alternatives have occurred since the Draft EIS was published. However, for all alternatives except Phase 2 of Phased Implementation, the changes would have less than a 5 percent effect on the alternative's employment levels. The modeling analysis of the Phased Implementation (Total alternative) has been revised to reflect the revised employment estimates. No additional modeling has been performed for the other alternatives for the Final EIS.

The Final EIS also includes the Ex Situ/In Situ Combination 2 alternative, which was not analyzed in detail in the Draft EIS. Although estimates of peak employment were developed for this alternative, detailed year-by-year employment data were not available, and thus no socioeconomic impact modeling was performed. The discussions in Section 5.6 of the Ex Situ/In Situ Combination 2 alternative's impacts on Tri-Cities total nonfarm employment, population, taxable retail sales, housing prices, and public services and facilities were scaled from the impact analyses of other TWRS alternatives with similar employment levels.

The projection of Tri-Cities nonfarm employment showed a decline from 1994 to 1996, then an increasing trend. The increase in regional employment at the same time as Hanford Site employment declines reflects the experience in the Tri-Cities following the shut-down of Hanford Site plutonium production operations in 1988 (Section 4.6). The projection showed an approximately 33 percent increase in nonfarm employment between its lowest point in 1996 and the year 2040. Agriculture and food processing would remain important factors in the local economy, as would the role of the Tri-Cities as a regional retail center and transportation hub.

Figure 5.6.1 Current Hanford Site Employment Projection and Calculation Baseline, 1994 to 2040

The current projection of long-term, overall Hanford Site employment showed a decline from a peak of about 19,000 in 1994 to 15,000 in 1996 (Daly 1995). From 1996 to 2001, the current projection showed staffing at 15,000. From 2001 to 2030, the projection showed a steady decline in employment, reaching a level of 8,000 by 2030. For this analysis, the same rate of decline was continued through 2040, which was the end of the forecast period for the EIS socioeconomic impact analysis. Figure 5.6.2 shows the current Hanford Site employment projection and a projection of Tri-Cities area nonfarm employment based on that forecast of Hanford Site employment.

As described previously, the calculational baseline used to analyze and compare the socioeconomic impacts of the TWRS EIS alternatives reflects these same underlying trends except that the baseline excludes TWRS remediation. As a result, the economy showed slower growth for the period 1997 to 2030, which would be the primary period of TWRS activities. After 2030, however, the calculational baseline projection for the Tri-Cities area employment merged into the current projection.

The four capsule alternatives, No Action, Onsite Disposal, Overpack and Ship, and Vitrify with Tank Waste, are not described in detail because their potential socioeconomic impacts would be small. The capsules No Action alternative showed a peak labor requirement of 10 full-time equivalent employees per year. The Onsite Disposal alternative showed a peak labor requirement of 28 full-time equivalent employees per year. The Overpack and Ship and Vitrify with Tank Waste alternatives both showed a peak labor requirement of 47 full-time equivalent employees per year (WHC 1995n). These staffing levels were too small to have any measurable effect on economic conditions in the Tri-Cities and are not described further in this section.

5.6.1.1 Hanford Site Employment

Figures 5.6.3, 5.6.4, and 5.6.5 and Tables 5.6.1, 5.6.2, and 5.6.3 present total Hanford Site employment for the calculational baseline projection and each of the tank waste alternatives. All of the tank waste alternatives, except No Action and Long-Term Management, included employment estimates associated with the closure scenario. In all cases, closure-related employment would represent a small fraction of the total Hanford Site employment (less than 2 percent). Typically, closure activities would begin during the final phases of remediation activities. For all alternatives involving closure, peak employment impacts would occur during the construction and remediation phases of the alternative, and therefore closure employment would not appreciably affect the impacts described in the remainder of this section. The following text summarizes the impacts of each tank waste alternative on Hanford Site employment.

No Action Alternative (Tank Waste)

Under the No Action alternative, routine operations would be maintained at approximately their current level with approximately 1,000 employees during the 100-year institutional control period. Hanford Site employment under this alternative would begin to diverge from and exceed the baseline in 2006 because routine tank farm operations would begin to decline at that time in the calculational baseline. By 2030, when routine operations were fully phased out in the baseline, the No Action alternative would have about 1,000 employees more than the baseline.

Figure 5.6.3 Hanford Site Employment Baseline, No Action, Long-Term Management, In Situ Fill and Cap Alternatives for Selected Years

Figure 5.6.4 Hanford Site Employment Baseline, In Situ Vitrification, Ex Situ Intermediate Separations, and Ex Situ No Separations Alternatives for Selected Years

Figure 5.6.5 Hanford Employment Baseline, Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1, and Phased Implementation Alternatives for Selected Years

Table 5.6.1 Hanford Site Employment Changes from the Baseline for Selected Years with No Action, Long-Term Management, and In Situ and Fill and Cap Alternatives

Long-Term Management Alternative

In terms of Site employment, the Long-Term Management alternative would be the same as the No Action alternative, except that replacement DSTs would be constructed between the years 2031 and 2037. Constructing the new tanks would add approximately 350 additional employees to the level of employment shown for the No Action alternative. This would be about 1,350 more employees than in the baseline during the 2030's.

In Situ Fill and Cap Alternative

Employment under this alternative would peak at 150 workers in 2001 during remediation activities and continue at nearly that level until 2012 when the remediation phase would end. For closure activities under the In Situ Fill and Cap alternative, employment would never exceed 150 jobs in any single year and would have a maximum impact on Hanford Site employment of less than 2 percent.

Table 5.6.2 Hanford Site Employment Changes from the Baseline for Selected Years with In Situ Vitrification, Ex Situ Intermediate Separations, and Ex Situ No Separations Alternatives

In Situ Vitrification Alternative

Under the In Situ Vitrification alternative, the greatest onsite employment impact would occur during remediation in 2004, when there would be 2,600 more workers employed at the Hanford Site or about 19 percent more workers above the baseline level. When the remediation phase ended in 2016, employment under this alternative would be below 1,000 workers. Closure activities would begin in 2016 and end in 2020. The year 2020 shows a reduction in Hanford

Site employment that would be below the baseline level. This would be caused by the faster phase-out of routine tank farm operations compared to the baseline because routine operations would cease when all waste in a given tank farm was vitrified. The in situ vitrification activities, including closure, would be completed by 2033 except for monitoring and maintenance.

Ex Situ Intermediate Separations Alternative

The Ex Situ Intermediate Separations alternative would have its greatest impact on Hanford Site employment during the remediation phase of the alternative in 2002, when total Site employment was estimated to be about 4,000 above the calculational baseline; a 29 percent increase. These initial increases would result from construction employment. There would be a second increase in employment in 2009 when full waste processing would begin.

Table 5.6.3 Hanford Site Employment Changes from the Baseline for Selected Years with Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1 , and Phased Implementation Alternatives [1]

The greatest percentage change would occur in 2015, where the percentage change would be 47 percent and when the alternative's total employment would be about 3,800. The greater percentage change in 2015 would be caused by the decline in overall Hanford Site employment in the calculational baseline scenario, which would make the smaller number of TWRS employees a larger percentage of the baseline. This same paradox of large percentage would impact in later years, because TWRS employment would impact a smaller base of total Hanford Site employment, which would apply to the Ex Situ No Separations and Ex Situ Extensive Separations alternatives as well.

Overall employment under the alternative would decline substantially from 2015 to 2024 as remedial construction and waste processing began to phase out. Remediation would end in 2028. Closure activities would begin in 2010 and end in 2034. During the early phase of closure, less than 5 percent of the workers would result from closure activities, and the highest level of employment would reach 90 workers in 2031.

Ex Situ No Separations Alternative

Analysis of the Ex Situ No Separations alternative showed a substantial increase in Hanford Site employment compared to the calculational baseline between 1996 and about 2018. There would be an employment spike (a short-term increase that dropped off rapidly after the peak year) between 1996 and 2003 because of construction employment. The largest impact under this alternative would occur during construction in 2000, when there would be over 4,400 more Hanford Site employees than in the baseline, a difference of approximately 30 percent. Remediation would end in 2017. Closure activities would have a peak employment of 510 in 2018.

Ex Situ Extensive Separations Alternative

The Ex Situ Extensive Separations alternative shows an initial spike in Hanford Site employment in 1998, then a second, larger spike that would peak in 2003. Both of these spikes would be attributable to construction employment. The largest percentage impact of the alternative would occur in 2003 during construction, when Hanford Site employment would be almost 50 percent above the calculational baseline, a difference of approximately 6,700 jobs. The 1998 and 2003 spikes in the projections of Hanford Site employment under this alternative would result in a boom-bust pattern that could have adverse impacts on the local economy and public services. Remedial activities would end in 2024, with closure activities beginning in 2010, and would end in 2030. Peak closure-related employment would be 370 jobs in 2023.

Ex Situ/In Situ Combination 1 Alternative

Under this alternative, Hanford Site employment would peak at about 16,800 employees in 2001, which would be 17.0 percent higher than the calculational baseline. Employment would remain at about 17 percent (more than 2,200 employees) above the baseline through 2004. Activities under this alternative would contribute approximately 2,000 employees to the total Hanford Site workforce until 2018. Remediation activities would end in 2023 with closure beginning in 2010 and ending in 2034. Peak employment during closure would reach 390 employees in 2024.

Ex Situ/In Situ Combination 2 Alternative

Employment under this alternative would peak in 2001 with total Hanford Site employment of approximately 16,600, which would be 15.3 percent higher than the calculational baseline. From the years 2009 to 2018, during the alternative's peak operations phase, the Ex Situ/In Situ Combination 2 alternative would add approximately 750 workers to the Site's workforce.

Phased Implementation Alternative

Phase 1

The Phased Implementation alternative was analyzed in two parts. Part one analyzed Phase 1 of the Phased Implementation alternative and part two analyzed the total Phased Implementation alternative.

The Phased Implementation alternative would cause a large increase in Hanford Site employment compared to the calculational baseline between 1997 and 2001. This increase would result from constructing the waste treatment facilities associated with the alternative. During the alternative's operation phase, Site employment would exceed the baseline by approximately 4 to 5 percent or about 550 workers. There would be no impacts after 2013 because all activities, including decommissioning and decontamination, would have been completed.

Total Alternative

Hanford Site employment for the Phased Implementation alternative would include the employment discussed for Phase 1 of the alternative through 2003 and Phase 2, which would start in 2004. Construction of the Phase 2 treatment facilities would begin in 2005. The additional Hanford Site employment in the Phased Implementation total alternative would peak in 2010, with about 6,700 additional workers, which would be an approximate 65 percent increase over the calculational baseline. Site employment would remain over 40 percent above the baseline during the period of full-scale operations. Operations would begin to decline in 2024 , followed by a period of decommissioning and decontamination activities ending about 2030. Closure and management and maintenance activities would continue through 2040, accounting for a small continued increase in employment above the baseline. Employment associated with closure would peak in 2023 at about 1,600 jobs.

5.6.1.2 Tri-Cities Area Employment

Changes in Hanford Site employment would be the primary source of socioeconomic impacts on the Tri-Cities for all the tank waste alternatives. These impacts would be driven by the changes in the area's nonfarm employment caused by changes in Site employment. Nonfarm employment included all employment in the Tri-Cities except for permanent and migratory farm workers. Nonfarm employment included food processing, which is classified in government statistics as a type of manufacturing. Farm workers were excluded from the impact analysis because farm employment would not be affected by Hanford Site employment.

Tables 5.6.4, 5.6.5, and 5.6.6 show Tri-Cities nonfarm employment for each tank waste alternative for the years 1994 through 2040. The following text summarizes the potential impacts of each tank waste alternative on Tri-Cities nonfarm employment.

No Action Alternative (Tank Waste)

Under the No Action alternative, Tri-Cities area nonfarm employment would track the baseline through 2005, then increase through the end of the forecast period in 2040. This reflects the continuation of routine operations at the tank farms under the No Action alternative. By 2040, Hanford Site employment would be about 1,000 employees above the baseline, which would translate to a 2 percent increase (1,600 jobs) in nonfarm employment in the local economy.

Long-Term Management Alternative

Under this alternative, Hanford Site employment would be the same as the No Action alternative until 2031, when replacement DSTs tanks would be constructed. The new tank construction would increase Site employment, which would result in an increase of about 2.5 percent (2,200 jobs) in local employment during the tank construction period. By the year 2040, however, when the retanking was completed, Tri-Cities nonfarm employment would fall back to the same level as in the No Action alternative.

Table 5.6.4 Nonfarm Employment in the Tri-Cities - Changes from the Baseline for Selected Years with No Action, Long-Term Management, and In Situ Fill and Cap Alternatives

In Situ Fill and Cap Alternative

Under the In Situ Fill and Cap alternative, nonfarm employment impacts would peak in the year 2000 at approximately 320 jobs over the baseline, a difference of 0.5 percent. Nonfarm employment would stay slightly over the baseline until 2020.

Ex Situ No Separations Alternative

The impacts of the No Separations alternative on area nonfarm employment would peak in 1999 and 2000, when employment would be 10 to over 11 percent higher (over 7,400 jobs) than the calculational baseline. The higher employment would fall off by 2003, then peak again in 2005 at 8 percent (5,700 jobs) above the baseline. By 2020, nonfarm employment impacts of the alternative would correspond to the baseline.

Table 5.6.5 Nonfarm Employment in the Tri-Cities - Changes from the Baseline for Selected Years with In Situ Vitrification, Ex Situ Intermediate Separations, and Ex Situ No Separations Alternatives

In Situ Vitrification Alternative

For the In Situ Vitrification alternative, a large increase in area nonfarm employment would occur from 2000 to 2007. Employment then would decline relative to the calculational baseline. By 2017, nonfarm employment with this alternative would fall below the baseline and remain below the baseline through 2029. This would reflect lower Hanford Site employment under the In Situ Vitrification alternative caused by the faster phase-out of routine tank farm operations compared to the baseline. In the peak impact year (2000), there would be over 4,300 more nonfarm jobs compared to the calculational baseline, an increase of approximately 6.2 percent.

Ex Situ Intermediate Separations Alternative

The Ex Situ Intermediate Separations alternative would result in nonfarm employment above the calculational baseline from 1996 through 2030. Implementing this alternative would result in two large increases in employment compared to the baseline. The first, with a peak in 2000, would occur when the alternative's employment peaked during the construction of the waste retrieval and treatment facilities. At this peak, there would be about 6,700 more jobs, an increase of 9.6 percent over the baseline. The second increase, beginning about 2009, would occur during the peak of the alternative's operation phase when employment would be about 6,300, or 8.8 percent over the baseline.

Table 5.6.6 Nonfarm Employment in the Tri-Cities - Changes from the Baseline for Selected Years with Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1 , and Phased Implementation Alternatives

Ex Situ Extensive Separations Alternative

Analysis of the Ex Situ Extensive Separations alternative showed a spike in nonfarm employment compared to the calculational baseline in 1997 and 1998. In 1998, there would be 8.6 percent (5,900 jobs) more nonfarm jobs in the area than would exist for the baseline conditions. By 2000, the level of increase in nonfarm jobs would fall to 2.9 percent over the baseline. Nonfarm employment then would spike again compared to the baseline, peaking at 17.2 (12,200 jobs) percent above the baseline in 2003. Employment then would begin to fall back to the baseline, and by 2020 would be only 2.2 percent higher than the baseline.

Ex Situ/In Situ Combination 1 Alternative

This alternative would have its greatest impacts on Tri-Cities nonfarm employment in 2000 and 2001, when nonfarm employment would be 5.8 percent (4,100 jobs) above the calculational baseline.

Tri-Cities nonfarm employment under this alternative would remain above the baseline through 2030.

Ex Situ/In Situ Combination 2 Alternative

This alternative would be expected to have its peak impacts on total nonfarm employment in approximately 2001. In that year, nonfarm employment would be about 5.1 percent (3,600 jobs) higher than the calculational baseline. Tri-Cities nonfarm employment would remain above the baseline until about 2030.

Phased Implementation Alternative

Phase 1

The peak impact on Tri-Cities employment under this alternative would occur in 1999, when area employment would be 8.4 percent (5,900 jobs) above the calculational baseline. There would be a dip in employment in 2002 after the completion of the construction phase, caused by the loss of several thousand construction jobs.

Total Alternative

The employment impacts on the Tri-Cities showed two peaks for the total Phased Implementation alternative. Employment under the total alternative tracked the impacts of Phase 1 through 2003, with a peak of more than 8 percent in 1999. Beginning in 2004, the increased Hanford Site employment under the Phased Implementation total alternative would result in a second increase in area employment. The maximum impact would occur in 2010, with a 15.4 percent increase in employment over the calculational baseline, or about 11,000 additional jobs. Employment would remain well above the baseline through 2025 , then converge to the calculational baseline over the next 5 years as the Phased Implementation alternative was completed and decommissioning and decontamination and closure activities was finished.

5.6.1.3 Taxable Retail Sales

Taxable retail sales are an important indicator of economic impacts. The data on taxable retail sales used in this analysis, as reported by Washington State, included services, building contracting, manufacturing, wholesaling, and other industries in addition to sales by retail stores. These data are representative of aggregate economic activity in the Tri-Cities area.

Table 5.6.7 shows the taxable retail sales impacts of the various alternatives. For all tank waste alternatives except No Action, Long-Term Management, and In Situ Fill and Cap, there would be a large increase in taxable retail sales from current levels between 1999 and 2040. This result would be consistent with the experience in the Tri-Cities during the economic downturn of 1988 and 1989, when retail sales continued to increase despite employment reductions at the Hanford Site (Section 4.5). The projected retail sales growth would be equivalent to an approximate 3.5 percent average annual rate of growth from current levels. However, the data used to estimate the forecasting equation for retail sales were not corrected for inflation so that much of the apparent growth in retail sales could be accounted for by inflation.

One important implication of the increase in taxable retail sales would be that cities and counties would receive increased revenues from their share of sales taxes. Increases in sales tax revenues from higher employment would help finance the increased services needed for the increased population that would follow increased employment. Population impacts are described in Section 5.6.1.2.

The maximum impact under the tank waste No Action alternative would occur between 2025 and 2035 when taxable sales would be approximately 0.6 percent above the baseline. The largest impact under the Long-Term Management alternative would occur in 2035, when sales would be approximately 0.8 percent above the calculational baseline. The taxable retail sales impacts of the In Situ Fill and Cap alternative would be small, peaking at approximately $3 million in 2022. The maximum impact under the In Situ Vitrification alternative would occur in 2002, with retail sales 4.5 percent higher than the baseline.

Table 5.6.7 Taxable Retail Sales in the Tri-Cities - Changes from the Baseline for Selected Years

In 2002, retail sales in the Ex Situ Intermediate Separations alternative would be 7.3 percent above the baseline. The Ex Situ No Separations alternative would have its peak impact on retail sales in 2000, when sales would be 8.7 percent above the baseline. The Ex Situ Extensive Separations alternative's retail sales impacts would peak in 2004, when sales would be 10.8 percent above the baseline. The Ex Situ/In Situ Combination 1 alternative's impacts would peak in 2001 at 4.4 percent above the baseline , while the Ex Situ/In Situ Combination 2 alternative's impacts would peak in the same year at about the same level . Under the Phased Implementation alternative, the maximum impact would be 6.6 percent in 2000 during Phase 1, with another peak in 2011 of 7.6 percent.

For all tank waste alternatives, the pattern of the impacts closely followed the impacts on nonfarm employment, especially with respect to the timing of the divergence from the baseline. Taxable retail sales would exceed those of the baseline when nonfarm employment under the alternative exceeded baseline employment. The main difference is that the impacts of the alternative on taxable retail sales would be smaller (in terms of percent changes) than their impacts on nonfarm employment.

5.6.1.4 Employment Impacts by Ethnic Group

The analysis of employment impacts by ethnic group focused on Hanford Site employment. The breakdown of Hanford Site Management and Operations contractor employment by occupational category and minority group as of November 1994 showed that African Americans, Asians, and Native Americans account for the same or higher percentage of the Management and Operations contractor workforce than the group's proportion to the total labor force in the Tri-Cities area (Pitcher 1994). Hispanics, however, accounted for about 4 percent of the Site work force, compared to 11.4 percent of the total labor force in the Tri-Cities. Therefore, the analysis of employment impacts of the EIS alternatives by ethnic group focused on Hispanic employment. Assuming that the proportions of Hispanic workers in the different occupational categories at the Site Management and Operations contractor remained constant, it would be possible to estimate the employment impact of different EIS alternatives on the Hanford Site's Hispanic labor force.

Hispanics currently are underrepresented in the Tri-Cities construction labor force. Data show that Hispanics account for about 2.5 percent of the construction workers in Benton and Franklin Counties, while the Hispanic origin category in the 1990 census represents about 13 percent of the two counties' population. The estimates of the Hispanic construction workers under the EIS alternatives assumed that Hispanics' participation in the local construction trades remained at current levels. Table 5.6.8 shows estimated Hispanic employment under the various EIS alternatives during both construction and operation phases.

Table 5.6.8 Estimated Employment Impacts on the Tri-Cities Hispanic Labor Force of EIS Alternatives [1]

5.6.2 Population and Housing

Changes in employment and economic activity would cause changes in population, which in turn would have impacts on housing and the demand for public facilities and services. This section describes population and housing. Public facilities and services impacts are described in Section 5.6.3.

5.6.2.1 Population

Table 5.6.9 provides population projections for the Tri-Cities for the calculational baseline and population projections based on implementing the tank waste alternatives. While the time paths of the population projections closely track the time paths of the corresponding nonfarm employment projections, there are two differences. First, the population projections lag behind employment projections by one year. For example, employment impacts would peak under the

Ex Situ Intermediate Separations alternative in the year 2000, while the population impacts would peak in 2001. Based on the historical experience of the Tri-Cities (Section 4.6), population changes lag behind changes in employment. This tendency was reflected in the forecasting model used for this analysis. Second, the impacts of each EIS alternative in terms of percentage changes from the calculational baseline would be smaller for population changes than for employment changes. The following text summarizes the potential impacts on the Tri-Cities population under each tank waste alternative.

Table 5.6.9 Population Changes in the Tri-Cities from the Baseline for Selected Years

No Action Alternative (Tank Waste)

Under the No Action alternative, population would exceed the baseline by about 2,400 persons or 1.2 percent by 2035.

Long-Term Management Alternative

Under the Long-Term Management alternative, population change would peak at 1.6 percent in 2035. The population difference between this alternative and the calculational baseline projection in 2035 would be approximately 3,200.

In Situ Fill and Cap Alternative

Under this alternative, peak impacts on Tri-Cities population would occur in 2001 at approximately 460 people (0.3 percent) over the calculational baseline.

In Situ Vitrification Alternative

The In Situ Vitrification alternative would have its peak population impact in 2001, with approximately 6,300 more people than in the baseline projection. This would represent a 3.8 percent change from the baseline.

Ex Situ Intermediate Separations Alternative

For the Ex Situ Intermediate Separations alternative, the maximum change in population would occur in 2001, when population would be 9,900 above the calculational baseline, a difference of 5.9 percent. By 2020, the population changes compared to the baseline would be 2,900 (1.6 percent).

Ex Situ No Separations Alternative

The Ex Situ No Separations alternative would result in a population increase over the calculational baseline beginning in 1997. The maximum impact under this alternative would occur in 2000, when population would be 11,700 over the baseline, an increase of 7 percent. By 2020, the population impact would be approximately 380 (0.2 percent).

Ex Situ Extensive Separations Alternative

The Extensive Separations alternative would result in a spike in population peaking in 1999 and a second spike peaking in 2004. Each spike in population would be followed by a large drop in population, especially the spike in 2004. The peak impact in 2004 would result in a population 17,800 (10.5 percent) above the baseline. However, by 2005 the increase would be down to 11,300 or 6.6 percent. Population impacts would continue until 2025 when they would be approximately 1,700 people (0.9 percent) over the baseline. The population spikes with the Ex Situ Extensive Separations alternative could result in potential adverse socioeconomic impacts on the Tri-Cities because of the short-term demands on housing and public facilities caused by large numbers of construction workers moving into the area for a limited time.

Ex Situ/In Situ Combination 1 Alternative

Under this alternative, peak impacts on Tri-Cities population would occur in 2001, when population would be 6,000 people (3.6 percent) above the calculational baseline. Population would remain between 3 and 3.5 percent above the baseline until 2015.

Ex Situ/In Situ Combination 2 Alternative

Under this alternative, peak impacts on Tri-Cities population would occur in 2001 or 2002 when population would be about 5,300 (3.2 percent) above the baseline. From approximately 2010 to 2019, population levels in the Tri-Cities would be about 2,000 (slightly over 1 percent) above the baseline.

Phased Implementation Alternative

Phase 1

The peak impact under Phase 1 of the Phased Implementation alternative on population would occur in 2000, with an increase of 8,600 people (5.1 percent) above the calculational baseline. After construction was completed in 2001, employment would decline and population growth would begin to decline in 2003. After Phase 1 was completed in 2013, employment and population would decline.

Total Alternative

Population under the Phased Implementation alternative would follow the changes resulting from Phase 1 through 2003, with a peak of 5.1 percent above the calculational baseline in 2000, followed by a decline through 2003. However, from 2004 the higher levels of employment resulting from Phase 2 implementation would cause higher population levels. The peak impact would occur in 2011, with 16,100 additional persons, or about 9.3 percent more than the calculational baseline. This would result in a boom-bust pattern, which could have impacts on housing and public facilities.

5.6.2.2 Housing Prices

Table 5.6.10 shows projected average home prices for the calculational baseline and prices that would result from the various alternatives. These projections closely matched the projections of nonfarm employment in timing and direction. However, while population projections for the tank waste alternatives showed smaller impacts than in the projections of nonfarm employment, the projections for average home prices showed larger impacts.

The baseline projection showed housing prices in the Tri-Cities rising steadily from 1997 through 2040. All tank waste alternatives would result in consistent increases in housing prices, although there would be fluctuations in prices with all tank waste alternatives except for No Action and Long-Term Management. These housing price fluctuations reflected the fluctuations in Tri-Cities area nonfarm employment that would be caused by implementing these alternatives.

In some years under the In Situ Vitrification alternative and the various ex situ alternatives, average housing prices would decline at the same time as total Hanford Site employment and total Tri-Cities nonfarm employment declines. However, these declines would be from projected average prices the proceeding year. In all cases, housing prices would be higher than they would be in that year under the baseline scenario. The following text summarizes the potential impacts on housing prices in the Tri-Cities under each tank waste alternative.

Table 5.6.10 Average Home Price Changes ($ Thousands) in the Tri-Cities from the Baseline for Selected Years

No Action Alternative (Tank Waste)

The No Action alternative would have no impact on housing prices until approximately 2010. The impacts would peak in 2025 and for the following decade when average housing prices would be $4,000 over the calculational baseline, a difference of over 2 percent.

Long-Term Management Alternative

Housing prices under this alternative would be the same as under the No Action alternative, except for slightly higher prices in the 2030's, when replacement tanks would be constructed. In those years, housing prices would be approximately $5,000 over the baseline, a difference of almost 3 percent.

In Situ Fill and Cap Alternative

The In Situ Fill and Cap alternative would have minor impacts on housing prices because of its small impact on employment and population.

In Situ Vitrification Alternative

Under the In Situ Vitrification alternative, housing prices would increase above the baseline levels from 1999 until nearly 2010. Impacts would peak in 2001 when average prices would be $11,000 (9.3 percent) over the calculational baseline. There then would be several years of modest declines in housing prices from the preceding year, although prices still would exceed the baseline.

Ex Situ Intermediate Separations Alternative

The Ex Situ Intermediate Separations alternative would lead to increases in the average housing prices from 1997 through 2020. The peak impact year would be 2001, when average prices would be $16,000 (14.5 percent) above the calculational baseline. There would be housing price declines from the proceeding year between 2005 and 2008 and again in 2020, reflecting declines in Hanford Site and Tri-Cities total employment.

Ex Situ No Separations Alternative

The Ex Situ No Separations alternative would have impacts on housing prices between approximately 1998 and 2020. The maximum impact would be in the year 2000, with average home prices exceeding the baseline by $19,000 (17.5 percent). There would be a decline in housing prices (compared to the previous year, not compared to the baseline) in 2004, followed by a resumption in housing price growth in 2005.

Ex Situ Extensive Separations Alternative

The Ex Situ Extensive Separations alternative would show a peak in housing prices in 1999 with average housing prices exceeding the baseline by $14,000 (13.3 percent), then dropping and peaking again to reach an even higher peak in 2004, with prices $30,000 (25.1 percent) above the baseline.

Ex Situ/In Situ Combination 1 Alternative

Under this alternative, housing prices would exceed the calculational baseline from 1996 until 2030. In the 2001 peak year, housing prices would be $10,000 (8.8 percent) above the baseline.

Ex Situ/In Situ Combination 2 Alternative

Under this alternative, housing prices would show a peak increase over baseline levels in 2001 or 2002. In the peak year, housing prices would be approximately 8 percent higher than the baseline.

Phased Implementation Alternative

Phase 1

Housing prices would reflect changes in employment under Phase 1 of the Phased Implementation alternative. The peak impact would occur in 2000, when the average home price would be $14,000 above the calculational baseline, a difference of 12.9 percent.

Total Alternative

Housing prices reflected the pattern in employment under the Phased Implementation alternative, with prices tracking prices in Phase 1 and peaking in 2000 at 13 percent above the calculational baseline, then falling through 2003. Prices would start rising again in 2004 with the implementation of Phase 2, with a second higher peak in 201 0 , when the average price would be $22,000 (19.9 percent) above the baseline.

5.6.2.3 Impacts of Higher Housing Prices

Higher housing prices that would be related to the various ex situ alternatives, the Ex Situ/In Situ Combination 1 and 2 alternatives, and the In Situ Vitrification alternative could have a negative impact on home buyers in the Tri-Cities area. Young families, low-income families, and first-time home buyers could be adversely affected by the higher prices and might find it difficult to buy a house. This could also affect families moving into the Tri-Cities area to work. Higher housing prices could make it harder for employers to attract new workers to the region.

The Ex Situ Extensive Separations alternative and, to a lesser extent, the Ex Situ No Separations alternative would have impacts that reflect the boom-bust pattern in Hanford Site and total Tri-Cities nonfarm employment that could cause adverse impacts on the housing market. The potential problems would be caused not so much by the size of the price increases, but by the fact that the price increases would result from the large number of construction workers involved in relatively short-term but labor-intensive projects. The Ex Situ Intermediate Separations alternative also would lead to considerable housing price increases, but would not have the same level of boom-bust impacts as the other two ex situ alternatives.

The sharp increases in housing prices in some years under the Ex Situ Extensive Separations and Ex Situ No Separations alternatives would make it more difficult for lower-income residents to purchase homes, while the sharp declines in housing prices might adversely affect existing home owners. Permanent residents moving into the area at the peak of one of these spikes may have to pay higher prices for housing, and then see the prices of their homes drop after the peak. This could be a serious loss for many families for whom their home is their major asset. Over time, average home prices would rise, as in the baseline, but stable housing prices would make it easier for families to plan their future and reduce the potential for loss if the family needed to sell its home on short notice.

At the same time, the higher housing prices would be caused by higher levels of employment associated with the tank waste alternatives. Therefore, while higher prices could adversely affect young families and low-income families, the greater employment opportunities would benefit these same families. In addition, higher housing prices would benefit current homeowners, especially if they were selling their homes.

5.6.2.4 Rental Housing Prices (All Alternatives)

Rental housing would show price increases consistent with single-family home prices. Higher employment levels would increase the demand for rental units, thus raising rates. Unless new rental construction was sufficient to keep prices down, rents would increase. Because many renters are young or lower-income families or individuals, they would be adversely affected. Although in many cases, these adverse impacts could be offset by increased employment opportunities. While this is a common situation in any growing economy, the impacts could be more severe in an area like the Tri-Cities where the total supply of rental housing is smaller than in a large, metropolitan area.

5.6.2.5 Housing Starts

The projected increases in housing prices for the various alternatives might stimulate new housing construction in the Tri-Cities. The level and timing of any additional housing construction would depend in part on the size, timing, and expected duration of the employment and population growth associated with individual alternatives. The Ex Situ Extensive Separations, Ex Situ No Separations, Ex Situ Intermediate Separations, and the Phased Implementation alternatives could have the largest impact on housing starts because of their associated levels of employment and population growth.

5.6.3 Public Facilities and Services

This section describes the impacts of the various EIS alternatives on public facilities and services in the Tri-Cities area. The most important driving forces for impacts on public facilities and services were 1) changes in population, which create changed levels of demand on the agencies and facilities providing these services; and 2) changes in the local economy, which cause population changes and generate the local tax revenues that fund public services.

Sharp upturns or downturns in a local economy, coupled with fluctuations in the population base, can strain the ability of agencies to meet service requirements in a timely manner. The Tri-Cities area has faced such problems in the past, in large part because of cycles of growth and decline at the Hanford Site. The rapid growth at the Hanford Site from the late 1980's to 1994 led to population growth that strained public services, particularly local school districts. The ongoing and expected reductions in budgets and employment at the Hanford Site likely will ease some of the problems related to continuing rapid growth in the area. However, losses to the local economic base from Hanford Site cutbacks also will impact the vitality of the local economy and public service systems. In addition, not all workers who may be drawn to the Tri-Cities to work on the relatively short-term TWRS construction activities would bring their families to the area, thus reducing the demand on public services and facilities. Table 5.6.11 summarizes the EIS alternatives' impacts on local public facilities and services.

Current baseline population forecasts for the Tri-Cities area (without implementing any of the EIS alternatives) showed relatively slow growth through 2040 (Section 5.6.2). This projected population growth rate was well below recent levels of increase and reflected the expected long-term decline in Hanford Site employment.

5.6.3.1 Public Safety

Increases in population that would result from the alternatives would place additional demands on public safety services provided by local jurisdictions.

Table 5.6.11 Impacts on Public Facilities and Services in the Tri-Cities Area

Long-Term Management Alternative

Impacts under the Long-Term Management alternative would be the same as under the No Action alternative. Local police departments each would require one additional officer in Pasco, Richland, Kennewick, and Benton County. Local fire departments would not require additional staff.

No Action Alternative

Under the No Action alternative, to maintain existing service levels (based on officers per population of 1,000), the police departments of Pasco, Richland, and Kennewick, and the Benton County Sheriff's Department each would require one additional officer during the 2025 to 2040 period compared to baseline levels (Table 5.6.11). Local fire departments would not require any additional staffing under this alternative. The alternative would not result in the need for new public safety facilities (e.g., police or fire stations).

In Situ Fill and Cap Alternative

The In Situ Fill and Cap alternative would involve little population growth, and thus no additional police or fire department personnel or facilities would be required.

In Situ Vitrification Alternative

Under the In Situ Vitrification alternative, for local agencies to maintain existing service levels (officers per population of 1,000), an additional two to three officers each over baseline levels would be required by the Richland, Kennewick, and Pasco police departments and the Benton County Sheriff's Department in the peak year (2001). Local fire departments also could require one to two additional personnel each. No new public safety facility requirements would be expected.

Ex Situ Intermediate Separations Alternative

Under the Ex Situ Intermediate Separations alternative, to maintain existing service levels,

the Richland, Kennewick, and Pasco police departments and the Benton County Sheriff's Department would require an additional three to four officers each over baseline levels during the 1999 to 2019 time frame. Local fire departments in Richland, Kennewick, Pasco and the Benton County Fire Department also could require two to three additional personnel each. It is unlikely that new public safety facilities (e.g., police or fire stations) would be needed, assuming that TWRS population growth was centered within established residential areas or in newly developed areas in close proximity to established areas.

Ex Situ No Separations Alternative

The Ex Situ No Separations alternative would require an additional three to four officers over baseline levels by each of the Richland, Kennewick, and Pasco police departments and the Benton County Sheriff's Department to maintain existing service levels from 1999 to 2003. Local fire departments in Richland, Kennewick, Pasco, and the Benton County Fire Department also might require two to three additional personnel each. No new public safety facilities would be required.

Ex Situ Extensive Separations Alternative

To maintain existing ratios of officers per population of 1,000, the Ex Situ Extensive Separations alternative would require as many as four to five additional police officers by each of the Richland, Kennewick, and Pasco police departments and the Benton County Sheriff's Department in the single peak year of 2004, and three to four additional officers between 2003 and 2008. Fire departments in Richland, Kennewick, Pasco and the Benton County Fire Department would need two to three additional personnel each in the 2003 to 2008 time period. No new public safety facilities would be required.

Ex Situ/In Situ Combination 1 Alternative

Under this alternative, the Richland, Kennewick, and Pasco police departments and the Benton County Sheriff's Department would each need an additional two to three officers over baseline levels to maintain current service levels in the year 2001. Local fire departments could each require one to two additional personnel. No new public safety facilities would be required.

Ex Situ/In Situ Combination 2 Alternative

Under this alternative, the Richland, Kennewick, and Pasco police departments and the Benton County Sheriff's Department would be expected to need two or three additional officers each to maintain current service levels in the peak year, which would be 2001 or 2002. Local fire departments could each require an additional one to two personnel. No new public safety facilities would be required.

Phased Implementation Alternative

Phase 1

This alternative would have impacts similar to the Ex Situ Intermediate Separations alternative in terms of additional public safety services needs. To maintain current services levels, the Richland, Kennewick, and Pasco police departments and the Benton County Sheriff's Department would require an additional three to four officers each over baseline levels. The peak requirement would occur from 1999 to 2001, with a smaller requirement of perhaps one additional officer in each jurisdiction from 2002 to 2013. Local fire departments also could require two to three additional personnel each.

Total Alternative

The Phased Implementation alternative, when fully implemented, would involve the impacts detailed for Phase 1 as well as impacts associated with the second phase of the alternative. Peak requirements for police and fire services under Phase 2 would occur in 2011 when Richland, Kennewick, and Pasco police departments and the Benton County Sheriff's Department would require four to five officers over baseline levels. The local fire departments would also require four to five additional personnel.

Capsule Alternatives

None of the cesium and strontium capsule alternatives would require new public safety personnel or facilities. This is because employment and resulting population growth for the capsule alternatives would be small.

5.6.3.2 Medical Services

The projected population increase associated with the various EIS alternatives (as much as 10.5 percent over baseline levels in the peak year) would create additional demands on the facilities and services provided by the area's three major hospitals. However, these hospitals currently are operating at between 35 and 50 percent capacity (Cushing 1995). Although some additional staffing might be required to handle the potential increase in admissions, the existing facilities should be able to accommodate the impacts associated with all alternatives -- given current use rates and the moderate expected baseline growth. The supply of medical personnel (e.g., physicians) currently is adequate, and no major problems would be expected in accommodating growth as a result of implementing any of the EIS alternatives.

5.6.3.3 Schools

Local schools in the Kennewick, Richland, Pasco, and Kiona-Benton school districts all are operating at or near their capacities in 1995 (Section 4.6). Although the pace of enrollment growth over the next few years could slow somewhat as Hanford Site employment declines and associated population growth rates decline (particularly in the Richland school district), current capacity problems need to be addressed. School district enrollment grew by an average of 1.2 percent in the 1995 to 1996 school year even though Hanford Site employment declined in 1995. In all cases, the severity of impacts related to increased school enrollment would be partially dependent on the various school districts resolving existing capacity issues. Table 5.6.11 provides data on estimated school enrollment impacts of the EIS alternatives.

No Action Alternative

Under the No Action alternative, population increases compared to baseline levels would be relatively minor up to the year 2025. In 2025, increases in enrollments would be approximately 1.2 percent over projected baseline enrollments. Because of the long planning horizon and the relatively minor enrollment increases (670 students), these additional students should be accommodated fairly easily.

Long-Term Management Alternative

Under the Long-Term Management alternative, impacts on school enrollment would be similar to the No Action alternative. By the year 2035, enrollment would be approximately 1.6 percent over projected baseline enrollments. Because of the relatively minor increases (900 students), the impacts should be accommodated fairly easily.

In Situ Vitrification Alternative

The In Situ Vitrification alternative would have its most substantial school enrollment increase compared to baseline levels between 2000 and 2008, with the peak year occurring in 2001. In 2001, assuming that the school growth was distributed proportionally among the school districts, area school enrollment would increase over calculational baseline levels by the following amounts: Kennewick 760; Richland 500; Pasco 450; and Kiona-Benton 90. These would represent enrollment increases of 3.8 percent over calculational baseline levels.

In Situ Fill and Cap Alternative

The In Situ Fill and Cap alternative would involve additional school enrollments of less than one-half of 1 percent (140 students) over baseline levels. This increase should be accommodated fairly easily.

Ex Situ Intermediate Separations Alternative

With the Ex Situ Intermediate Separations alternative, substantial school enrollment increases would occur between 1999 and 2019, with the peak year occurring in 2002. In the peak year, area school enrollment would increase over calculational baseline levels by the following amounts: Kennewick 1,200; Richland 780; Pasco 700; and Kiona-Benton 140. This would represent an increase of 5.9 percent over baseline levels.

Ex Situ No Separations Alternative

The Ex Situ No Separations alternative would involve substantial school enrollment increases in the 1999 to 2003 time frame, peaking in 2000. In 2000, area school enrollment would increase over calculational baseline levels by the following amounts: Kennewick 1,400; Richland 920; Pasco 830; and Kiona-Benton 160. This would represent increases of 7 percent over calculational baseline levels. Annual growth would continue at more moderate rates (3 to 4 percent per year higher than the baseline) until 2015.

Ex Situ Extensive Separations Alternative

The Ex Situ Extensive Separations alternative would result in an increase over the baseline of 10.5 percent and would lead to the largest school enrollment increases of all the EIS alternatives.

Enrollment would increase considerably between 2003 and 2008, peaking in 2004. In that year, area school enrollment would increase over calculational baseline levels by the following amounts:

Kennewick 2,100; Richland 1,400; Pasco 1,300; and Kiona-Benton 250. The severity of these impacts would depend in part on the district's ability to solve current capacity problems. Annual growth would remain at over 4 percent per year higher than the calculational baseline until 2015.

Ex Situ/In Situ Combination 1 Alternative

This alternative would have a peak impact on school enrollments in 2001. In that year, assuming that the school growth is distributed proportionally among the school districts, area school enrollment would increase over calculational baseline levels by the following amounts: Kennewick 720; Richland 470; Pasco 430; and Kiona-Benton 80. This growth would represent a 3.6 percent increase over calculational baseline levels.

Ex Situ/In Situ Combination 2 Alternative

Peak impacts on school population under this alternative would occur in 2001 or 2002 when there would be approximately 1,500 more students than under baseline conditions. Assuming that the growth was distributed proportionately among the area school districts, school enrollments would be over calculational baseline levels by approximately the following amounts: Kennewick 640, Richland 410, Pasco 380, and Kiona-Benton 70.

Phased Implementation Alternative

Phase 1

Phase 1 impacts on school enrollment would peak in 1999. In that year, area school enrollment would increase over calculational baseline levels by the following amounts: Kennewick 1,000; Richland 680; Pasco 610; and Kiona-Benton 120. This would represent a 5.1 percent increase over calculational baseline levels.

Total Alternative

The Phased Implementation alternative, when fully implemented, would involve the impacts detailed for Phase 1 as well as impacts associated with the second phase of the alternative. Peak impact on school enrollments would occur in

2011 when 4,600 new students would be enrolled in the four school districts. This growth would represent a 9.3 percent increase over baseline levels distributed as follows: Kennewick 1,900 ; Richland 1,300 ; Pasco 1,200 ; and Kiona-Benton 230 .

5.6.3.4 Electricity, Natural Gas, and Fuel Oil

For all TWRS alternatives, construction, operation, and project-related population growth would result in an increased demand for electricity. Domestic electrical demand would be expected to directly reflect the population growth associated with each alternative, which could peak at over 10 percent above baseline levels in 2001 to 2002 under the Ex Situ Extensive Separations alternative. For all alternatives that involved waste vitrification, operation phase electrical demands would be more substantial than the population growth incremental demand, but would peak later than the population demand. This is because waste vitrification is an electrical power-intensive operation.

The incremental electrical demand of all the vitrification alternatives (up to over 320 megawatts [MW]) would be a substantial increase over the 1994 estimated Hanford Site electrical requirement of approximately 57 MW. However, this demand still would be less than Site electrical usage in the late 1980's, when average Site requirements were approximately 550 MW (Cushing 1994). The Site has the electrical power infrastructure required by the TWRS alternatives' without major modifications other than new powerlines (mostly for the In Situ Vitrification alternative) and an additional electrical substation in the 200 Areas.

The incremental demand under all EIS alternatives would be no more than 1.5 percent of the Pacific Northwest electrical generation system's guaranteed energy supply capacity. Additional hydroelectric generating capacity, which is the primary electrical power source in the region, is being constructed in the region, and there are proposals being considered by various utilities in the region to construct natural gas-fired power plants. Currently, the Pacific Northwest has a surplus of electrical generating capacity.

Natural gas is a minor energy source in the Tri-Cities area, and incremental consumption related to population growth under any alternative would have negligible impacts. The operation phase of the EIS alternatives also would require up to 38,000 L/day (10,000 gal/day) of fuel oil. No substantial impacts on local supply or distribution systems would be expected from this level of demand.

5.6.3.5 Sanitary Waste Disposal

Under all EIS alternatives, project-induced population growth would increase demands on local municipal wastewater systems. The treatment systems of Richland, Kennewick, and Pasco would be expected to be able to accommodate these increased demands because they all are currently operating at 50 to 60 percent capacity (Cushing 1994). The current sanitary waste disposal system in the 200 Areas, however, would not be able to accommodate the additional personnel and tank waste treatment activities required under any of the EIS alternatives except the No Action, Long-Term Management, and In Situ Fill and Cap alternatives (Harvey 1995).

5.6.3.6 Solid Waste

The Hanford Site's solid waste landfill is expected to reach capacity by 1996. In October 1995, an agreement was announced between DOE and the city of Richland under which nonregulated, nonhazardous solid waste generated at the Hanford Site would be accepted by the city of Richland's sanitary landfill (DOE 1995k). The first shipments of Site solid waste to the Richland landfill occurred in November 1995.

The solid waste landfills that serve the Tri-Cities area (including the city of Richland-owned landfill and landfills in Arlington, Oregon and Roosevelt, Washington, which are operated by firms that contract with Kennewick, Pasco, and West Richland) all have current capacity life expectancies of 40 to 50 years. Thus, no TWRS alternatives would be expected to cause any difficulties in terms of municipal solid waste disposal.

5.7 LAND USE

This section describes the land-use impacts of the various EIS alternatives. Land-use impacts were addressed in terms of the compatibility of temporary and permanent land-use commitments under each alternative with past, present, and planned and potential future uses of the land and the surrounding area. Also addressed were potential conflicts with uses of land adjacent to the land that would be impacted under each alternative and unique land uses in proximity to the proposed TWRS sites, including the Hanford Reach of the Columbia River and the Fitzner Eberhardt Arid Land Ecology Reserve. Conflicts between EIS alternatives and Federal, State, local, and Tribal Nation land-use policies, plans, and controls are described in Section 5.17.

Temporary and permanent proposed land-use commitments for remedial activities under all TWRS EIS alternatives would be consistent with past and existing land uses for the 200 Areas, as well as with proposed use of the area as an exclusive-use waste management area for Hanford Site waste disposal and environmental restoration programs. Potential land-use commitments do not conflict with land uses in the area of the Hanford Site immediately surrounding the 200 Areas, recreational resources such as the Hanford Reach of the Columbia River, or the Fitzner Eberhardt Arid Land Ecology Reserve. For some of the alternatives, temporary land-use commitments associated with use of potential borrow sites outside of the 200 Areas may conflict with future Site land-use plans. However, borrow sites identified in this EIS were used only to compare potential impacts associated with one closure scenario. When a final closure plan is selected, borrow material needs may be much lower, and different onsite or offsite sources of borrow material may be selected to support closure activities. In August 1996, the Hanford Site published the Draft Hanford Remedial Action EIS and Comprehensive Land Use Plan (DOE 1996) , which addresses future Site uses and the cleanup levels required to facilitate the uses identified for various areas of the Hanford Site, including the 200 Areas and the Central Plateau.

5.7.1 Land-Use Commitments

All major remediation activities associated with the EIS alternatives would occur within the current boundaries of the 200 Areas. However, the closure scenario used to compare impacts would result in activities at two potential borrow sites (Vernita Quarry and McGee Ranch), which lie to the north and west of the 200 Areas, and at the potential Pit 30 borrow site, which is located between the 200 East and 200 West Areas (Figure 5.7.1). For more than 40 years, the 200 Areas have been used for industrial and waste management activities associated with the Hanford Site's past national defense mission and current waste management and environmental restoration cleanup mission. The 200 Areas consist of approximately 2,600 ha (6,400 ac). The tank farms where the tank waste currently is stored would be the location of the in situ remediation activities under the In Situ Vitrification and In Situ Fill and Cap alternatives. The tank farms currently are being used for waste management purposes.

All proposed permanent land-use commitments would consist of changes from existing waste management uses to waste disposal uses, which is consistent with the exclusive use for waste management designation for the Central Plateau including the 200 Areas. All EIS alternatives would result in temporary and permanent land-use commitments. Temporary land-use commitments would include currently undisturbed areas used for constructing and operating the alternatives, and construction activities associated with closure. Temporary land-use commitments would include facility footprints, parking lots, construction laydown areas, materials storage areas, facility assembly areas, new power line corridors, and areas used at the three potential borrow sites. Permanent land-use commitments would include areas that would be permanently committed to waste disposal as a result of an EIS alternative. This would include the areas committed through the remedial phase of the alternatives, such as the tank farms and the LAW vaults associated with all the ex situ alternatives (except Ex Situ No Separations) and with the Ex Situ/In Situ Combination 1 and 2 alternatives . Permanent land use commitments associated with the closure scenario would include the areas that would be covered by the Hanford Barriers under all alternatives except No Action and Long-Term Management.

It is likely that there would be some land exclusion zones or restricted use zones around areas that were permanently committed to waste disposal. No exclusion or restricted use zones have been defined, but this type of land-use issue has been addressed in the land-use planning process for the Hanford Site that is currently underway (DOE 1996c) .

Groundwater use at the Hanford Site is controlled at present because of existing groundwater contamination. Groundwater contamination has land-use implications. While some land uses might not be precluded because of underlying groundwater contamination, the value of land for potential future uses such as agriculture could be diminished or restricted because the underlying groundwater could not be used. Under all EIS alternatives, TWRS activities would contribute to future Site groundwater contamination.

Figure 5.7.1 Future Land Uses Showing Potential TWRS Borrow Sites

At some point in the future, from a few hundred to several thousand years from now depending on the alternative, contaminants from TWRS tanks would reach the groundwater and begin migrating with the underlying groundwater flow patterns toward the Columbia River (Sections 5.2 and 5.11). The size (areal extent) as well as the timing of the TWRS-related groundwater contamination would differ for each alternative. The nature, extent, and timing of TWRS groundwater contamination, and thus the potential implications for future land uses, would depend on TWRS closure decisions that have not yet been made, as well as on the future Sitewide land-use planning decisions. Likewise, many relevant decisions related to non-TWRS-related groundwater contamination and overall Hanford Site groundwater cleanup have not yet been made.

The EIS analyzes use of three potential borrow sites. F inal selection of borrow sites for TWRS uses will be made in the future after the Site land-use planning process is completed.

Temporary and permanent land-use commitments for the various alternatives are summarized in Table 5.7.1. None of the alternatives would require temporary or permanent land-use commitments that would exceed the available land for waste management within the 200 Areas. All land-use commitments would constitute a small fraction of the 200 Areas' 2,600 ha (6,400 ac). The greatest impact on land use would result from the Phased Implementation alternative. This alternative would require approximately 320 ha (790 ac) for temporary construction-related uses and 49 ha (120 ac) for permanent land uses. Approximately 40 percent of the temporary land use would be outside the 200 Areas at the potential borrow sites. Thus, the alternative would use about 6 percent of the total 200 Areas temporarily and 2 percent of the total 200 Areas for permanent land uses.

All of the ex situ alternatives and the Ex Situ/In Situ Combination 1 and 2 alternatives would involve the temporary storage of vitrified HLW onsite until a potential geologic repository was able to accept the waste for permanent disposal.

The Hanford Site has no designated prime or unique farmlands (Section 4.7). There are no known plans for agricultural use of the 200 Areas, although such future uses cannot be precluded given possible DOE or other agency land-use decisions.

No Action Alternative (Tank Waste)

The No Action alternative would involve no incremental land-use commitment, as no new construction would occur. The 17 ha (42 ac) currently used for the 18 existing tank farms would be permanently committed to waste disposal. As stated previously, and as is true for all the other alternatives described in the following text, the permanent land-use commitment areas described in this section do not include any exclusion or restricted-use zones that may be designated around the tank farms.

Long-Term Management Alternative

The Long-Term Management alternative would involve temporarily committing 50 ha (120 ac) of land for two new tank farms in the 200 East Area and 16 ha (40 ac) of land at the potential Pit 30 borrow site . Only 25 ha (62 ac) would be permanently committed to waste disposal; 8 ha (20 ac) at the new tank farms and 17 ha (42 ac) at the existing tank farms. Under this alternative, no other land commitments would occur.

Table 5.7.1 TWRS Alternatives Land-Use Commitments

In Situ Fill and Cap Alternative

For the remediation phase of the project, 26 ha (64 ac) would be temporarily committed and 17 ha (42 ac) of land would be permanently committed (Figure 5.7.2). For the total In Situ Fill and Cap alternative, temporary commitments would total 97 ha (240 ac) of land. Of this total, 76 ha (190 ac) would be at the three potential borrow sites with virtually all of the remaining committed land being used during construction of the Hanford Barriers. The only permanent land-use commitment would be 25 ha (62 ac) for the tank farms and Hanford Barriers over the tank farms.

In Situ Vitrification Alternative

The remediation activities would temporarily commit 110 ha (270 ac) and permanently commit 17 ha (42 ac) of land (Figure 5.7.2). For the total In Situ Vitrification alternative, temporary commitments would total 190 ha (470 ac) for project use, including 70 ha (170 ac) for the potential new power transmission corridors, a total of 74 ha (190 ac) at the three potential borrow sites, and 21 ha (52 ac) for constructing the tank farm confinement structures for use during remedial operations. Because there would be no new waste processing facilities, the only additional land permanently committed to waste disposal would be 25 ha (62 ac) for the tank farms and Hanford Barriers.

Figure 5.7.2 Land-Use Commitments in the 200 Areas - In Situ Alternatives

Ex Situ Intermediate Separations Alternative

Remediation activities would temporarily commit 120 ha (300 ac) and permanently commit 35 ha (86 ac) of land (Figure 5.7.3). For the total Ex Situ Intermediate Separations alternative, temporary commitments would total 240 ha (590 ac) of land. This would include 89 ha (220 ac) for constructing and operating waste retrieval, transfer, and processing facilities; 24 ha (59 ac) used during Hanford Barrier construction; and 130 ha (320 ac) at the three potential borrow sites (Figure 5.7.4). Permanent land-use commitments for waste disposal would total 46 ha (110 ac) for tank farms and LAW disposal vaults, Hanford Barriers over the tank farms and LAW vaults, and contaminated portions of the waste treatment facility site.

Ex Situ No Separations Alternative

Remediation activities would temporarily commit 170 ha (420 ac) and permanently commit 20 ha (4 9 ac) of land (Figure 5.7.3). For the total Ex Situ No Separations alternative, temporary commitments would total 260 ha (650 ac) of land, 70 ha (170 ac) for constructing and operating new waste retrieval, transfer, and processing facilities; 20 ha (49 ac) for constructing Hanford Barriers at the tank farms; and 170 ha (420 ac) at the potential borrow sites. A total of 28 ha (69 ac) would be permanently committed to the tank farms and Hanford Barriers over the tank farms and at contaminated portions of the waste treatment facility site.

Ex Situ Extensive Separations Alternative

The remediation phase activities would temporarily commit 120 ha (300 ac) and permanently commit 33 ha (82 ac) of land (Figure 5.7.3). For the total Ex Situ Extensive Separations alternative, temporary land commitments would total 240 ha (590 ac). This would include 88 ha (220 ac) for constructing and operating waste retrieval, transfer, and processing facilities; 24 ha (59 ac) disturbed during Hanford Barrier construction at the tank farms and LAW disposal vaults; and 130 ha (320 ac) at the three potential borrow sites. Permanent land-use commitments would total 44 ha (110 ac) for the tank farms, the Hanford Barriers over the tank farms, the LAW vaults, and the contaminated portions of the waste treatment facility site.

Ex Situ/In Situ Combination 1 Alternative

For the remediation activities, 120 ha (300 ac) of land would be temporarily committed and 31 ha (77 ac) of land would be permanently committed (Figures 5.7.2 and 5.7.3). For the total Ex Situ/In Situ Combination 1 alternative, temporary commitment would total 210 ha (520 ac) of land. This would include 85 ha (210 ac) for constructing and operating new waste retrieval, transfer, and processing facilities; 22 ha (54 ac) during Hanford Barrier construction;

and 100 ha (250 ac) at the three potential borrow sites. A total of 41 ha (100 ac) would be permanently committed to waste disposal.

Figure 5.7.3 Land-Use Commitments in the 200 Areas

Figure 5.7.4 Land-Use Commitments at Potential Borrow Sites

Ex Situ/In Situ Combination 2 Alternative

During remediation activities, 100 ha (250 ac) of land would be temporarily committed and 25 ha (62 ac) would be permanently committed. For the total Ex Situ/In Situ Combination 2 alternative, temporary land commitments would total 180 ha (440 ac). This would include 63 ha (160 ac) for constructing and operating new waste retrieval, transfer, and processing facilities; 22 ha (54 ac) during Hanford Barrier construction; and 92 ha (230 ac) at the three potential borrow sites. A total of 34 ha (80 ac) would be permanently committed to waste disposal.

Phased Implementation Alternative

Phase 1

Phase 1 of the Phased Implementation alternative would involve disturbing a total of 33 ha (82 ac) of land during construction and operation. This would include about 32 ha (79 ac) for new waste processing facilities at the facility site in the easternmost portion of the 200 East Area, and 1 ha (2 ac) at the potential Pit 30 borrow site to obtain sand and gravel for construction phase concrete needs. There would be no permanent land-use commitments resulting from this phase.

Total Alternative

The Phased Implementation alternative, when fully implemented, would include the impacts detailed for Phase 1 as well as impacts associated with Phase 2 of the alternative. During remediation activities alone, 200 ha (490 ac) of land would be temporarily committed and 38 ha (94 ac) of land would be permanently committed (Figure 5.7.3). The total alternative land-use commitments would temporarily commit 320 ha (790 ac) of land: 150 ha (380 ac) for constructing and operating new facilities; 24 ha (60 ac) for Hanford Barrier construction at the tank farms; and 140 ha (350 ac) at the potential borrow sites. A total of 49 ha (120 ac) would be permanently committed to surface barriers over the tank farms, the LAW vaults, and at contaminated portions of the vitrification facility sites.

Capsules Alternatives

The cesium and strontium capsule alternatives all would involve relatively few land-use commitments. The capsules No Action alternative would involve no incremental land-use commitment because all activities would take place within the current footprint of the existing WESF site. Permanent land-use commitment at this site would total 0.6 ha (1.5 ac). The Onsite Disposal alternative would temporarily commit 4 ha (10 ac) and permanently commit 1.8 ha (4.4 ac) of land for the disposal facility. The Overpack and Ship and Vitrify with Tank Waste alternatives temporarily would commit approximately 2 ha (5 ac) for the handling and processing facilities. The Overpack and Ship and Vitrify with Tank Waste alternative would have minimal permanent land-use commitments. These land areas are included within the areas that would be committed for the ex situ alternatives because the facilities for these alternatives would be located within the proposed tank waste treatment facility complex.

5.7.2 Impacts on Surrounding Land Uses

As designated by the Hanford Site Development Plan (DOE 1993e), current and planned land uses that surround the 200 Areas would include research and development, engineering areas, and a buffer zone (undeveloped areas) (Figure 5.7.1). Research and development and engineering areas include developing scientific and engineering technology and managing waste. The waste management use of the 200 Areas would be within the overall Central Plateau use as a waste management area. Under the Hanford Site Development Plan, the Central Plateau waste management area would consist of approximately 11,700 ha (28,800 ac). Waste management would take place on 4,900 ha (12,200 ac) of the area while the remaining 6,700 ha (16,600 ac) would be designated for use as a buffer zone. The 200 Areas constitute approximately 2,600 ha (6,400 ac) of the waste management area (53 percent).

The buffer undeveloped areas would provide a land-use transition between the waste operations of the 200 Areas and other more sensitive use areas. Similar uses have occurred in these locations for over 40 years without land-use conflicts. Thus, the EIS alternatives' activities in the 200 Areas would be consistent with existing and currently planned land uses in surrounding Hanford Site areas. None of the alternatives would directly or indirectly impact current or planned land uses in surrounding areas. The Hanford Comprehensive Land-Use Plan, which was released for public comment in August 1996, designate s future land-use plans for the Site under various alternatives .

5.7.2.1 Recreational Resources and the National Environmental Research Park

Although the Hanford Site is designated as a National Environmental Research Park (Section 4.7), the 200 Areas do not contain any designated or protected wildlife areas, wildlife refuges, or recreational areas. However, the 200 Areas do contain shrub-steppe habitat of ecological value. The 200 Areas have been used for more than 40 years for defense production and waste management purposes. All EIS alternatives would continue past and current land uses and would not conflict with the goals of the National Environmental Research Park.

The Fitzner Eberhardt Arid Land Ecology Reserve is located approximately 3 km (2 mi) southwest of the 200 Areas. The Saddle Mountain National Wildlife Refuge is located approximately 8 km (5 mi) north of the 200 Areas. The Wahluke Slope Wildlife Recreation Area is located approximately 8 km (5 mi) northeast of the 200 Areas. The McNary National Wildlife Refuge is located approximately 20 km (13 mi) southeast of the 200 Areas. The Hanford Reach of the Columbia River, which is proposed for designation as a Recreational River under the Wild and Scenic Rivers Act, is located approximately 11 km (7 mi) from the 200 Areas. Implementing any of the EIS alternatives would not preclude or adversely affect the current or planned use of any of these sensitive wildlife or recreational areas.

5.8 VISUAL RESOURCES

This section describes the impacts of the TWRS alternatives on the visual resources of the Hanford Site and vicinity, focusing primarily on potential impacts from offsite locations. The visual impacts of all TWRS alternatives would result from developing the facilities associated with waste retrieval, processing, and storage activities, and from borrow site activities associated with implementing the alternatives.

As described in Section 4.8, the Hanford Site landscape is characterized primarily by its broad plateau (Section 4.8). This visual setting provides for sweeping vistas of the area broken up by more than a dozen large Hanford Site facilities (e.g., processing plants and nuclear reactors) located around the Hanford Site. Only 6 percent of the Hanford Sites total area has been used for industrial activities. The 200 Areas, where virtually all proposed TWRS activities except for borrow site use would occur under all alternatives, currently contain three large processing facilities (the Plutonium-Uranium Extraction [PUREX] Plant in the 200 East Area and B Plant and U Plant in the 200 West Area) as well as the 18 tank farms that contain the tank waste and numerous multi-story support facilities.

The potential Pit 30 borrow site, which would provide sand and gravel as part of implementing all EIS tank waste alternatives except No Action and Long-Term Management, is located between the 200 East and 200 West Areas. The potential Vernita Quarry and McGee Ranch borrow sites, which would be used (if selected and approved) under all tank waste alternatives except No Action and Long-Term Management for closure-related activities, are located in undeveloped areas approximately 6 km (4 mi) north and west of the 200 West Area.

The following text summarizes the potential impacts to visual resources under each of the EIS alternatives.

No Action Alternative (Tank Waste)

Under the No Action alternative, impacts would be largely limited to continuing existing visual disturbance from ongoing use of the tank farms. No additional facilities would be constructed, and routine tank farm operations would continue in their current form.

Long-Term Management Alternative

This alternative would have the same visual impacts as the No Action (Tank Waste) alternative (continuation of existing visual disturbance) until new replacement storage tanks were developed to replace the existing DSTs. In the 2030's and again in the 2080's, 26 additional underground tanks would be built to replace the existing tanks that would reach the end of their design lives. The new tanks would be constructed in a previously disturbed area of the 200 East Area about 180 by 150 m (600 by 500 ft). The new tank farms would not be visible from any offsite locations because they would be in the interior of the Hanford Site, and most of the facilities would be underground. The new tank farms would, however, be visible from elevated locations on the Site (Gable Mountain, Gable Butte, and Rattlesnake Mountain) that are used by Native Americans for religious purposes. The Confederated Tribes of the Umatilla Indian Reservation have expressed the concern that visibility of new TWRS facilities under this and virtually all other alternatives except No Action would represent an adverse impact on these religious sites (CTUIR 1996).

In Situ Fill and Cap Alternative

The In Situ Fill and Cap alternative would not develop any new treatment facilities in the 200 Areas. However, Hanford Barriers would be developed over each of the tank farm sites. Visually, the Hanford Barriers, which would be associated with the closure scenario, would resemble a 4.5-m (15-ft) soil mound with sloping sides covered with soil and vegetation. Because of this low visual profile, impacts would be minor. There would be no visual impacts from any offsite locations, including the Columbia River.

Borrow site activities would leave a topographic depression at each of the three potential borrow sites for this alternative, as well as for all other tank waste alternatives except No Action and Long-Term Management. While such topographic changes would be visually inconsistent with the surrounding landforms, there would be limited viewing opportunities from offsite. The potential Pit 30 borrow site is in the interior of the Hanford Site and could not be seen from offsite except from elevated locations. Borrow site impacts associated with closure are described to provide a basis for comparing the impacts of this EIS. The potential Vernita Quarry borrow site would be expanded to support TWRS project closure activities. The past quarry operations site is highly visible from State Route 24, and the expansion area also would be highly visible from the highway. The potential McGee Ranch borrow site would be located near State Route 24. The borrow activities would be visible to travelers on State Route 24 traveling east-west just west of the Yakima Barricade, and travelers on State Route 24 after it turns north-south at the Yakima Barricade.

In Situ Vitrification Alternative

The primary visual feature of the In Situ Vitrification alternative would be the large confinement structures that would be erected over each tank farm during operations (Figure 3.4.5). A tank farm confinement structure would enclose an entire tank farm, reaching a maximum abovegrade height of 30 to 45 m (100 to 150 ft). There would be one tank farm confinement structure in operation and two tank farm confinement structures under construction at any one time over the 18-year period between 1998 and 2016.

The number of tank farm confinement structures would increase steadily as activities proceeded under this alternative, eventually reaching a total of 18 such structures (one for each tank farm). Decontamination and decommissioning of all tank farm confinement structures would occur when vitrification was completed at the last tank farm. After 2016, the structures would be removed and their visual impact would be eliminated.

Each in situ vitrification facility would have one 30-m (100-ft)-high stack and a number of support facilities, none of which would be more than one to two stories high. There also would be power line segments installed to provide electrical power to the in situ vitrification operations at each tank farm. After the waste vitrification activities at the tank farms were complete, each tank farm would be covered with a Hanford Barrier.

Figure 5.8.1 illustrates the alternative's potential visual impacts. The tank farm confinement structures would be visible from several kilometers away and each would resemble a large industrial building with an exposed steel arch roof structure. They would be visible along an approximately 11-km (7-mi) segment of State Route 240 to the south and east of the 200 Areas. Travelers on State Route 240 would see the confinement structures in the 200 West Area tank farms as part of the visual middleground, defined as 0.8 to 8 km (0.5 to 5 mi) away. Offsite viewing would be of moderate visual intrusiveness because the TWRS sites would be relatively similar to other industrial facilities currently existing at the Hanford Site. Tank farm confinement structures in the 200 East Area would be visible in the visual background (more than 8 km [5 mi] away). Vitrification operations would not be expected to produce any stack plumes that would be visible from offsite locations.

Figure 5.8.1 Potential Visual Impacts of TWRS Alternatives

Post-remediation Hanford Barriers would have minimal visual impacts from any offsite locations because of their low visual profiles and the distances involved. None of the facilities (including the tank farm confinement structures) would be expected to be visible from offsite locations other than State Route 240. The facilities would be visible from elevated locations such as Gable Mountain, Gable Butte, and Rattlesnake Mountain, but would not be visible from the Columbia River.

Borrow site impacts essentially would be the same as for the In Situ Fill and Cap alternative: borrow activities and the resulting land form changes would be highly visible at the potential Vernita Quarry borrow site from State Route 24, visible at the potential McGee Ranch borrow site from State Route 24, and not visible from public roadways at the potential Pit 30 borrow site . All activities at the potential borrow sites would be visible from elevated locations such as Gable Mountain, Gable Butte, and Rattlesnake Mountain.

Ex Situ Intermediate Separations Alternative

This alternative would require two large facilities, both located in the same portion of the 200 East Area. These would be a HLW vitrification facility reaching 30 m (100 ft) abovegrade, and a LAW vitrification facility reaching 19 m (63 ft) abovegrade. Each plant would have two 55-m (180-ft)-high stacks. The two large vitrification facilities with their 55-m (180-ft)-high stacks occasionally might be visible in the visual background from State Route 240 (Figure 5.8.1). Because of the distance involved, visual impacts would be minor and similar to the impacts that currently exist. Plumes from the vitrification facility stacks might be visible occasionally from locations near the Site boundaries under certain atmospheric conditions (e.g., high humidity and no wind). The LAW vaults and tank farms would not be visible from State Route 240 because of their size (no more than the equivalent of one to two stories high) and the distances involved. None of the TWRS sites would be expected to be visible from any other offsite locations, including the Columbia River. However, the facilities would be visible from elevated locations such as Gable Mountain, Gable Butte, and Rattlesnake Mountain.

As part of the closure scenario, there also would be Hanford Barriers over the tank farms and LAW disposal vaults. Borrow site impacts would be the same as described for the In Situ Vitrification alternative, high at the potential Vernita Quarry and McGee Ranch borrow sites , and low at the potential Pit 30 borrow site .

Ex Situ No Separations Alternative

The remedial activities of the Ex Situ No Separations alternative would result in similar impacts to the Ex Situ Intermediate Separations alternative. There would be only one large stack because there would be only one vitrification facility. This stack would be briefly visible in the visual background by travelers on State Route 240 and facilities would be visible from elevated locations . Plumes from the vitrification facility stack might be visible from locations near Site boundaries under certain atmospheric conditions. Because there would be no onsite LAW disposal vaults, closure would require fewer Hanford Barriers. Visual impacts at the potential borrow sites resulting from their use to support closure would be the same as described for the other tank waste alternatives.

Ex Situ Extensive Separations Alternative

The remediation actions under this alternative would result in essentially the same visual impacts as described earlier for the Ex Situ Intermediate Separations alternative. Visual impacts would result from two large vitrification facilities of the same height as described previously, both with 55-m (180-ft)-high stacks. Closure impacts would include the Hanford Barriers over the tank farms and LAW disposal vaults, and land form changes at the potential borrow sites and disposal vaults.

The two vitrification facilities occasionally would be visible in the visual background from State Route 240, and all facilities would be visible from elevated locations. No facilities would be visible from the Columbia River. Plumes from the vitrification facility stacks could be visible occasionally near the Hanford Site boundaries on days with certain atmospheric conditions (e.g., high humidity and no wind).

Ex Situ/In Situ Combination 1 and 2 Alternatives

These alternatives would have essentially the same visual impacts as described for the Ex Situ Intermediate Separations alternative. Changes to the visual environment would occur at facility sites during remediation and at Hanford Barriers and the potential borrow sites during closure.

Phased Implementation Alternative

Phase 1

Phase 1 of the Phased Implementation alternative would have similar visual impacts to the other ex situ alternatives. The primary visual impact would be from 46-m (150-ft)-high stacks on each vitrification facility, although the overall complex would be smaller than the other ex situ alternatives. The vitrification facility stacks occasionally would be visible from State Route 240, and under certain atmospheric conditions, plumes from the stack might be visible from near Site boundaries. The Phased Implementation facilities would be visible from elevated locations. No facilities would be visible from the Columbia River. Phase 1 of Phased Implementation would involve no onsite LAW disposal vaults. The only borrow site visual impacts would be from the disturbance of 0.4 ha (1 ac) at the potential Pit 30 borrow site.

Total Alternative

The Phased Implementation alternative, when fully implemented, would include the impacts detailed for Phase 1 as well as impacts associated with the second phase of the alternative. The additional visual impacts would include two large vitrification tactics with their stacks. All other impacts would be similar to those of the Ex Situ Intermediate Separations alternative.

Capsule Alternatives

All cesium and strontium capsule alternatives except Onsite Disposal would have negligible visual impacts because no activities would be visible from offsite locations. The No Action alternative would involve continued use of the current WESF site. The Onsite Disposal alternative would involve using a disturbed site adjacent to the 200 East Area and facilities but would have 672 1.2-m (4-ft)-high cement caps over each of the drywells, which would be visible from elevated locations. The Overpack and Ship and Vitrify with Tank Waste alternatives would require small facilities that would be sited within the large TWRS sites proposed for the 200 East Area under the various ex situ alternatives. These capsule facilities would not be noticeable within the complex.

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5.9 NOISE

The following text summarizes potential noise impacts to onsite workers, the public, and wildlife from the construction and operations phase of each alternative. Potential construction noise impacts were compared with the General Service Administration construction noise specifications, and a bounding case scenario was evaluated to estimate the probable distance from construction activities that would be impacted. For operations phase noise, noise impacts of activities within facilities and exterior to facilities were addressed.

Potential noise impacts of all alternatives would be minor. All tank waste alternatives except the No Action alternative would involve noise generation associated with construction and operation phase activities. However, all proposed sites are a considerable distance from sensitive receptors such as residences, hospitals, and schools. None of the alternatives would have noise impacts on offsite locations, nor would any violations of Federal or State noise standards occur. The only potential onsite noise impact on human beings would be occupational noise effects on project workers from exposure to construction equipment noise and the noise of waste treatment facility operations. Noise protection measures would be used to ensure that no occupational noise standards would be violated. Noise emissions during construction activities and noise associated with borrow site activities could cause minor disturbance to sensitive wildlife species (particularly birds of prey) in the vicinity of the construction and potential borrow sites (Section 5.4.2). The affected Tribal Nations have expressed the concern that noise emissions, which would be highest during construction, could adversely impact Gable Mountain, which is used by Native Americans for religious purposes (CTUIR 1996). However, because Gable Mountain is approximately 3 km (2 mi) from TWRS areas, TWRS noise emissions would have only very minor impacts on noise levels at Gable Mountain or at Gable Butte.

During both construction and operation phases of all tank waste alternatives, there would be some increases in noise levels offsite from vehicular travel (worker vehicles and trucks) along existing roadways near the Hanford Site. The noise impacts of these incremental noise emissions would be minor because they would occur on existing roadways that currently are used extensively.

5.9.1 Construction Phase Noise Impacts

Construction phase noise impacts would result largely from noise generated by mechanized equipment such as loaders, bulldozers, cranes, and trucks. Borrow site activities would involve similar heavy equipment. The noise emissions of various alternatives likely would differ somewhat depending on the types and number of pieces of mechanized equipment in use at a given time and location and on the duration of construction and borrow site activities. Noise emission levels from all mechanized equipment used during construction and borrow site activities for all alternatives would be within the General Services Administration construction noise specifications or other similar noise standards. Table 5.9.1 lists noise specifications for some of the types of construction equipment likely to be used.

Table 5.9.1 General Services Administration Construction - Noise Specifications [1]

Because of the remoteness and natural setting of much of the Hanford Site, potential noise impacts to resident wildlife species were of concern. Table 5.9.2 presents the results of this analysis, in which a scraper, bulldozer, and grader were assumed to operate concurrently at the same location. Because these pieces of equipment likely all would be in relatively constant motion, it is likely that three such pieces of equipment would be operating in close proximately to each other only for short periods of time. At a distance of 15 m (50 ft), the cumulative noise level would be 90 decibels on the A scale (dBA). The noise level would reduce to less than 74 dBA at 100 m (330 ft) and 62 dBA at 400 m (1,300 ft). To place these noise levels in perspective, 90 dBA is approximately the noise level of a food blender at a distance of 1 m (3 ft). Riding inside an automobile at 65 km (40 mi) per hour produces approximately 75 dBA. Normal speech is 60 dBA. Consequently, there would be some short-term disturbance of noise-sensitive wildlife species near the TWRS activity sites during construction and borrow site activities (Section 5.4). Construction noise levels would approach background levels at distances greater than 600 m (2,000 ft), although some species could be disturbed up to a distance of up to 800 m (2,700 ft) from the construction sites.

Table 5.9.2 Probable Bounding Case Cumulative Noise Impact During the Construction Phase (All Alternatives)

No Action Alternative (Tank Waste)

Because the No Action alternative would involve no new construction, there would be no construction phase noise impacts. Noise emissions from routine maintenance activities would be monitored, and appropriate noise protection measures would be taken under routine Hanford Site occupational health and safety procedures.

Long-Term Management Alternative

This alternative would have no construction phase noise impacts until the 2030's and again in the 2080's, when new underground storage tanks would be constructed to replace existing DSTs at the end of their design lives. Noise impacts would be the same as described in Table 5.9.2.

In Situ Fill and Cap Alternative

The In Situ Fill and Cap alternative would involve minimal construction activities (i.e., only those associated with preparing to place the fill material in the tanks). This alternative would involve borrow site activities and associated noise emissions at the potential Vernita Quarry, McGee Ranch, and Pit 30 borrow sites, as well as noise emissions associated with constructing Hanford Barriers at the tank farms (during closure). Noise impacts would be as described in Table 5.9.2.

In Situ Vitrification Alternative

The In Situ Vitrification alternative would involve construction activities for constructing tank farm confinement facilities and installing vitrification equipment throughout the 200 Areas at the 18 tank farms, and along the transmission line corridors in the 200 Areas where new powerlines would be installed to supply power to the vitrification activities. Borrow site activities and noise emissions would occur at the potential Pit 30 borrow site. Noise emissions also would occur during closure at the potential Vernita Quarry and McGee Ranch borrow sites and while constructing Hanford Barriers at the tank farms. Noise impacts would be as described in Table 5.9.2.

Ex Situ Intermediate Separations Alternative

The Ex Situ Intermediate Separations alternative would involve noise emissions from waste retrieval and waste processing facility construction during remediation. During closure, noise emissions would include Hanford Barrier construction at the tank farms and LAW vaults and heavy equipment activities at borrow sites. Impacts would be as described in Table 5.9.2.

Ex Situ No Separations Alternative

The Ex Situ No Separations alternative would involve construction noise emissions from all of the same activities at the same locations as the Ex Situ Intermediate Separations alternative, except that no vault construction or Hanford Barriers would be required for LAW vaults during closure. The Ex Situ No Separations alternative would involve no long-term LAW storage on the Hanford Site.

Ex Situ Extensive Separations Alternative

The Ex Situ Extensive Separations alternative would involve noise emissions similar to the Ex Situ Intermediate Separations alternative. This alternative would involve similar activities at the same locations (i.e., tank farms, waste processing facilities, borrow sites, and LAW vaults).

Ex Situ/In Situ Combination 1 and 2 Alternatives

These alternatives would involve noise emissions from waste retrieval construction and fill and cap activities at the tank farms and from constructing the proposed TWRS sites in the 200 East Area during remediation. They also would result in impacts from constructing Hanford Barriers at the tank farms as part of the closure process and from constructing Hanford Barriers at the LAW vaults following emplacement of the stabilized LAW. Noise emissions also would be generated at the potential Vernita Quarry, McGee Ranch, and Pit 30 borrow sites during closure.

Phased Implementation Alternative

Phase 1

This phase of the alternative would involve noise emissions from constructing the two demonstration separations and vitrification facilities.

Total Alternative

The Phased Implementation alternative, when fully implemented, would include the impacts for Phase 1 as well as impacts associated with the second phase of the alternative. The total alternative noise impacts would involve construction emissions from all of the same activities at the same locations as the Ex Situ Intermediate Separations alternative.

Capsule Alternatives

All cesium and strontium capsule alternatives would have minor noise impacts during construction. The No Action alternative would involve no construction activities. The Onsite Disposal alternative would involve construction noise at a site adjacent to the western edge of the 200 East Area. The Overpack and Ship and Vitrify with Tank Waste alternatives would involve minimal construction, all of which would occur as part of developing the proposed TWRS sites in the 200 East Area associated with the various ex situ alternatives.

5.9.2 Operation Phase Noise Impacts

For all tank waste alternatives except the No Action and Long-Term Management alternatives, operation phase noise emissions would be largely related to operating process equipment (e.g., evaporator, mixer pumps, and melter and quencher). The No Action alternative would involve only the continuation of noise from ongoing, routine tank farm operations. The Long-Term Management alternative would involve operating two new tank farms, but there would be noise emissions from the existing 18 tank farms. Because the waste treatment process equipment for the various vitrification alternatives would be operating inside enclosed structures, exterior noise levels would not be substantially increased. There would be some exterior noise emissions from the emplacement of fill material in the tanks under the In Situ Fill and Cap alternative.

All facilities and working conditions would comply with the Occupational Safety and Health Administration occupational noise requirements contained in 29 CFR 1910.95. Pursuant to these occupational noise requirements, noise exposures for an 8-hour duration would not exceed 85 dBA. In cases where the workers would be exposed to noise levels exceeding this value, administrative controls, engineering controls, or personal protective equipment use would be required to reduce the noise exposures below the allowable maximum.

5.10 TRANSPORTATION

This section describes the impacts of the vehicular traffic associated with the various TWRS alternatives on the roadway system of the Hanford Site and vicinity. As described in Section 4.10, the roadways of primary concern would be 1) the segment of Stevens Road at the 1100 Area, which is the primary Site entrance from the city of Richland; and 2) the segment of Route 4, which is a continuation of Stevens Road northward into the Hanford Site, west of the Wye Barricade. Stevens Road and Route 4 are by far the Hanford Site's most heavily traveled north-south route, and both of the road segments experienced heavy peak hour congestion in the recent past, although congestion has declined in 1995 as Site employment levels declined. The standard traffic Level of Service hierarchy ranges from Level of Service A (least congested) to Level of Service F (most congested). Conditions worse than Level of Service D are considered unacceptable. Prior to mid-1995, morning peak hour congestion on Stevens Road frequently reached Level of Service F, while on Route 4, it frequently reached Level of Service E.

To estimate vehicular traffic impacts, expected incremental traffic volumes (approximately 98 percent personal vehicles and 2 percent trucks for all EIS alternatives) were added to estimated future baseline Hanford Site traffic volumes. The analysis focused on the peak year of activity for each EIS alternative, which differed based on the alternative-specific schedule for construction and operation. The approximate time frames before and after the peak year when increased traffic congestion also would be expected were identified as well. Because Hanford Site traffic volumes typically reach their daily peaks during the morning shift change, this analysis focused on the morning peak hour, the time period of expected greatest impact.

For the tank waste No Action, Long-Term Management, and In Situ Fill and Cap alternatives and all capsule alternatives, there would be negligible impacts on traffic conditions on the two roadways of primary concern. All of the remaining tank waste alternatives would contribute to level of service conditions, which are considered unacceptable (Level of Service E and F). The impacts of these alternatives generally would build prior to the peak year and decline in the years following the peak year. The peak year for the various EIS alternatives except Phased Implementation would be from 2001 to 2004 depending on the alternative. For the Phased Implementation (Total) alternative, the peak year of traffic impacts would be in 2010.

Impacts of TWRS alternatives' rail transport to and from the Hanford Site are described in Section 5.10.3. Transportation accident risks are described in Section 5.12 (Accidents).

There are a number of key assumptions that underlie the EIS traffic impact analysis, which include the following.

- Approximately 12 percent of the future total average daily traffic on Stevens Road would occur during the morning peak hour, while about 25 percent of the average daily traffic on Route 4 west of the Wye Barricade would occur during the morning peak. This assumption was based on traffic data from the last few years (BFRC 1993 and WHC 1994c).
- All TWRS day shift employee vehicular traffic would occur during the Hanford Site's morning peak hour, with an assumed average of 1.35 persons/vehicle to account for carpooling and vanpooling.
- There would be heavy use by TWRS employees of both the new State Route 240 Access Road (Beloit Avenue), which avoids Stevens Road and Route 4 entirely, and of the Route 2/11A route to the 200 Areas from the Wye Barricade, which avoids the critical segment of Route 4 west of the Wye Barricade.
- It is assumed that approximately 11 percent of TWRS employees would commute from areas west of the Hanford Site (e.g., Benton City and Prosser) and that about 6 percent would commute from West Richland. This was the distribution of Hanford Site employee points of origin in 1992 (BFRC 1993). These TWRS commuters were assumed largely to use alternatives to Stevens Road and Route 4, i.e., the Yakima Barricade Site entrance (commuters from the west), or Route 10 (West Richland commuters).

The transportation of borrow material from the potential Vernita Quarry and McGee Ranch borrow sites during closure, which would occur under all alternatives except No Action and Long-Term Management, would increase truck traffic on State Route 24 and on Route 11A leading to the 200 Areas. This traffic increase would take place during the construction of Hanford Barriers after waste treatment was completed. Hanford Barrier construction would occur almost entirely in the 2020's under all alternatives. No quantitative analysis has been performed, but given the projected long-term declines in overall Hanford Site employment, no substantial traffic congestion would be expected at this future date.

The onsite transport of waste from the inactive miscellaneous underground storage tanks would occur by a specially designed truck. There could be occasional interference with normal traffic flow onsite during these waste transport activities to ensure safety during the waste transport operations; however, the impact of these disruptions to peak community employee traffic could be mitigated by scheduling truck traffic during nonpeak hours.

5.10.1 Tank Waste Alternatives

The traffic impacts of each EIS alternative are described in the following text and summarized in Table 5.10.1.

No Action Alternative (Tank Waste)

Traffic impacts under the No Action alternative would be lowest of all the tank waste alternatives because this alternative would have the lowest employment levels (routine tank farm operations only). On Stevens Road, total morning peak hour traffic volumes would be approximately 3,100 (Table 5.10.1), which is about 6 percent lower than the 1992 levels that were evaluated as Level of Service F (highly congested). Thus, a Level of Service in the D to E range would be expected, which represents congestion approaching unacceptable conditions. On Route 4 west of the Wye Barricade, morning peak hour volumes would exceed 1,900, which is nearly 20 percent below the congested (Level of Service E) conditions observed in mid-1994. Thus, acceptable traffic conditions would be expected.

Long-Term Management Alternative

This alternative would have the same traffic volumes and impacts as the No Action alternative until the 2030's when there would be construction of new underground tanks. Because projecting future traffic levels 35 years in the future has large uncertainties, the traffic impacts of the Long-Term Management alternative were assumed to be the same as for No Action. Thus in 2001, it was assumed that traffic congestion would be approaching unacceptable levels on Stevens Road and acceptable levels on Route 4 west of the Wye Barricade.

Table 5.10.1 Peak Year Traffic Impacts

In Situ Fill and Cap Alternative

Under the In Situ Fill and Cap alternative, incremental traffic volumes in all years would be small because of the small workforce associated with the alternative (less than 150 in any year). Incremental traffic on the roadways of concern would not exceed 50 vehicles in the morning peak hour, which would have a negligible impact on traffic conditions.

In Situ Vitrification Alternative

Under the In Situ Vitrification alternative, during the peak year of 2004, morning peak hour volumes would reach 3,600 vehicles on Stevens Road at the 1100 Area. Additionally, traffic would be congested on the State Route 240 Bypass Highway approaching the intersection with Stevens Road. The TWRS traffic on Stevens Road would represent an increase of 33 percent above baseline levels in that year. Traffic congestion would be extremely heavy (Level of Service F). On Route 4 west of the Wye Barricade, morning peak hour volumes would be 2,100 vehicles, with TWRS vehicles representing an increase of about 25 percent above baseline traffic volumes. Traffic conditions would be somewhat congested (Level of Service D), as the volumes would be approximately 10 percent lower than the volumes that produced Level of Service E on the same road in 1994. Congestion on both roads would begin to build up in 2001 and would remain steady until 2007.

Ex Situ Intermediate Separations Alternative

Under the Ex Situ Intermediate Separations alternative, peak traffic flows would occur in the year 2002 and would result in extreme peak hour congestion (Level of Service F) on both roadways of interest. On Stevens Road, the morning peak hour volume would be about 4,700 vehicles. This would be well over the volumes that produced Level of Service F conditions in 1994. Additionally, traffic would be congested on the State Route 240 Bypass Highway approaching the intersection with Stevens Road. The TWRS traffic would increase peak hour volumes on Stevens Road by over 60 percent above the baseline. On Route 4, TWRS traffic volumes (3,100 vehicles) would be 70 percent above the baseline, which would produce total peak hour volume about 30 percent higher than the Level of Service E conditions observed in 1994. Congestion would begin to build up in 1999 and would continue at high levels until 2004.

Ex Situ No Separations Alternative

With the Ex Situ No Separations alternative, morning peak hour conditions in the year 2000 would be extremely congested (Level of Service F) on both roadways of concern. On Stevens Road in the 1100 Area, traffic volumes would be about 4,800 vehicles, with the alternative's traffic representing an increase of 60 percent over the baseline. Additionally, traffic would be congested on the State Route 240 Bypass approaching the intersection with Stevens Road. On Route 4 west of the Wye Barricade, traffic volumes would be approximately 3,200, an increase of 70 percent over baseline levels. Severely congested conditions would begin in 1999 and last through 2001.

In Situ Vitrification Alternative

Under the In Situ Vitrification alternative, during the peak year of 2004, morning peak hour volumes would reach 3,600 vehicles on Stevens Road at the 1100 Area. Additionally, traffic would be congested on the State Route 240 Bypass Highway approaching the intersection with Stevens Road. The TWRS traffic on Stevens Road would represent an increase of 33 percent above baseline levels in that year. Traffic congestion would be extremely heavy (Level of Service F). On Route 4 west of the Wye Barricade, morning peak hour volumes would be 2,100 vehicles, with TWRS vehicles representing an increase of about 25 percent above baseline traffic volumes. Traffic conditions would be somewhat congested (Level of Service D), as the volumes would be approximately 10 percent lower than the volumes that produced Level of Service E on the same road in 1994. Congestion on both roads would begin to build up in 2001 and would remain steady until 2007.

Ex Situ Intermediate Separations Alternative

Under the Ex Situ Intermediate Separations alternative, peak traffic flows would occur in the year 2002 and would result in extreme peak hour congestion (Level of Service F) on both roadways of interest. On Stevens Road, the morning peak hour volume would be about 4,700 vehicles. This would be well over the volumes that produced Level of Service F conditions in the recent past. Additionally, traffic would be congested on the State Route 240 Bypass Highway approaching the intersection with Stevens Road. The TWRS traffic would increase peak hour volumes on Stevens Road by over 60 percent above the baseline. On Route 4, TWRS traffic volumes (3,100 vehicles) would be 70 percent above the baseline, which would produce total peak hour volume about 30 percent higher than the Level of Service E conditions observed in 1994. Congestion would begin to build up in 1999 and would continue at high levels until 2004.

Ex Situ No Separations Alternative

With the Ex Situ No Separations alternative, morning peak hour conditions in the year 2000 would be extremely congested (Level of Service F) on both roadways of concern. On Stevens Road in the 1100 Area, traffic volumes would be about 4,800 vehicles, with the alternative's traffic representing an increase of 60 percent over the baseline. Additionally, traffic would be congested on the State Route 240 Bypass approaching the intersection with Stevens Road. On Route 4 west of the Wye Barricade, traffic volumes would be approximately 3,200, an increase of 70 percent over baseline levels. Severely congested conditions would begin in 1999 and last through 2001.

Ex Situ Extensive Separations Alternative

The Ex Situ Extensive Separations alternative would have the most intense traffic impacts of the EIS alternatives. In the peak year of 2003, extremely severe congestion (Level of Service F) would occur during the morning peak hour on both Stevens Road at the 1100 Area and on Route 4 west of the Wye Barricade. On Stevens Road, peak hour volumes would be approximately 6,200 vehicles, which would be a 130 percent increase over baseline conditions. This volume also would be 2,800 more vehicles than caused extreme congestion (Level of Service F) conditions on Stevens Road in 1992. Additionally, traffic would be congested on the State Route 240 Bypass approaching the intersection of Stevens Road. On Route 4 west of the Wye Barricade, traffic volumes would be approximately 4,700 vehicles, an increase of approximately 150 percent over the expected baseline volume. Severe congestion would begin in the year 2002 and continue through 2004.

Ex Situ/In Situ Combination 1 Alternative

Under this alternative, morning peak hour traffic volumes would occur in 2001 and would result in severe congestion (Level of Service F) on Stevens Road at the 1100 Area and slightly less severe but still unacceptable (Level of Service E) congestion on Route 4 west of the Wye Barricade. Additionally, traffic would be congested on the State Route 240 Bypass Highway approaching the intersection with Stevens Road. On Stevens Road, morning peak hour volumes would be about 3,700 vehicles. This would be about 350 vehicles (10 percent) more than the volumes that created Level of Service F in 1992. On Route 4 west of the Wye Barricade, morning peak hour volume would be approximately 2,200 vehicles, slightly less than the volumes that created Level of Service E in 1994. Congestion would begin to build up in 1999 and continue through 2004.

Ex Situ/In Situ Combination 2 Alternative

This alternative would have similar peak traffic volumes and resulting traffic impacts as the Ex Situ/ In Situ Combination 1 alternative. In the peak year of 2001, severe congestion (Level of Service F) would occur on Stevens Road at the 1100 Area, and slightly less severe but still unacceptable congestion (Level of Service E) would occur on Route 4, west of the Wye Barricade. Traffic on the 240 Bypass Highway approaching the intersection with Stevens Road also would occur. Morning peak hour volumes on Stevens Road would be about 3,600 vehicles. This would be about the same as the volumes that created Level of Service F in 1992. On Route 4 west of the Wye Barricade, morning peak hour volumes would be about 2,200 vehicles, which is almost the same as the volumes that created Level of Service E in 1994.

Phased Implementation Alternative

Phase 1

The greatest morning peak hour traffic volumes under Phase 1 of Phased Implementation would occur in 1999. These volumes would lead to severe congestion (Level of Service F) on Stevens Road at the 1100 Area and severe congestion (Level of Service E to Level of Service F) on Route 4 west of Wye Barricade. There also would be congestion on State Route 240 Bypass Highway approaching the intersection with Stevens Road. On Stevens Road, morning peak hour volumes would be approximately 4,300 vehicles, which would be about 30 percent more vehicles than the volume that produced Level of Service F conditions in 1992. On Route 4 west of Wye Barricade, morning peak hour volumes would be about 2,700 vehicles. This would be nearly 15 percent more vehicles than the volume that created Level of Service E conditions in 1994. This phase of the alternative's impacts would begin to build up in 1998 and would continue until 2000.

Total Alternative

The Phased Implementation alternative, when fully implemented, would involve the impacts detailed for Phase 1 as well as impacts associated with Phase 2 of the alternative. The peak traffic flows would occur in the year 2010 and would result in extreme peak hour congestion (Level of Service F) on both roadways of interest. On Stevens Road, the morning peak hour volume would be approximately 5,600 vehicles. On Route 4, the incremental TWRS traffic volumes of 2,900 vehicles would produce peak hour traffic that would result in Level of Service F conditions. Congestion would begin to build in 2007 and would continue at high levels and continue for several years after the 2010 peak.

5.10.2 Capsule Alternatives

Because employment under the cesium and strontium capsule alternatives would be less than 50 employees in the peak year, traffic volumes would be small. The capsule alternatives' incremental traffic volumes would have negligible impacts on traffic conditions at the Hanford Site.

5.10.3 Rail Traffic

Rail traffic volume would be relatively small for all EIS alternatives, and small impacts on the rail systems would be expected (Table 5.10.2). The No Action (Tank Waste) alternative would involve no rail traffic. The Long-Term Management alternative would involve approximately 65 rail trips per year during new tank construction in the 2030's and 2080's. The In Situ Fill and Cap alternative would involve three rail trips per year to deliver materials to the Site during construction and operations. The In Situ Vitrification alternative would involve 16 rail trips per year for transporting construction materials and chemicals used during operations to the Site.

The Ex Situ Intermediate Separations alternative would involve an average of 25 rail trips per year to deliver materials to the Site during construction and operations phases, and 17 rail trips per year to transport HLW to the potential geologic repository. In the year 2020 , when both waste processing operations and HLW shipments are ongoing, total rail traffic would be 42 trips per year (more than 3 trips per month).

Table 5.10.2 Rail Traffic Volumes

The Ex Situ No Separations alternative (Vitrification) would require 38 rail trips per year during construction and operations and 145 rail trips per year for HLW transport to the potential geologic repository. During the year 2020, when operation and HLW shipments overlap, a total of 50 rail trips per year (approximately 4 rail trips per month) would be expected. The calcination option for the No Separations alternative would involve 18 trips per year during construction and operations, 51 HLW shipments per year to the potential geologic repository, and a combined peak (in 2020) of 69 rail trips per year (up to 6 trips per month).

The Ex Situ Extensive Separations alternative would require 30 rail trips per year to the Site during construction and operations phases and 5 trips per year of HLW shipments to the potential geologic repository. From 2022 to 2023 , when both operations and HLW shipments would be ongoing, rail trips would average 35 per year (3 per month). The Ex Situ/In Situ Combination 1 alternative would require 14 rail trips to the Site during construction and operations and 12 HLW rail shipments per year to the potential geologic repository. From 2022 to 2023 , when both operations and HLW shipments would be ongoing, rail trips would average 26 per year (2 per month). The Ex Situ/In Situ Combination 2 alternative would involve 9 trips per year during construction and operations, 7 HLW rail shipments per year, and 16 rail trips per year during 2020 when both operations and HLW shipments would be ongoing.

Phased Implementation (Phase 1) would involve 11 rail shipments per year to bring materials onto the Site, but no offsite shipments of HLW. The total Phased Implementation alternative would require 26 rail shipments per year during construction and operations, 17 rail shipments per year to the potential geologic repository. This results in 43 rail trips per year (3 to 4 rail trips per month) from 2022 to 2028 when both operations activities and HLW shipments would be ongoing.

Rail traffic volumes associated with the capsule alternatives would be minimal, as discussed in the following text. The No Action and Onsite Disposal alternatives would involve no rail traffic. The Overpack and Ship alternative would involve six rail shipments of HLW per year to the potential geologic repository in 2028 and 2029 only. Rail trips associated with the Vitrify with Tank Waste alternative were included in the rail trips estimated for each of the tank waste ex situ alternatives.

5.11 ANTICIPATED HEALTH EFFECTS

This section describes the anticipated risk to human health for each of the EIS alternatives. The categories of anticipated risk presented were 1) remediation risk resulting from routine remediation activities, such as retrieving waste from tanks and waste treatment operations; 2) post-remediation risk, such as the risk resulting from residual contamination remaining after the completion of remediation activities; and 3) post-remediation risk resulting from human intrusion directly into the residual tank waste remaining after remediation.

Carcinogenic and noncarcinogenic adverse health effects on humans from exposure to radioactive and toxicological contaminants associated with each of these categories of risk were evaluated for each alternative. He alth effects from accidents are described in Section 5.12 and ecological risk effects are described in Section 5.4.6.

The No Action, Long-Term Management, In Situ Fill and Cap, and In Situ Vitrification tank waste alternatives each would result in less than one occupational latent cancer fatality, and cancer risk from chemical exposures for workers would range from 9.84E-07 to 1.95E-07 . During tank waste remediation activities, all of the alternatives involving waste retrieval would result in a similar number of latent cancer fatalities to involved and noninvolved workers (two to four according to the alternative) and similar levels of cancer risk from chemical exposure from 2.52E-06 to 8.22E-07. These health effects would be the result of the large number of tank waste remediation workers for the ex situ alternatives and retrieval, treatment, and handling of the waste. All of the capsule alternatives would result in less than one occupational latent cancer fatality from radiological exposures during remediation. All of the tank waste or capsule alternatives would result in less than one latent cancer fatality and cancer risk of less than 3.35E-06 to the general public during remedial activities.

After remediation was completed, there would be no potential for occupational health risk ; however, migration of residual tank waste and contaminants disposed of onsite in LAW vaults could pose risk to future Hanford Site users. The greatest health risk to future Site users would result from alternatives that would leave all of the waste untreated in the tanks (No Action, Long-Term Management, and In Situ Fill and Cap alternatives) or large amounts of untreated waste in the tanks (Ex Situ/In Situ Combination 1 and 2 alternatives). All of these alternatives would pose similar risk with peak years of risk occurring from 300 to 2,500 years in the future. All of the ex situ alternatives would pose similar lower incremental lifetime cancer risk and hazard indices. Peak years of risk would occur from 5,000 to 10,000 years in the future. Future Site users that intruded into the waste remaining in the tanks would be exposed to substantial risk of a latent cancer fatality under all alternatives that leave more than 1 percent of the waste in the tanks (a probability of 1 in 100 and 3,000) compared to all of the ex situ alternatives (a probability of 1 in 11,700).

Radiation Effects

The effects of radiation emitted during disintegration (decay) of a radioactive substance depend on the kind of radiation (alpha and beta particles, and gamma and x-rays) and the total amount of radiation energy absorbed by the body. This absorbed energy is referred to as the absorbed dose. The absorbed dose, when multiplied by certain quality factors that take into account different sensitivities of various tissues, is referred to as the effective dose equivalent, or simply dose. The common unit of effective dose equivalent is the rem (1 rem equals 1,000 mrem). The total dose received by the exposed population is measured in person-rem. For example, if 1,000 people each received a dose of 0.3 rem (300 mrem), the collective dose would be 1,000 persons 0.3 rem (300 mrem) = 300 person-rem. Alternatively, the same collective dose (300 person-rem) would result from 10,000 people, each of whom received a dose of 0.03 rem (30 mrem) (10,000 0.03 = 300 person-rem).

An individual could be exposed to ionizing radiation externally (from a radioactive source outside the body) and internally (from ingesting or inhaling radioactive material). The external dose is different from the internal dose. It is estimated that the average individual in the United States receives a dose of about 0.3 rem (300 mrem) per year from natural sources of radiation. For perspective, a modern chest x-ray results in an approximate dose of 0.008 rem (8 mrem), while a diagnostic hip x-ray results in an approximate dose of 0.083 rem (83 mrem). A person must receive an acute (short-term) dose of approximately 600 rem (600,000 mrem) before there is a high probability of near-term death. Radiation also can cause a variety of ill-health effects in people. The consequence of environmental and occupational radiation exposure is the induction of latent cancer fatalities. This effect is referred to as latent cancer fatalities because the cancer may take many years to develop and for death to occur.

The factor that this EIS used to relate a dose to its effect was 0.0004 latent cancer fatalities per person-rem for a Site worker and 0.0005 latent cancer fatalities per person-rem for individuals among the general population. The general population latent cancer fatalities factor is slightly higher due to the presence of individuals in the general public that may be more sensitive to radiation than workers (e.g., infants). The concept of calculating latent cancer fatalities can be demonstrated by estimating the effects of natural radiation exposure on an individual. For example, the number of cancer fatalities corresponding to an individual's exposure over a (presumed) 70-year lifetime with a natural radiation dose of 0.3 rem (300 mrem) per year is as follows:

1 person 0.3 rem (300 mrem)/year 70 years 0.0005 latent cancer fatalities/person-rem = 0.0105 latent cancer fatalities.

This should be interpreted in a statistical sense; that is, the estimated effect of background radiation exposure on an exposed individual would produce a 1.05 percent chance that the individual might incur a latent cancer caused by the exposure. In other words, about 1.05 percent of the population is estimated to die of cancer induced by the radiation background.

Uncertainty in Risk Assessments

Human health risk assessment results are conditional estimates dependent on the assumptions that must be made to account for uncertainties of biological processes or a lack of information on source data, transport, or receptor behavior. Therefore, in evaluating risk estimates, it is important to recognize the uncertainties involved in the analysis to place the risk estimates in proper perspective. The uncertainties associated with the TWRS EIS risk estimates are quantitative where many parameters are involved in the models used in the analysis and qualitative for certain risk, such as worker risk based on the historical statistics or actuarial data. Volume Three, Appendix D presents some parameter uncertainties associated with remediation risk (Section D.4.16), anticipated post-remediation risk (Section D.5.17), ecological risk (Section D.6.5), and intruder risk (Section D.7.5), which are briefly discussed as follows. A detailed discussion of the uncertainties associated with the risk assessment is presented in Volume Five, Appendix K.

To estimate risk, information must be available on dose-response relationships, which defines the biological response from exposure to a contaminant. Although human epidemiological data are used for developing radiation and nonradiological chemical dose-response models, this information also is developed in laboratory tests using animals exposed to relatively high doses. Therefore, uncertainty is inherent in dose-response relationships, including extrapolating from effects in animals at high doses to potential effects in humans that most often are exposed at much lower doses.

Another important component of risk assessment is estimating exposure concentration. Uncertainties associated with this component of the analysis included estimating releases of contaminants from emission sources to different environmental media such as the groundwater, soil, air, and surface water, the transport and transformation of contaminants in these media, and the pathway, frequency, and duration by which humans contact the contaminants.

The risk associated with the potential release of radionuclides or chemicals to ambient environmental media during routine operations was estimated using models. The risk estimates determined by these models have a greater uncertainty than those based on the historical or actual data. However, it is reasonable to assume that potential releases would occur on a routine basis over the operational lifetime of the facility. The risk estimates for post-remediation and intruder scenarios were associated with more uncertainty than facility routine operation risk and involved uncertainties associated with the hypothetical land use and intrusion in addition to modeling. Finally, the maximally-exposed individual risk estimates generally involved a greater level of uncertainty than population risk estimates.

5.11.1 Remediation Risk

Radiological and chemical risk from remediation activities for each alternative was evaluated for Hanford Site workers involved in remediation activities; Hanford Site workers not involved in remediation activities (noninvolved workers); the general public; and a maximally-exposed individual from the workers, noninvolved workers, and general public. A maximally- exposed individual is an individual who is assumed to receive the highest possible exposure.

A more detailed description of the methodology and assumptions used in the assessment of human health risk is contained in Volume Three, Appendix D.

5.11.1.1 Comparison of Radiological Consequences from Remediation Operations

Table 5.11.1 summarizes latent cancer fatality risk for each alternative. Details of the risk calculation methodology are presented in Volume Three, Appendix D. Factors that were incorporated into the analysis included differences in the dose-to-risk conversion factor between workers and noninvolved workers and the general population; extent of exposure in each category; and the number of workers involved in each alternative.

The worker dose would result from occupational exposure to radiation. The historical dose to a Hanford Site tank farm worker has been 14 mrem/year. This same dose was assumed for radiation workers during construction of the transfer lines, retrieval system tie-ins, and tank farm confinement facilities, and during tank farm operations, monitoring, maintenance, and closure activities. A dose of 200 mrem/year was assumed for personnel operating evaporators, retrieval facilities, separation and treatment facilities (both in situ and ex situ), and for processing the capsules. The dose of 200 mrem/year was the average whole body deep exposure to operational personnel at the PUREX Plant facility in 1986 (WHC 1995g and Jacobs 1996). An average dose of 200 mrem/year was assumed for the capsule alternatives.

The maximally-exposed individual worker dose is based on a Hanford Site maintenance and operations contractor administrative control level of 500 mrem/year (HSRCM 1994). Because each alternative consists of several operations, the duration of exposure for the maximally-exposed individual was assumed to be equivalent to the duration of the operation requiring the greatest amount of time.

The potential exposure to the noninvolved worker was based on inhaling respirable radiological contaminants, which would be released to the atmosphere (at ground level or through an elevated stack) from remediation activities during each year of operation. The noninvolved worker population was assumed to occupy the area from the Hanford Site boundary to within 100 m (330 ft) of the point of release. The maximally-exposed individual was also assumed to be within 100 m (330 ft) from the point of release for ground releases and between 200 and 800 m (600 and 2,600 ft) from the point of release for elevated releases.

The potential exposure to the general public would result from exposure from air emissions released to the environment during remediation activities, and transported offsite by atmospheric dispersion during each year of operation. Routes of exposure would be from inhaling gaseous and particulate emissions; ingesting vegetables, meats, and milk products contaminated by airborne deposition; and receiving external exposure from submersion in contaminated airborne plumes. The general public population was assumed to occupy the area extending from the Hanford Site boundary (Volume Three, Section D.2.2.3) to an 80-km (50-mi) radius from the release point, centered in the 200 Areas. A reduced Site boundary was assumed for risk assessment and excluded areas that are likely to be released by DOE in the near future. Volume Three, Section D.2.2.3 defines the adjusted Site boundary. The maximally-exposed individual was assumed to live on the Hanford Site boundary and raise and consume all of their own food.

Table 5.11.1 Comparison of Radiological Consequences from Remediation Operations Under Normal Conditions

In the case of an exposed population, risk is expressed as the expected increase in latent cancer fatalities in the population at risk over the duration of the proposed alternative. For the maximally- exposed individual, it is expressed as the increased probability of dying from cancer as a result of the exposure over the duration of the alternative.

The results of the health risk calculations for the tank waste alternatives are presented in Table 5.11.1. The greatest risk to workers would result from the Phased Implementation alternative (3.27 latent cancer fatalities to the worker population as a result of remediation). Risk to the worker population was of similar magnitude for all ex situ alternatives (e.g., 1.96 latent cancer fatalities for Ex Situ No Separations, 2.02 latent cancer fatalities for the Ex Situ/In Situ Combination 1 and 2 alternatives , and 3.12 latent cancer fatalities for Ex Situ Intermediate Separations). This is a result of the large number of tank farm radiation workers that would be involved with these alternatives (e.g., 53,500 person-years for Ex Situ Extensive Separations; 58,500 person-years for Ex Situ Intermediate Separations; 45,000 person-years for Ex Situ/In Situ Combination 1 and 2; 36,700 person-years for Ex Situ No Separations; and 58,500 person-years for Phased Implementation).

For the noninvolved worker population, the greatest risk would be from the Phased Implementation alternative (e.g., 9.04E-04 latent cancer fatalities). The risk from other ex situ alternatives are essentially the same but slightly lower than the Phased Implementation alternative. The risks from Ex Situ Intermediate Separations, Ex Situ No Separations, and Ex Situ Extensive Separations alternatives are 7.92E-04, 8.28E-04, and 7.24E-04 latent cancer fatalities, respectively. All of these risks are extremely low. These risks result primarily from onsite transportation of waste and separation and treatment operations.

For the general public population, no latent cancer fatalities would be expected under any of the tank waste alternatives. The calculations for the cesium and strontium capsule alternatives show there would be no expected latent cancer fatalities under any of the alternatives for remediation workers, noninvolved Hanford Site workers, or the general public population.

5.11.1.2 Comparison of Nonradiological Chemical Consequences from Remediation Operations

The chemical hazard evaluation estimated inhalation intakes for identified chemical emissions and evaluated potential Incremental Lifetime Cancer Risk (ILCR) and noncarcinogenic health hazards using chemical-specific cancer slope factors and reference doses, respectively. Although the cesium and strontium capsules contain chloride, fluoride, and the decay products barium-137 and zirconium-90, no emissions of these chemicals would be associated with any of the capsule alternatives. Consequently, chemical risks were not evaluated for the capsule alternatives. The detailed methodology for estimating chemical intakes and subsequent cancer risk and noncancerous hazards are presented in Volume Three, Appendix D. The key assumptions, methodology overview, and risk assessment results are summarized in the following text.

During remediation activities, routine chemical emissions from the tank farm were based on calculations using tank farm emissions data (Jacobs 1996). Operational emissions from the tank farms, such as would occur while retrieving waste from tanks and gravel-filling the tanks, were based on the tank farm emissions data and appropriate scaling for potential increased emission rates.

The hazard index approach conservatively assumed that the noncarcinogenic health effects would be additive for all chemicals (i.e., all chemicals would have the same mechanism of action and affect the same target organ). The hazard index represents the summation of hazards evaluated. A hazard index greater than or equal to 1.0 (unity) would be indicative of potential adverse health effects in the population of concern from exposure to multiple chemicals. Conversely, a hazard index less than 1.0 would suggest that no adverse health effects would be expected.

All carcinogenic risks were assumed to be additive. Consequently, the total ILCR would represent the summation of individual chemical cancer risks, from each emission source, for each alternative analyzed. Regulatory agencies have defined an acceptable level of risk to be between 1 in 10,000 (1.0E-04) and 1 in 1,000,000 (1.0E-06), with 1.0E-06 being the point of departure and referred to as de minimis (below which there is no concern) risk. For the purpose of this EIS, a risk below 1.0E-06 was considered low, and a risk greater than 1.0E-04 was considered high.

Tables 5.11.2 and 5.11.3 summarize the noncarcinogenic health hazards and carcinogenic risks associated with air emissions for each alternative. As shown by the results in Table 5.11.2, the hazard indices for the maximally-exposed individual worker, maximally-exposed individual noninvolved worker, and maximally-exposed individual general public were well below the benchmark value of 1.0 for all alternatives. Therefore, none of the proposed remediation alternatives would be expected to result in adverse health effects from air emissions.

As shown by the results in Table 5.11.3, ILCR for the maximally-exposed individual general public would be well below 1.0E-06 for all remediation alternatives. For the maximally-exposed individual non-involved worker, estimated ILCRs were slightly greater than 1.0E-06 for the Ex Situ Intermediate Separations (1. 09 E-06), Ex Situ/In Situ Extensive Separations (1.01E-06), Ex Situ/In Situ Combination 1 and 2 (1. 09 E-06), and Phased Implementation (1. 09 E-06) alternatives. For these alternatives, the majority of the overall risk (approximately 73 percent of the overall risk) was attributable to emissions released during tank waste retrieval operations. For the maximally-exposed individual involved worker, estimated ILCRs were just above 1.0E-06 for the Ex Situ Intermediate Separations (2.5 1 E-06), Ex Situ No Separations (1.9 0 E-06), Ex Situ Extensive Separations (2.3 3 E-06), Ex Situ/In Situ Combination 1 and 2 (2.5 2 E-06), and Phased Implementation (2.5 1 E-06) alternatives. For these alternatives, the majority of the overall cancer risk (between 70 and 73 percent of the overall risk) was attributable to emissions released during tank waste retrieval operations.

Table 5.11.2 Comparison of Nonradiological Chemical Hazards from Remediation Operations

Table 5.11.3 Comparison of Nonradiological Chemical Cancer Risks from Remediation Operations

5.11.2 Post-Remediation Risk

5.11.2.1 Methodology

This section describes the potential risks to human health after all remediation activities were completed. Post-remediation human health risks were calculated for two types of health effects: the potential for ILCR and toxic effects. The ILCR was expressed as the increased probability of an individual developing cancer from exposure to radioactive or nonradioactive carcinogenic chemicals. The ILCR rate was approximately one and one-half times higher than the latent cancer fatality risk discussed in Section 5.11.1. There is no universally accepted standard for the level of risk that is considered acceptable. For known or suspected carcinogens, acceptable exposure levels suggested by Federal (55 FR 8666 and 40 CFR 300) and State (WAC 173-340) standards generally are those that represent an ILCR in the range between 1.0E-04 and 1.0E-06, which indicates a probability of 1 in 10,000 to 1 in 1,000,000, respectively. An ILCR of 1.0 means that an individual's lifetime probability of developing cancer approaches 100 percent. For the purposes of this EIS, a risk of less than 1.0E-06 (1 in 1,000,000) was considered low. A risk greater than 1.0E-04 (1 in 10,000) was considered high.

Noncarcinogenic chemicals were evaluated in terms of a hazard index, which is the ratio of chemical intake to a reference dose below which no adverse health effects would be expected. For a hazard index less than 1.0, no adverse health effects would be expected. For a hazard index greater than 1.0, adverse health effects would be expected. A health effect could be fatal or it could be a minor temporary effect on the human body, depending on the specific chemical and amount of exposure involved.

Three key factors were involved in calculating potential risks: the source term, transport, and exposure. The source term is the amount and type of contaminant that may be released to the environment. For example, under the No Action (Tank Waste) alternative the source term would be the entire contents of the tanks that could be released over time into the groundwater. The source terms of the alternatives would vary because of the differences in the quantity, form, or manner of containment of the waste left onsite. The source term for each alternative is described in Volume Three, Appendix D and summarized in Section 5.11.2.2.

Transport refers to movement of the contaminants in the environment from the source (e.g., tanks) to the receptor, which is the person who might be exposed to the contaminant. Following loss of institutional controls (assumed to be 100 years), the tank contents would be released to the subsurface soils and be available for transport to groundwater from infiltration of rainwater and percolation through the soil column. Based on the existing depth of the tanks, resulting soil contamination would be below the maximum depth of soil likely to be contacted by all potential receptors, with the exception of the intruder scenario. Consequently, the soil medium was not evaluated as a post-remediation transport mechanism for any of the alternatives. Because tank waste would be released to the subsurface, no contaminants would be transported into the air, and this medium was not evaluated for any of the alternatives. Also, for this EIS, post remediation impacts for all tank waste alternatives except No Action and Long-Term Management included a closure scenario (closure as a landfill) that included covering the tank farms and LAW vaults with a Hanford Barrier. Therefore, groundwater would be the only post-remediation transport mechanism for all the alternatives.

Under all of the alternatives, any waste that would be disposed of offsite would not be of concern for exposure at the Hanford Site. Any waste that remained on the Hanford Site would have a potential to cause exposure to people in the surrounding community. Onsite waste, under all of the alternatives, would be in a waste tank, a LAW vault, or drywells (cesium and strontium capsules). The potential transport of waste from the tanks or the vaults could result from leaks that might occur during retrieval. Another mechanism would be precipitation filtering through the Hanford Barriers placed over the tanks and vaults, into the underlying vadose zone, and then into the groundwater aquifer. This process can be extremely slow because of the low precipitation rates for the Hanford Site, the ability of the Hanford Barrier to retard water movement, the slow rate that some contaminants would be leached by water, and the slow rate that the contaminated water would move through the vadose zone into the groundwater aquifer. Once in the groundwater, the contaminants would move relatively quickly to the Columbia River, where they would discharge as springs along the river bank or seep directly into the river. Once in the surface water, contaminants would be rapidly diluted by mixing with the river flow. The total process can be extremely slow, taking hundreds or thousands of years from the initiation of the leak, depending on the alternative. Groundwater migration with subsequent discharge to the Columbia River would be the only pathway for migration of contaminants that would occur after remediation was complete for any of the alternatives. A detailed description and computer modeling of the groundwater transport pathway for each alternative is contained in Volume Four, Appendix F and summarized in Section 5.2.

Because the groundwater pathway can take hundreds or thousands of years to result in exposures, and because contaminants in the waste are persistent (i.e., remain in the environment for a long time), risk must be calculated for a number of extended time periods. This shows how potential risk may increase or decrease over time as contaminants move through the groundwater and as radioactive decay changes the characteristics of the contaminants. To show these changes, risks were calculated for five time periods: 300, 500, 2,500, 5,000, and 10,000 years from the present.

The risks described in this section are the incremental risks for the TWRS alternatives only, and do not take into account soil and groundwater below the tank farms and other portions of the Hanford Site that currently are contaminated with a wide variety of radiological and chemical contaminants.

Exposure was the third factor involved in calculating potential risk. Exposure involves the pathway, duration, and intensity of potential exposure from contaminants that have been transported into and through the groundwater. The type and amount of exposure would be dependent on future potential land uses. Five exposure scenarios were modeled: Native American , residential farmer, industrial worker, recreational land user, and recreational shoreline user of the Hanford Reach along the Columbia River. These exposure scenarios were considered likely post-remediation future uses of the land on and adjacent to the Hanford Site and represented a range of land uses that aided in comparison of the impacts of alternatives. The potential risk for each of these future uses would be different because each scenario would involve different levels of consumption and contact with contaminated groundwater or surface water contaminated by discharge of groundwater. Future Site uses will be the subject of analysis in the Hanford Remedial Action EIS, which is being prepared by DOE.

The Native American scenario represented exposures to a Native American who engaged in both traditional lifestyle activities (e.g., hunting, fishing, and using a sweat lodge) and contemporary lifestyle activities (e.g., irrigated farming). Exposure pathways included those defined for the residential farmer scenario plus additional pathways unique to the Native American subsistence lifestyle (such as sweat lodge use). The exposures were assumed to be continuous for 365 days per year over a 70-year lifetime. The scenario used native food ingestion rates. By incorporating subsistence lifestyle activities and native food ingestion rates, this scenario resulted in exposures that would be approximately five times higher than the exposures for the residential farmer scenario.

The residential farmer scenario represented use of the land for residential and agricultural production. This scenario involved a person living on the Hanford Site, drinking water pumped from the groundwater, and producing and consuming animal, vegetable, and fruit products irrigated with groundwater. The exposures were assumed to be continuous and included occasional surface water recreational activities and surface water sediment contact.

The industrial worker scenario involved exposures to workers who lived outside of the Hanford Site but worked in a commercial or industrial setting on the Hanford Site for 20 years. The scenario involved consuming water pumped from the groundwater and indoor activities, although some outdoor activities also were included. These exposures would not be continuous because the worker was assumed to go to a home outside the Hanford Site at the end of the 8-hour work day. The scenario was intended to represent nonremediation workers who would wear no protective clothing.

The recreational land user was a random Sitewide land user. This scenario involved exposure to contamination from recreational camping, hiking, and other land-based recreational activities. These exposures would not be continuous, but rather were assumed to occur for 14 days per year for 30 years. There would be no groundwater or surface water pathway for the recreational land user, thus there were no risks for this exposure scenario under any of the TWRS alternatives. This scenario is not described further in this analysis.

The recreational shoreline user scenario involved exposure to contamination in the groundwater and Columbia River and along its shoreline from recreational swimming, boating, and other shoreline activities. The scenario involved mainly outdoor activities. These exposures would not be continuous, but rather were assumed to occur for 14 days per year for 30 years.

The exposure parameters (e.g., amount of water consumed) for each of these exposure scenarios are shown in Volume Three, Appendix D. The residential farmer, industrial worker, and recreational user exposure scenarios were consistent with the Hanford Site Risk Assessment Methodology, which is the Site-approved method for calculating risks (DOE 1995c). For the first time, DOE has included a Native American exposure scenario in an analysis of potential long-term health effects. This scenario was developed from the Columbia River Comprehensive Impact Assessment (Napier et al. 1996), which was modified at the request of and in consultation with the potentially affected Tribes. This scenario is in its initial stages of development and has not received a complete review by the scientific community, nor has it been approved by the potentially affected Tribes. Therefore, this scenario should be considered preliminary and may have more uncertainty associated with it than the other scenarios. However, the scenario does provide a bounding assessment of the potential health effects to a Native American who might inhabit the Site in the future and engage in both subsistence lifestyle activities (e.g., hunting, fishing, and using sweat lodges) and contemporary lifestyle activities (e.g., irrigated farming). Volume Three, Appendix D contains a detailed description of the methodology and assumptions used to develop the risk calculations.

5.11.2.2 Risk Assessment Results

Summary

Table 5.11.4 shows the maximum calculated potential ILCR from both radiological and carcinogenic chemicals and the noncarcinogenic chemical hazard for each tank waste alternative. The ILCR data shown in Table 5.11.4 are plotted graphically for the Native American, residential farmer, industrial worker , and recreational shoreline user scenarios in Figures 5.11.1 through 5.11. 4 . Risk distribution contour maps for the residential farmer at the time of maximum risk for each alternative are shown in Figures 5.11.5 through 5.11.14. Similar figures showing risk distributions for the other exposure scenarios are presented in Volume Three, Appendix D.

Potential risks were not shown for the recreational land user because this exposure would involve no consumption of groundwater and no contact with the Columbia River. Therefore, there would be no pathway for potential exposure, and there would be no post-remediation risks associated with this scenario.

In general, the results showed the following ranking of the tank waste alternatives from greatest risk to lowest risk, although the order would change somewhat over the 10,000-year period addressed in this analysis:

- No Action;

- Long-Term Management;
- In Situ Fill and Cap;
- Ex Situ/In Situ Combination 2;
- Ex Situ/In Situ Combination 1 ;
- Ex Situ Intermediate Separations;
- Phased Implementation;
- Ex Situ Extensive Separations;
- Ex Situ No Separations; and
- In Situ Vitrification.

All of the ex situ alternatives, except the Ex Situ/In Situ Combination 1 and 2 alternatives , would result in similar risk levels. This is because most of the risk would result from contaminants leached from the 1 percent residual waste that would be left in the tanks after waste retrieval under these alternatives. The risk from the 1 percent residuals in the tanks generally would be 100 or more times greater than the risk from contaminants leached from the LAW vaultsalthough this would vary somewhat at different time periods.

An assessment was prepared of the total latent cancer incidence and fatalities that could occur over 10,000 years for each of the exposure scenarios: Native American , residential farmer, industrial worker, and recreational shoreline use. Table 5.11.5 presents the potential total cancer incidence and fatalities for each alternative over the entire 10,000-year period. The methodology and detailed analysis are presented in Volume Three, Appendix D, Section D.5.15.1. The uncertainties associated with these calculations are high; however, these calculations provide an estimate of possible impacts under one set of future use assumptions and help to compare the long-term risks among the alternatives. These calculations were based on assumptions and represent one set among many possible sets of scenarios representing long-term risk.

Figure 5.11.1 Post-Remediation Risk to the Native American for All Tank Waste Alternatives

Figure 5.11.2 Post-Remediation Risk to the Residential Farmer for All Tank Waste Alternatives

Figure 5.11.3 Post-Remediation Risk to the Industrial Worker for All Tank Waste Alternatives

Figure 5.11.4 Post-Remediation Risk to the Recreational Shoreline User for All Tank Waste Alternatives

Figure 5.11.5 No Action Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals at 300 Years from Present

Figure 5.11.6 Long-Term Management Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals at 300 Years from Present

Figure 5.11.7 In Situ Fill and Cap Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure 5.11.8 In Situ Vitrification Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals at 10,000 from Present

Figure 5.11.9 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals and LAW Vaults at 5,000 Years from Present

Figure 5.11.10 Ex Situ Extensive No Separations Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure 5.11.11 Ex Situ Extensive Separations Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals and LAW Vaults at 5,000 Years from Present

Figure 5.11.12 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post-Remediation Risk

from Tank Residuals and LAW Vaults at 5,000 Years from Present

Figure 5.11.13 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals and LAW Vaults at 5,000 Years from Present

Figure 5.11.14 Phased Implementation Alternative, Residential Farmer Scenario, Post-Remediation Risk from Tank Residuals and LAW Vaults at 5,000 Years from Present

Table 5.11.4 Summary of Bounding Case Incremental Lifetime Cancer Risks and Hazard Indices

Table 5.11.4 Summary of Bounding Case Incremental Lifetime Cancer Risks and Hazard Indices (cont'd)

The integrated post-remediation health effects over 10,000 years from the present for the downriver population on the Columbia River for an estimated population of 500,000 were calculated for each alternative. Table 5.11.6 presents the total fatalities, population dose, and maximum incremental dose for each alternative.

As discussed earlier in this section, the post-remediation risk calculations contained a number of conservative assumptions designed to ensure that the results would provide an upper bound of the long-term risk associated with the TWRS alternatives. For comparison purposes, a nominal case was also evaluated. The nominal case was based on average rather than conservative assumptions. Evaluation methods for the nominal case were identical to the bounding case. Tables 5.11.7 and 5.11.8 present the risk range for the bounding and nominal cases. Risk range refers to the difference between the risk values for the bounding case and the corresponding values for the nominal case.

Table 5.11.5 Bounding Case Post-Remediation Total Cancer Incidence and Cancer Fatalities for 10,000 Years from the Present for all Alternatives

Table 5.11.6 Estimated Fatality, Population Dose (person-rem), and Maximum Incremental Dose (mrem) for the Columbia River User (500,000 persons) for 10,000 Years for all Alternatives

Table 5.11.7 shows the maximum calculated values for ILCR and noncarcinogenic chemical hazard for the bounding and nominal cases. Values shown are the highest values calculated for each exposure scenario and time period under each alternative. The risk range can be determined by comparing values for the bounding case with the corresponding values for the nominal case. For example, under the bounding case for the No Action (Tank Waste) alternative, the post-remediation risk to the residential farmer at 300 years was calculated to be 4.58E-01; the corresponding risk for the nominal case was calculated to be 1.92E-01 (Table 5.11.7).

Table 5.11.8 shows the total post-remediation cancer incidence calculated over a 10,000 year period for the bounding and nominal cases. The risk range can be determined in the same manner as for the maximum risk range. For example, under the bounding case for the No Action (Tank Waste) alternative, the total cancer incidence for the residential farmer over 10,000 years was calculated to be 759; the corresponding cancer incidence for the nominal case was calculated to be 626 (Table 5.11.8).

No Action Alternative (Tank Waste)

The source term under this alternative would be the entire inventory of the tank waste. After the 100-year administrative control period, the tank tops would collapse, and without a Hanford Barrier, precipitation would move through the waste relatively fast, leaching contaminants into the underlying vadose zone and groundwater. The groundwater would rapidly transport contaminants to the Columbia River. The fastest moving contaminants would reach the groundwater aquifer in approximately 140 years after 100 years of administrative control. Within 300 years the ILCR for the Native American, residential farmer , and industrial worker scenarios would be greater than 1.0E-01 (high risk), and the hazard indices would be greater than 1.0 for all the scenarios, indicating that toxic effects would occur. Within 300 years, the ILCR for the recreational shoreline user would be greater than 1.0E-02 (high risk). The ILCR slowly would decrease over time but would be high for at least 10,000 years for the Native American scenario and at least 2,500 years for the residential farmer scenario.

Table 5.11.7 Risk Range for the Bounding and Nominal Cases, Maximum Incremental Lifetime Cancer Risks and Hazard Indices

Table 5.11.8 Risk Range for the Bounding and Nominal Cases, Post-Remediation Total Cancer Incidence for 10,000 Years from the Present for All Alternatives

Long-Term Management Alternative

Under this alternative, the source of contamination would be the entire inventory of the tank waste. This would be the same source as under the No Action (Tank Waste) alternative; however, 1 percent of the current DST inventory would remain in the original DSTs as residual waste and the other 99 percent would be contained in replacement DSTs. As in the No Action alternative, the tank tops would collapse after the administrative control period; however, this collapse would take longer to occur because of the replacement DSTs. As previously described, without a Hanford Barrier, contamination would rapidly leach from the tanks and would reach the groundwater in approximately 140 years after 100 years of administrative control.

Within 300 years, the ILCR would exceed 1.0E-01 (high risk) for the Native American, residential farmer, and industrial worker scenarios and 1.0E-02 (high risk) for the recreational shoreline user. The hazard indices would be greater than 1.0 for all the scenarios, indicating that toxic effects would occur. The ILCR would decrease over time at a somewhat more rapid rate than for the No Action alternative but would remain high for at least 10,000 years for the Native American scenario and at least 2,500 years for the residential farmer scenario.

In Situ Fill and Cap Alternative

The source for contamination under this alternative would be the entire inventory of the tank waste. This would be the same source as under the Long-Term Management alternative; however, there would be a Hanford Barrier over the tanks to retard infiltration under this alternative. Water from precipitation would move slowly through the Hanford Barrier and leach contaminants from the unstabilized waste. Contaminants would not reach the groundwater until approximately 2,300 years from the present. The ILCR would be less than 1.0E-06 (low risk) for all receptors until after 2,500 years. At 5,000 years, potential risks would exceed 1.0E-01 (high risk) for the Native American , 1.0E-02 (high risk) for the residential farmer, 1.0E-03 (high risk) for the industrial worker, and 1.0E-04 (high risk) for the recreational shoreline user. The hazard indices would approach or reach 1.0, indicating that toxic effects would be expected.

In Situ Vitrification Alternative

The source term under this alternative would be the entire inventory of the tank waste. This would be the same waste inventory as under the No Action (Tank Waste) alternative ; however, the waste would be in an immobilized (vitrified) form, and there would be a low-permeability Hanford Barrier over the tanks to retard infiltration of precipitation. Water from precipitation would move slowly through the Hanford Barrier and leach contaminants from the vitrified waste. Contaminants would not reach the groundwater aquifer for approximately 2,350 years , and the ILCR would be less than 1.00-06 (low risk) for all receptors until after 2,500 years.

At 5,000 and 10,000 years, the ILCR would exceed 1.0E-04 (high risk) for the Native American scenario and be between 1.0E-06 (low risk) and 1.0E-04 for the residential farmer, industrial worker, and recreational shoreline user scenarios. The hazard indices would be less than 1.0 for all exposure scenarios and all time periods, indicating that no toxic effects would occur.

Ex Situ Intermediate Separations Alternative

There would be two sources for contamination under this alternative. One source term would be the 1 percent of the current tank waste that would remain in the tanks as residual waste. The other source would be the vitrified waste in the LAW vaults. Both sources would be covered with a Hanford Barrier. While water from precipitation would move slowly through the Hanford Barrier and through the tanks as previously described, the volume of contaminants available to be leached would be only 1 percent of the current tank volume; therefore , the levels of contamination in the groundwater would be reduced substantially. Water from precipitation also would move slowly through the Hanford Barrier and through the LAW vaults, slowly leaching contaminants in the vitrified waste into the groundwater aquifer. The groundwater contamination from the 1 percent residual waste in the tanks would be approximately 100 times or more greater than the contaminants from the LAW vaults, although this would vary somewhat at different time periods. Contaminants would not reach the groundwater until approximately 1,100 years from the present.

The ILCR would be less than or near 1.0E-06 (low risk) until after 2,500 years for all but the Native American scenario. Potential risks for the Native American scenario would exceed 1.0E-04 (high risk) at 2,500 years and would remain above 1.0E-04 through the 10,000-year time period. At 5,000 years, the hazard index would exceed 1.0 for the Native American, indicating that toxic effects would be expected. For the residential farmer and industrial worker scenarios, the ILCR would exceed 1.0E-04 at 5,000 years and be between 1.0E-06 and 1.0E-04 at 10,000 years. The hazards index for the residential farmer would exceed 1.0 at 5,000 years, indicating that toxic effects would be expected. The hazard index for the industrial worker would not exceed 1.0 for any time period. For the recreational shoreline user scenario, the ILCR would only exceed 1.0E-06 (but be below 1.0E-04) at the 5,000-year time period, and the hazard index would be below 1.0. The ILCR from the 1 percent residuals in the tanks would be approximately 100 times greater than the ILCR from the LAW vaults.

Ex Situ No Separations Alternative

Under this alternative, the source would be the same as under the Ex Situ Intermediate Separations alternative except there would be no LAW vaults because all waste retrieved would be disposed of at the potential geologic repository. The source for this alternative would be the 1 percent of the current tank waste that would remain in the tanks as residual waste. As described previously, water from precipitation would move slowly through the Hanford Barrier and leach the residuals into the aquifer within approximately 1,100 years from the present. The risks and hazards associated with this alternative would be nearly identical to the Ex Situ Intermediate Separations alternative because the risks from the 1 percent residuals would be 100 times greater than from the LAW vaults, and they overshadow the ILCR from the LAW vaults. The absence of LAW vaults under this alternative would have little impact on risks. Hazard indices would approach or reach 1.0 at 5,000 years for the Native American and residential farmer, indicating that toxic effects would be expected.

Ex Situ Extensive Separations Alternative

Under this alternative, the sources would be the same as under the Ex Situ Intermediate Separations alternative except that the LAW vaults would contain approximately 100 to 1,000 times lower concentrations of technetium-99 and uranium (total). However, because the ILCR from the 1 percent residuals would be 100 times greater than the LAW vaults in the Ex Situ Intermediate Separations alternative, the reduction in the technetium-99 and uranium (total) would have little e ffect on overall ILCR. Therefore, the ILCR and hazard indices for this alternative essentially would be the same as the Ex Situ Intermediate Separations and Ex Situ No Separations alternatives.

Ex Situ/In Situ Combination 1 Alternative

Under this alternative, approximately one-half of the tank waste by volume would be remediated using the In Situ Fill and Cap alternative and the other half would be remediated under the Ex Situ Intermediate Separations alternative. By selecting the appropriate tanks for retrieval, approximately 90 percent of the largest contributors to groundwater risk (technetium-99, iodine-129, carbon-14, and uranium) would be retrieved, vitrified, and disposed of in the HLW, which would be sent to the potential geologic repository. Both the tanks and the LAW vaults would be covered with a Hanford Barrier, and water from precipitation would leach the contaminants as previously described. Contaminants would not reach the groundwater for approximately 500 years. At 2,500 years, the ILCR would exceed 1.0E-04 (high risk) for the Native American scenario but would be less than or near 1.0E-06 (low risk) for the other scenarios. At 5,000 years, the ILCR would exceed 1.0E-03 for the Native American, residential farmer, and industrial worker, and be between 1.0E-06 and 1.0E-04 for the recreational shoreline user. Potential risks would decrease over time but would remain above 1.0E-04 for the native American and residential farmer at the 10,000-year period, and between 1.0E-06 and 1.0E-04 for the industrial worker and recreational shoreline user. Hazard indices would exceed 1.0 only for the Native American and residential farmer at 5,000 and 10,000 years, indicating that toxic effects would be expected at these time periods.

Ex Situ/In Situ Combination 2 Alternative

The Ex Situ/In Situ Combination 2 alternative would use modified tank selection criteria to provide for ex situ treatment of the largest contributors to groundwater risk while limiting the volume of waste to be processed. Under this variation, approximately 25 tanks instead of 177 tanks would be retrieved and remediated using the Ex Situ Intermediate Separations alternative, while the remaining tanks would be remediated under the In Situ Fill and Cap alternative. As for the Ex Situ/In Situ Combination 1 alternative, the tanks and LAW vaults would be covered with a Hanford Barrier and contaminants would not reach groundwater for approximately 500 years. The ILCR would be less than or near 1.0E-06 (low risk) until after 2,500 years. Potential risks at 5,000 and 10,000 years would be higher than for Ex Situ/In Situ Combination 1 alternative because a greater volume of unstabilized tank waste would be available to leach into the groundwater. The ILCR would exceed 1.0E-04 for all scenarios at 5,000 years and remain above 1.0E-04 for all but the recreational shoreline user through the 10,000-year period. Hazard indices would exceed 1.0 only for the Native American and residential farmer at 5,000 and 10,000 years, indicating that toxic effects would be expected at these time periods.

Phased Implementation Alternative

There would be two sources for contamination under this alternative. One source term would be the 1 percent of the current tank waste that would remain in the tanks as residual waste. The other source would be the vitrified waste in the LAW vaults. Both sources would be covered with a Hanford Barrier. While water from precipitation would move slowly through the Hanford Barrier and through the tanks as previously described, the volume of contaminants available to be leached would be only 1 percent of the current tank volume; therefore, the levels of contamination in the groundwater would be reduced substantially. Water from precipitation also would move slowly through the Hanford Barrier and through the LAW vaults, slowly leaching contaminants in the vitrified waste into the groundwater aquifer. The groundwater contamination from the 1 percent residual waste in the tanks would be approximately 100 times or more greater than the contaminants from the LAW vaults, although this would vary somewhat at different time periods. Contaminants would not reach the groundwater until approximately 1,100 years from the present. At 2,500 years, the ILCR would exceed 1.0E-04 (high risk) for the Native American scenario but would be less than or near 1.E-06 (low risk) for the other scenarios. At 5,000 years, the ILCR would exceed 1.0E-04 for the Native American, residential farmer, and industrial worker, and be between 1.0E-06 and 1.0E-04 for the recreational shoreline user. Potential risks would decrease over time but would remain above 1.0E-04 for the Native American at the 10,000-year period and between 1.0E-06 and 1.0E-04 for the residential farmer and the industrial worker. Hazard indices would exceed 1.0 only for the Native American and residential farmer at 5,000 years, indicating that toxic effects would be expected. The ILCR from the 1 percent residuals in the tanks would be approximately 100 times greater than the ILCR from the LAW vaults.

Capsule Alternatives

All of the cesium and strontium capsule alternatives, except Onsite Disposal, would involve removing all of the cesium and strontium from the Hanford Site, and therefore would not result in any post-remediation risks. Under the Onsite Disposal alternative, the cesium and strontium would decay into their stable progeny before the steel canisters corroded and allowed the release of cesium and strontium, which could move through the vadose zone (Section 5.2). Cesium and strontium, with half-lives of only 30.2 and 28.6 years, respectively, would decay into their stable progeny, barium-137 and zirconium-90. As described in Volume Four, Appendix F, it would take approximately 600 years to transport the cesium and strontium to the groundwater. After this time period, there would be small amounts of cesium and strontium remaining, and no measurable amount would reach the groundwater. Barium and zirconium, the progeny, eventually would reach the groundwater in concentrations so low that they would represent a negligible risk. Therefore, none of the capsule alternatives would result in any substantial post-remediation risks.

5.11.3 Post-Remediation Intruder Scenario

An intruder scenario analysis is presented in Volume Three, Appendix D. The increased cancer incidence risk and increased latent cancer fatality risk for the alternatives are calculated in Volume Three, Appendix D, Section D.7.0, Tables D.7.4.1 and D.7.4.2. The intrusion was a postulated well drilling scenario on the Hanford Site after the assumed loss of institutional control 100 years from the present. The exposure to the well driller who would drive a 30-cm (0.98-ft)-diameter well through the onsite waste and would bring the waste to the surface was calculated. Exposure to a post-drilling resident also was calculated. The post-drilling resident was assumed to have a vegetable garden in the exhumed waste that supplied 25 percent of this individual's vegetable intake.

The greatest risk would come from the No Action, Long-Term Management and In Situ Fill and Cap tank waste alternatives, in which the entire nonimmobilized inventory of waste would remain in the tanks. For each of these three alternatives, the probability of a cancer incidence was calculated to be 1.02E-02 (1 in 100) for the driller and 5.07E-02 (1 in 20) for the post-drilling resident. The probability of a latent cancer fatality was calculated to be 8.52E-03 (1 in 100) for the driller and 4.23E-02 (1 in 24) for the post-drilling resident.

The Ex Situ/In Situ Combination 1 alternative would have the next highest risk with a probability of a cancer incidence of 1.47E-03 (1 in 700) for the driller and 7.94E-03 (1 in 125) for the post-drilling resident. The probability of a latent cancer fatality was calculated to be 1.23E-03 (1 in 800) for the driller and 6.62E-03 (1 in 150) for the post-drilling resident. The Ex Situ/In Situ Combination 2 alternative would have the next highest risk with a cancer incidence probability of 7.26E-04 (1 in 4,000) for the driller and 3.04E-03 (1 in 328) for the post-drilling resident. The probability of a latent cancer fatality was calculated to be 6.05E-04 (1 in 1,500) for the driller and 2.53E-03 (1 in 400) for the post-drilling resident. These risks would be lower than the risks for the Ex Situ/In Situ Combination 1 alternative because waste would be retrieved from a greater number of DSTs. The Ex Situ/In Situ Combination 2 alternative would be similar to the In Situ Vitrification alternative, which would have a probability of a cancer incidence of 3.79E-04 (1 in 2,600) for the driller and 2.54E-03 (1 in 400) for the post-drilling resident. The probability of a latent cancer fatality was calculated to be 3.16E-04 (1 in 3,000) for the driller and 2.04E-03 (1 in 500) for the post-drilling resident.

The lowest risk would come from the Ex Situ Intermediate Separations, Ex Situ No Separations, Ex Situ Extensive Separations, and Phased Implementation alternatives in which 99 percent of the inventory of waste would be removed from the tanks. For each of these four alternatives, the probability of a cancer incidence was calculated to be 1.02E-04 (1 in 10,000) for the driller and 5.07E-04 (1 in 2,000) for the post-drilling resident. The probability of a latent cancer fatality was calculated to be 8.52E-05 (1 in 11,700) for the driller and 4.23E-04 (1 in 2,400) for the post-drilling resident.

The only increased risk from the capsule alternatives would come from the Onsite Disposal alternative. Under the other alternatives, cesium and strontium would be removed from the Hanford Site. The probability of a cancer incidence and latent cancer fatality for both the driller and the post-drilling resident was calculated to be 1.0.

5.12 ACCIDENTS

This section compares the risks resulting from potential accidents associated with the alternatives. Accidents are unplanned events or a sequence of events that would cause undesirable consequences. This analysis addresses the following:

- Occupational risks, including the nonradiological/nontoxicological injuries, illnesses, and fatalities from construction, operation, or transportation accidents common to the workplace such as falls, cuts, and operator-machine impacts. The risk associated with an accident was defined as the product of the probability of an accident occurring and the consequence of the accident; and
- Radiological and toxicological risks associated with transportation and operations. The risks associated with a toxicological or radiological release were expressed as the probability or the number of latent cancer fatalities given the occurrence and consequences of an accident.

The results of the analyses are summarized in the following sections. More detailed information concerning the methodology, supporting data, and assumptions for the basis of the analysis is contained in Volume Four, Appendix E. Appendix E also contains a latent cancer fatality point estimate risk evaluation. The point estimate risk accounted for the probability of the accident occurring. The probability was factored into the latent cancer fatality risk.

Nonradiological occupational and transportation accidents would largely be a function of the number of person-years of labor required to complete the total activities for each alternative. The more person-years of labor, the more injuries, illnesses, and fatalities. For the tank waste alternatives, the alternative that was estimated to have the greatest number of injuries, illnesses, and fatalities was Long-Term Management, and the alternative with the least number was In Situ Fill and Cap. Onsite Disposal would have the highest number of injuries, illnesses, and fatalities among the capsule alternatives, with the Overpack and Ship and Vitrify with Tank Waste alternatives having the lowest.

For radiological and chemical exposures resulting from accidents during remediation, the greatest risk to workers and the public would be associated with a flammable gas deflagration in a waste storage tank. The alternative that would allow the waste to remain unstabilized over the longest period of time would pose the greatest risk. Therefore, the No Action (Tank Waste) and Long-Term Management alternatives would have the highest risk. The lowest risk would come from In Situ Fill and Cap.

For radiological and chemical exposure resulting from accidents after remediation, the greatest risk to the general population would be associated with the No Action and Long-Term Management tank waste alternatives in which the tanks would not have been stabilized with gravel.

In Volume Five, Appendix K an analysis is presented regarding uncertainties associated with the accident analyses for the tank waste alternatives. For the operation accidents, uncertainties were associated with the inventory of waste in the tanks and the atmospheric conditions that would transport the waste released as a result of an accident. Because of this uncertainty, a 100-percent composite inventory was developed for tank farm accidents. This composite incorporated estimates of the historical tank contents, the results from prior individual tank analyses, and the results of recent tank characterization programs. This composite provided a bounding tank waste inventory for the accident analysis. A less conservative approach was to estimate the inventory of radioactive materials contained in the fuel from the single-pass reactors and N Reactor and sent to the tank farms. Reduction factors were applied to account for extracted plutonium, uranium, cesium, and strontium. This nominal radiological inventory is shown in Volume Four, Section E.1.0. Because the tank waste inventory has not yet been well characterized, bounding and nominal radiological and toxicological consequences were presented in the analysis to provide a risk range.

Atmospheric conditions would influence the dispersion in air of contaminants to potential receptors. To provide a bounding case for analysis in the EIS, very unlikely atmospheric conditions were used (99.5 percentile). To assess the effect of using the bounding atmospheric conditions, the uncertainties analysis compared the results of bounding case atmospheric conditions to typical atmospheric conditions (50th percentile).

There would also be uncertainties associated with the analysis of consequences of an accident involving the transportation of vitrified HLW to the potential geologic repository under certain tank waste alternatives. The potential consequences would be influenced by the percent for the HLW by weight that would be mixed in the glass. The baseline analysis in the EIS assumed a 20 percent waste loading ; however, a waste loading of as little as 15 percent and as much as 40 percent could occur. Uncertainties associated with waste loading are discussed further in Volume Two, Section B.8.0. To address this uncertainty , the impacts from a transportation accident involving the baseline waste loading were compared to an accident involving vitrified glass with a 15 percent waste loading and with a 40 percent waste loading (see Volume Four, Section E.16).

In addition to the uncertainties associated with the accident analysis, a number of important assumptions influenced the results presented in this section. These assumptions included the following :

- The offsite general public population for operation accidents was based on census data from the 1990 census. While it is unlikely that the general public population would be constant throughout the operation phase of each alternative, the use of the 1990 census provided a uniform basis for comparison of impact among the alternatives.
- The onsite worker population for operation accidents was based on the Hanford Site work force in 1995. In the future, the Site work force would likely decline , resulting in proportionately lesser impacts than are presented in the EIS. However, use of the existing worker population provided a bounding impact analysis in terms of total impacts and also provided a basis for uniform comparison of impacts among the alternatives.
- For nonradiological occupational construction, operation, and transportation accidents, it was assumed that injuries, illnesses, and fatalities would occur at rates similar to historical rates for each activity.
- It was assumed that there would be no evacuation of Hanford Site personnel in the event of an accident. Emergency planning and evacuation programs are in place at the Hanford Site to mitigate potential consequences resulting from an accident.
- For transportation of HLW to a potential geologic repository the accident scenarios were based on transportation of the waste from the Hanford Site to Yucca Mountain, Nevada by rail.

5.12.1 Comparison of Consequences from Nonradiological Occupational and Transportation Accidents

The number of total recordable cases (injuries and illnesses requiring medical care), lost workday cases (an injury or illness resulting in an employee missing work), and fatalities resulting from construction and operations for each alternative was based on the projected number of employees associated with the activity, multiplied by historical incidence rates. The incidence rates for total recordable and lost workday cases were based on Hanford Site construction statistics. Fatality incidence rates for all DOE sites were used. A comparison of the accident consequences is presented in Table 5.12.1.

Table 5.12.1 also presents consequences of transportation accidents, based on a comparison of the number of injuries and fatalities resulting from the direct impact of traffic accidents. The traffic scenarios analyzed included employee traffic to and from work, and transportation of building materials and other miscellaneous materials to support the alternatives. The incidence rates for injuries and fatalities were based on U.S. Department of Transportation statistics, Washington State Highway accident reports, and Hanford Site statistics.

The calculations for the tank waste alternatives showed the greatest nonradiological and nontoxicological risk would result from the Long-Term Management alternative. This is because of the large number of person-years that would be required to support 100 years of operations and the two retanking campaigns. The In Situ Fill and Cap alternative would have the lowest risk due to the reduced number of person-years required to support 12 years of construction and operation.

The calculations for the capsule alternatives showed the greatest nonradiological and nontoxicological risk would result from the Onsite Disposal alternative because it would require the greatest number of person-years among all of the capsule alternatives. The Overpack and Ship and the Vitrify with Tank Waste alternatives would have the lowest risk.

5.12.2 Comparison of Potential Consequences from Radiological Accidents

Risk is the product of the chance, or probability, of an accident occurring during an operation and the consequences of the accident if it were to occur. An event that was certain to occur would have a probability of 1 (a 100 percent certainty). If an accident was expected to happen once every 100 years, the frequency of occurrence would be 0.01 per year (1 occurrence divided by 100 years = 0.01 occurrences per year). If the operation was scheduled to continue for 20 years, the probability of the accident would be 0.2 (0.01 occurrences per year multiplied by 20 years of operation).

Table 5.12.1 Comparison of Potential Nonradiological/Nontoxicological Accident Consequences

Once the probability and the consequences (for radiation effects, measured in terms of the number of latent cancer fatalities caused by the radiation exposure) of an accident are known, the risk can be determined. The risk is the product of the probability of occurrence times the number of latent cancer fatalities or, in this scenario, a risk of 0.01 latent cancer fatalities . This risk expresses the expected number of latent cancer fatalities, taking account of both the chance that an accident might occur and the estimated consequences if it does occur.

Each phase of the various operations associated with the alternatives was assessed for potential accidents. The spectrum of accidents associated with each alternative is identified in Volume Four, Appendix E, from which dominant accident scenarios were selected for further analysis to determine the latent cancer fatality risk. Dominant accidents were selected through a screening process that involved multiplying the consequence of each accident by the probability of the accident.

5.12.2.1 Tank Waste Alternatives Accident Scenarios

Table 5.12.2 presents the accident scenarios postulated for each tank waste alternative. Table 5.12.3 presents the accident scenarios postulated for each capsule alternative.

5.12.2.2 Summary of Results

Table 5.12.4 compares the latent cancer fatality risk resulting from bounding accident scenarios of each alternative. Details of the risk calculation methodology are presented in Volume Four, Appendix E.

Table 5.12.2 Tank Waste Alternatives Accident Scenarios

Table 5.12.3 Capsule Alternatives Accident Scenarios

The values presented in Table 5.12.4 for the population receptors showed the total number of cancer fatalities resulting from radiological exposure. For the maximally-exposed individual, the table value is the probability that the individual would die as a result of the exposure assuming that the accident occurred.

The calculations for the tank waste alternatives showed the greatest radiological impact during remediation would result from an accident associated with the In Situ Vitrification alternative, in which all 10 workers potentially could die from a lethal radiological dose. From the same accident, 36 noninvolved workers and 5 individuals from the general public potentially could die from latent cancers. The accident could occur during in situ vitrification, if a double-ended break occurred in the off-gas line between the off-gas hood and the off-gas facility, resulting in an unfiltered release directly to the environment. The initiating event was postulated to be an earthquake.

The other alternatives would have the same radiological impact resulting from a flammable gas deflagration in a waste storage tank. The overall risk (factoring in the probability of occurrence) would be lowest for In Situ Fill and Cap, which would require the least amount of time to stabilize the waste.

Table 5.12.4 Comparison of Radiological Consequences Resulting from Potential Operations and Transportation Accidents

The post-remediation accidents with the greatest radiological and chemical risk would result from an accident associated with the No Action (Tank Waste) and Long-Term Management alternatives, in which 42 fatalities could be expected within the population living at that time (beyond the institutional control period) on the Hanford Site and 4 latent cancer fatalities could be expected within the population living off the Hanford Site. The accident could occur after the 100 years of institutional control, when the tanks have exceeded the design life and could collapse. The initiating event was postulated to be an earthquake. The tanks would be stabilized for all the other alternatives and there would be no airborne releases of waste from an earthquake.

A common accident to all capsule alternatives would be crushed capsules caused by an earthquake. It was postulated that the water could be drained from the pool cell storage and capsules crushed at WESF from structural failure because of an earthquake. The workers were assumed to have died as a direct result of the building collapsing on them. Latent cancer fatalities resulting from the exposure to the nonworkers and general public would be unlikely. No other accidents were identified that could result in radiological latent-cancer fatalities for the capsule alternatives.

Beyond design basis accidents (accidents with an annual frequency of happening between 1.0E-06 and 1.0E-07 or below the site-specific designated return frequency for natural events) were also analyzed in Volume Four, Appendix E for radiological and chemical consequences. The bounding beyond design basis accident, common to all tank waste alternatives, was a seismic event resulting in tank dome collapse. Exposure from this accident potentially could result in all the workers receiving a lethal dose and 11 noninvolved workers and 2 individuals from the general public dying from potential latent cancers.

5.12.3 Comparison of Consequences from Potential Toxicological Accidents

The chemical exposures for the accidents listed in Table 5.12.2 were calculated for each alternative. The chemical exposures to the maximally-exposed individual in each of the worker, noninvolved worker, and general public receptor groups were compared to the following guidelines.

The American Industrial Hygiene Agency Emergency Response Planning Guidelines (ERPGs) were used as the primary criteria. For those chemicals lacking published American Industrial Hygiene Agency ERPGs, Hanford Site-specific ERPGs were used as published in the Toxicological Evaluation of Tank Waste Chemicals, Hanford Environmental Health Foundation Industrial Hygiene Assessments (Dentler 1995). These tank farm-specific ERPGs were developed by the Hanford Environmental Health Foundation for the purpose of evaluating health hazards associated with chemicals in the tank farms for accidental releases.

Cumulative hazard indices were calculated for each maximally-exposed individual receptor and for each ERPG screening level (i.e., ERPG-1, ERPG-2, and ERPG-3). A cumulative (concentrations of chemicals with similar hazard effects were added) hazard index greater than 1.0 indicated that the acute hazard guidelines for a group of chemicals would be exceeded and the chemical group could pose a potential acute health impact. Chemicals were subdivided based on acute health impacts into toxic chemicals or corrosive/irritant chemicals.

Emergency Response Planning Guidelines

Emergency Response Planning Guidelines (ERPG): Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing the listed effects.

ERPG 1:

Mild transient adverse health effects or perceiving a clearly defined objectionable odor.

ERPG 2:

Irreversible or other serious health effects, or symptoms that could impair ability to take protective action.

ERPG 3:

Irreversible or life-threatening health effects could result from exposures exceeding one hour.

Table 5.12.5 summarizes the comparison of chemical exposures to their respective ERPGs for operational activities. The same methodology was applied to transportation accidents involving the transport of chemicals to the Hanford Site as summarized in Table 5.12.5 . An integrated worker/public population was used as the receptor for the transportation accident scenarios that included both onsite and offsite receptors.

Table 5.12.5 Comparison of Chemical Exposures Resulting From Potential Operations and Transportation Accidents

Table 5.12.5 Comparison of Chemical Exposures Resulting From Potential Operations and Transportation Accidents (cont'd)

The general public and nominal worker population exposure to toxic or corrosive/irritant chemicals resulting from potential accidents during operations would not exceed the cumulative ratio of exposure to ERPG-3 concentration value for any of the tank waste alternatives. The only such exposure potentially could occur as a result of a transportation accident when chemicals are being transported to the Hanford Site in support of the Ex Situ Intermediate Separations, Ex Situ No Separations, Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1 and 2 , and Phased Implementation alternatives.

A flammable gas deflagration in a waste storage tank would have the highest chemical impacts for all the alternatives. In the event of this accident, emergency planning and evacuation plans are in place at the Hanford Site to mitigate potential consequences. Consequently, these noninvolved workers would not likely be exposed to air concentrations that would result in significant health effects. Failure to evacuate could result in noninvolved worker exposure downwind from the plume source that could exceed the cumulative ratio of exposure to ERPG-3 concentration value. The potential exists for workers to exceed ERPG-3; however, the workers would have received a potentially lethal radiological dose from the accident. There would be no irreversible health effects to the general public.

The cesium and strontium capsule alternatives would not exceed the cumulative ratio of exposure to any ERPG concentration values for the general public, noninvolved worker, or worker.

5.12.4 Vitrified HLW Transport to the Potential Geologic Repository

Under the ex situ tank waste treatment alternatives the HLW streams would be vitrified or calcined and eventually shipped to a geologic repository assumed to be located 2,140 km (1,330 mi) offsite by a dedicated train of 10 railcars per train. The nonradiological and radiological transportation impacts associated with this activity are evaluated in this section.

The expected injuries and fatalities resulting from transportation accidents associated with each ex situ stabilization alternative are summarized in Table 5.12.6. Fatalities resulting from trauma caused by transportation accidents would be directly proportional to the number of miles driven. The Ex Situ No Separations alternative would have the highest number of shipments and therefore the most fatalities. The Ex Situ Extensive Separations alternative would have the least fatalities.

Table 5.12.6 Injuries and Fatalities from Rail Transportation Accidents

Radiological exposures resulting from routine exposures and accidents while the waste is in transit were analyzed using RADTRAN 4 (Neuhauser-Kanipe 1992). For routine risk, the key variable in the code was the dose rate from the vehicle package. The radioactive shipments in this analysis were assumed to be less than the regulatory maximum dose rate of 10 mrem per hour at 1 m (Jacobs 1996). For accidents, the population doses calculated by RADTRAN 4 were dependent on the accident probability, release quantities, atmospheric dispersion parameters, population distribution parameters, human uptake, and dosimetry models (Jacobs 1996).

The routine exposures were addressed as onsite population latent cancer fatality risk and offsite population latent cancer fatality risk. The analysis addressed radiological accident impacts as both integrated population latent cancer risk (i.e., accident frequencies time consequences integrated over the entire shipping campaign) and urban population latent cancer fatality risk. The routine and accident latent cancer fatality risks resulting from transporting vitrified or calcined HLW to a potential geologic repository are presented in Table 5.12.7 for each of the ex situ treatment alternatives. The radiological impacts from both routine exposure and accidents would be directly proportional to the number of trips made to the repository. The Ex Situ No Separations alternative would have the highest number of trips made to the repository. The Ex Situ No Separations alternative would have the highest number of shipments and therefore the highest latent cancer fatality risk. The Ex Situ Extensive Separations alternative would have the lowest latent cancer fatality risk.

Table 5.12.7 Latent Cancer Fatality Risk from Routine and Accident Radiological Exposures While Shipping Vitrified or Calcined High-Level Waste By Rail to a Proposed Geologic Repository

A main uncertainty associated with calculating the radiological doses resulting from transporting HLW to a potential geologic repository would be the location of the repository. The analysis was based on the assumption that the waste would be transported to Yucca Mountain should that site be shown to be acceptable and approved as a potential geologic repository. If Yucca Mountain should not be approved the latent cancer fatality risks could increase or decrease depending on the distance and population pathways of the alternative site.

5.13 CUMULATIVE IMPACTS

This section describes potential cumulative impacts associated with implementing the TWRS alternatives and other actions at the Hanford Site. The TWRS impacts described in this section include the impacts of both remediation of the tank waste and subsequent closure of the tank farms. The section identifies other actions that could impact the Hanford Site and, when possible, provides a qualitative or quantitative discussion of the potential cumulative impacts of the TWRS alternatives and the other actions.

The impacts of the tank waste and capsule alternatives described in previous sections would occur in the context of other past, present, and reasonably foreseeable activities at the Hanford Site. The National Environmental Policy Act (NEPA) implementation regulations define a cumulative impact as the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes other such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

As discussed in Section 5.0.4, post-remediation risk of TWRS EIS alternatives would be strongly influenced by the type and form of waste remaining in the tanks or on the Hanford Site following remediation, the amount of time and labor that would be needed to accomplish the alternative, and the environmental disturbance that would take place during the work, including permanent disturbance or long-term resource commitment. These factors were comprehensively analyzed and discussed throughout Section 5.0 for each resource for each of the TWRS alternatives. For purposes of discussing the potential cumulative impacts in this section, the TWRS alternative having the highest potential cumulative impacts was drawn from the comprehensive discussion and presented in combination with the other past, present, and reasonably foreseeable sources of impact. Thus the upper bound of the reasonably foreseeable potential cumulative impacts is presented.

Actions at the Hanford Site that would have quantifiable environmental impacts that would be cumulative with TWRS actions include the Hanford Site waste management and remedial action programs, the Environmental Restoration and Disposal Facility, the management of spent nuclear fuel stored in the K Basins, the US Ecology Site, and the replacement cross-site transfer system. While these activities would occur in the same general time frame as the EIS alternatives, little quantifiable cumulative impacts of the TWRS alternatives and other projects would be expected. Among the cumulative impacts that would occur would be impacts to land use and biological resources, human health, air quality, groundwater quality, and socioeconomics.

5.13.1 Actions at Other DOE Sites or Facilities and Programmatic Actions that Could Potentially Impact the Hanford Site

Programs or actions at other DOE sites and DOE programmatic evaluations that could impact the Hanford Site are described in this section.

Waste Management Programmatic EIS

DOE will determine what type, size, and number of waste storage, treatment, and disposal facilities will be needed for DOE waste and where to build them. This would include determining the transportation network; i.e., deciding what sites would ship to other sites for treatment, storage, and disposal.

Under the Waste Management Programmatic EIS, the Hanford Site is an alternative site for centralized or regionalized management of DOE waste (DOE 1995e). The Hanford Site would manage its own waste (decentralized alternative), receive waste from offsite (regional or centralized alternatives), or ship waste to another DOE or commercial waste management facility (regional or centralized alternatives).

In the EIS, DOE considered a broad spectrum of hazardous and radioactive waste management issues at the Hanford Site. The highest level of adverse impacts at the Hanford Site and the surrounding region would result from alternatives in which treatment and disposal facilities would be constructed for the Hanford Site to manage its own waste, in addition to accepting waste from offsite DOE facilities for treatment, disposal, or storage. Offsite waste received would include LAW and low-level mixed waste for treatment and disposal, transuranic waste for treatment, and HLW canisters for storage. The lowest level of adverse impacts of the waste management alternatives would be those in which the Hanford Site would package and ship its waste for offsite disposal, or would receive only small quantities of waste for treatment and disposal from other sites.

The Hanford Site-specific impacts under the DOE Waste Management Program alternatives would be primarily confined to the Central Plateau, the same area where proposed TWRS activities analyzed in the TWRS EIS would occur. Potential cumulative impacts of conducting waste management activities on the Central Plateau would involve increased land use, habitat, health effects, air quality, water quality, transportation, and socioeconomic impacts.

Disposal of Decommissioned, Defueled Cruiser, Los Angeles Class, and Ohio Class Naval Reactor Plants

The final EIS, prepared by the U.S. Navy, evaluates the potential impacts of disposing of defueled reactor plants from decommissioned naval vessels (Navy 1996). The preferred alternative is land burial at the low-level waste burial grounds at the Hanford Site. DOE is a cooperating agency in the preparation of this EIS.

5.13.2 Actions Adjacent to the Hanford Site

In addition to DOE waste management activities, there are other nuclear facilities at or near the Hanford Site that could contribute to radioactive releases. These facilities include a commercial radioactive waste burial site, a commercial nuclear power plant, a nuclear fuel production plant, a commercial low-level radioactive waste compacting facility, and a commercial decontamination facility. The ongoing operations of these facilities would have cumulative impacts with the proposed TWRS activities in areas such as socioeconomics, air and water emissions, transportation, and land use.

DOE actions near the Columbia River could be affected by the U.S. Department of Interior's proposal to designate the Hanford Reach of the Columbia River as a Recreational River under the Wild and Scenic Rivers Act. DOE was a cooperating agency with the U.S. Department of Interior in preparing the Hanford Reach of the Columbia River Final River Conservation Strategy EIS (NPS 1994). The U.S. Department of Interior published its Record of Decision and made its recommendation to Congress. Designation of the Hanford Reach as a Recreational River awaits congressional action.

5.13.3 Currently Planned or Reasonably Foreseeable DOE Actions at the Hanford Site

This section describes the currently planned and reasonably foreseeable actions originating at the Hanford Site with potential cumulative impacts. Actions are identified in the context of the existing, ongoing, or planned activities. The activities are grouped into actions on the Central Plateau and actions in other Hanford Site areas. A number of proposed actions at the Hanford Site are being evaluated in environmental assessments, as detailed in the Draft 1995 Hanford Mission Plan (DOE 1994g). At present, it is not possible to include a quantitative analysis of all the impacts from these projects in this analysis because evaluation of many of these projects is not complete. However, these projects may contribute to cumulative future impacts from proposed remedial actions in the geographic areas considered in this EIS.

5.13.3.1 Central Plateau

The major impacts from the proposed TWRS alternatives would occur on the Central Plateau in the 200 Areas from 1997 to 2028, although tank farm closure actions would occur later.

Closure

Closure of the SSTs and DSTs is beyond the scope of this EIS. However, closure options could be interrelated with the TWRS alternative that is selected for implementation and the long-term impacts of the alternatives would be influenced by closure actions. Due to a lack of information, decisions on the appropriate type of tank farm closure cannot be made at this time. However, the long-term impacts of closure are reasonably foreseeable, and therefore are discussed in this section. Closure options range from clean closure, in which the tanks and all associated waste would be removed from the tank farm areas and disposed of onsite or offsite, to leaving the tanks and most of the tank waste in-place as described in the In Situ Vitrification and the In Situ Fill and Cap alternatives. Tank farm closure methods would be determined when the overall long-term land-use policies were established at the Hanford Site. The impacts of closing existing TWRS sites are also related to other major waste disposal facility closure issues on the Central Plateau. For purposes of calculating the reasonably foreseeable long-term impacts of the TWRS alternatives it has been assumed that closure would consist of emplacement of engineered barriers over waste left or placed in the near surface soils. Ultimate closure decisions would affect long-term land use of the Hanford Site. Long-term land use and ongoing Hanford Site operational issues will be addressed in the Hanford Remedial Action EIS and the Site's Comprehensive Land Use Plan, both of which are being prepared, and the planned Hanford Sitewide EIS.

Environmental Restoration Disposal Facility

The Environmental Restoration Disposal Facility, which has been constructed adjacent to the 200 Areas, provide s for the safe storage and disposal of waste generated during environmental restoration activities at the Hanford Site (DOE 1994h). The Environmental Restoration Disposal Facility, a large double-lined subsurface trench, serve s as the disposal facility for most of the waste excavated during remediation of waste management units at the Hanford Site. Waste generated from remediating Comprehensive Environmental Response, Compensation, and Liability Act past practice units and RCRA closure and corrective action activities will be placed in the Environmental Restoration Disposal Facility. Only waste that originates within the Hanford Site will be placed in the facility. The waste is expected to consist of hazardous, radioactive, and mixed waste. The Environmental Restoration Disposal Facility site will cover as much as 4.1 km^2 (1.6 mi^2) on the Central Plateau, approximately in the center of the Hanford Site, southeast of the 200 West Area and southwest of the 200 East Area.

Under current climate conditions, none of the contaminants that would be placed in the Environmental Restoration Disposal Facility are expected to reach groundwater within 10,000 years. The shrub-steppe habitat at the Environmental Restoration Disposal Facility site is considered priority habitat by Washington State. The disturbed area includes the Environmental Restoration Disposal Facility site itself (including the trench, stockpiling areas, roads, and supporting facilities), a borrow area, and a rail line right-of-way. Environmental Restoration Disposal Facility impacts that might be cumulative with TWRS alternatives include land use, habitat, air quality, transportation, and socioeconomic impacts.

Safe Interim Storage of Hanford Tank Waste

As described in Section 3.2.1.6, DOE decided to implement most of the actions of the preferred alternative, which were evaluated in the Safe Interim Storage of Hanford Tank Waste EIS (DOE 1995i). The actions will involve the continued operation of the existing cross-site transfer system between 200 West and 200 East Area tank farms until replaced by construction and operation of a new replacement cross-site transfer system and the continued operation of the mixer pump installed in tank 241-SY-101 to mitigate the unacceptable accumulation of hydrogen and other flammable gases. In the interim period prior to making and implementing decisions based on the TWRS EIS, the replacement cross-site transfer system would be used to transfer liquid waste from interim stabilization of SSTs and waste generated by 200 West Area facilities. Construction of the replacement cross-site transfer system began in late 1995 and is to be completed in 1998. Safe interim storage impacts identified in the Safe Interim Storage of Hanford Tank Waste EIS that might be cumulative with TWRS alternatives include land use and habitat.

Hanford Site Plutonium Finishing Plant Stabilization

DOE evaluated alternatives to convert plutonium-bearing materials at the Plutonium Finishing Plant Facility into a more stable, safer form and to reduce potential environmental and worker safety risks.

The Plutonium Finishing Plant Stabilization Final EIS was published in May 1996 (DOE 1996d) and a Record of Decision was issued in July 1996 (DOE 1996c). DOE decided to initiate removal of plutonium-bearing material in hold-up at the Plutonium Finishing Plant Facility and to initiate the stabilization of this and other plutonium-bearing material at the facility . Impacts that may be cumulative with TWRS alternatives include health effects and socioeconomics.

Waste Receiving and Processing Facility

During 1994, construction was started on the first major solid waste processing facility associated with Hanford Site cleanup. Scheduled to begin operations in March 1997, the Waste Receiving and Processing Facility Module 1 will be used to analyze and prepare for disposal, drums, and boxes of waste resulting from plutonium operations at the Hanford Site. Some of the materials processed will qualify as LAW suitable for disposal directly at the Hanford Site. The remaining waste will be certified as transuranic waste and packaged for eventual shipment to the Waste Isolation Pilot Plant in Carlsbad, New Mexico. Materials requiring further processing to meet disposal criteria will be retained at the Hanford Site pending treatment.

The 4,800-m^2 (52,000-ft^2) facility will begin operations in 1997 near the Central Waste Complex in the 200 West Area. The facility is designed to process 6,800 drums of waste annually for 30 years. No potentially cumulative impacts have been identified at this time for this action.

Effluent Treatment Facility and Liquid Effluent Retention Facility

Th ese facilit ies will provide for collection, retention, and treatment if necessary, of liquid waste before it is discharged to the soil column through a Washington State-approved land disposal site north of the 200 West Area. An evaluation of the Effluent Treatment Facility indicated that no significant impacts would result (DOE 1992c). Therefore, no potentially cumulative impacts have been identified at this time for this action.

US Ecology Low-Level Radioactive Waste Disposal Facility

The US Ecology Low-Level Radioactive Waste Disposal Facility occupies 40 ha (100 ac) of land leased by DOE to Washington State. US Ecology subleases the land from the State. The facility is located just southwest of the 200 East Area and receives low-level waste from commercial organizations. US Ecology began operating in 1965 and since that time has received a total of approximately 3.4E+05 m^3 (1.3E+07 ft^3) of commercial low-level waste through December 1994. This waste consists of solid or solidified material, contaminated equipment, cleaning waste, tools, protective clothing, gloves, laboratory waste, and naturally occurring or accelerator- produced radioactive material containing about 2.2 million curies. All waste and waste containers have been emplaced in trenches excavated into the surficial sediments. When completely filled, each trench is covered with at least 2.4 m (8 ft) of soil and capped with a layer of gravel (Ledoux 1995). US Ecology is assumed to continue to receive and emplace commercial low-level waste through the year 2063 (Jacobs 1996). Impacts that might be cumulative with TWRS alternatives include land use, groundwater, and transportation.

5.13.3.2 Other Hanford Site Areas

Hanford Remedial Action Program

The Hanford Remedial Action Program encompasses remediating contaminated soil and groundwater, decommissioning and decontaminating structures, and closing treatment, storage, and disposal facilities. Much of the waste to be generated by environmental restoration activities at the Hanford Site would be placed in the Environmental Restoration Disposal Facility. The Hanford Remedial Action EIS (DOE 1996c) examine s these needs primarily in the context of DOE's responsibilities under RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act, and the Tri-Party Agreement (Ecology et al. 1994).

The Hanford Remedial Action EIS compare s alternatives for land use including no action, unrestricted use, restricted use, and exclusive-use scenarios for various areas of the Hanford Site. The EIS analysis divide s the Hanford Site into four geographic areas and evaluate s the land-use alternatives for each of those areas. The Hanford Remedial Action Draft EIS has been published for public review .

Waste generated by the Hanford Remedial Action Program would be disposed of in the Environmental Restoration Disposal Facility on the Central Plateau. Impacts that might be cumulative with TWRS alternatives include land use, habitat, groundwater, traffic, and socioeconomics.

Decommissioning Eight Surplus Production Reactors

Present and foreseeable actions in the 100 Areas consist primarily of decommissioning the eight surplus production reactors along the Columbia River. DOE has decided on safe storage for 75 years or less, followed by one-piece removal of each reactor block and transport intact on a tractor-transporter from its present location in the 100 Areas to the 200 West Area for disposal. Contaminated materials associated with the fuel storage basins would also be disposed of in the 200 West Area, along with contaminated equipment and components associated with the reactors. Uncontaminated portions of the fuel storage basins would be removed to provide access for the tractor-transporter. Other uncontaminated structures and equipment would be demolished and placed in landfills in the vicinity of the reactor sites (DOE 1992b and DOE 1993j). Impacts that might be cumulative with TWRS alternatives include land use and habitat.

Management of Spent Nuclear Fuel Currently Stored in the K Basins

DOE evaluated alternatives to reduce risks associated with spent nuclear fuel and sludge currently stored in the water-filled K East and K West Storage Basins (K Basins). A Final EIS was issued in January 1996 and a Record of Decision was issued in March 1996. DOE decided to implement the preferred alternative, which consists of removing the spent nuclear fuel from the storage basins, drying, conditioning, and sealing the fuel in canisters, and storing the canisters in a new dry storage facility for up to 50 years pending decisions on ultimate disposition. The storage facility will be located in the 200 East Area on the Central Plateau. Impacts that might be cumulative with TWRS alternatives include land use, habitat, transportation, and socioeconomics.

5.13.4 Summary of Cumulative Impacts

Although many of the activities described previously would occur in the same general time frame as the TWRS EIS alternatives, little quantifiable cumulative impacts of the TWRS alternatives and other projects would be expected because of differences in the nature of the activities and their physical separation.

From certain broader environmental perspectives, cumulative impacts of the TWRS alternatives and other projects can be expected. For example, multiple projects each impacting a small amount of sensitive shrub-steppe habitat eventually could have a more substantial impact by fragmenting the habitat and reducing the total amount of shrub-steppe remaining on the Hanford Site. Cumulative impacts from groundwater would consist of a combination of 1) the existing groundwater contamination; 2) potential additional contamination from waste currently in the soils above the groundwater; and 3) potential additions from waste left in place or placed in the ground by future activities including TWRS alternatives.

Another area in which cumulative impacts could occur is on the socioeconomic environment. For example, if decisions are made that lead to constructing and operating facilities at the Hanford Site that currently are not foreseen, there would be additional employment and other economic benefits for the Tri-Cities area. However, there also could be additional population growth and the resulting burdens on public services and facilities such as schools, and impacts on the price and availability of housing. Table 5.13.1 presents a matrix of Hanford Site activities that overlap the proposed TWRS alternatives in time and location and could have cumulative impacts.

The proposed TWRS activities would be carried out against the baseline of overall Hanford Site operations. The TWRS alternatives and ongoing operations would have cumulative socioeconomic, land use, risk, and ecological impacts. The range of operational alternatives would be quantified in the planned Hanford Sitewide EIS. At this time, the magnitude of the additive impacts cannot be quantified. Assuming that the Hanford Site's environmental restoration and waste management mission does not change, it is likely that the future range of operational impacts would not be greater than the current impacts associated with Hanford Site waste and operations.

Land Use and Biological Resources

The Hanford Site covers 145,000 ha (358,000 ac). Approximately 6 percent of the site has been disturbed and actively used (Cushing 1995). An assessment of future land uses at the Hanford Site was conducted as part of the scoping for the Hanford Remedial Action EIS and was published as the Final Report of the Hanford Future Site Uses Working Group (HFSUWG 1992). The Central Plateau of the Hanford Site, which encompasses the 200 East and 200 West Areas, is suggested for waste storage and disposal in support of Site cleanup. The area identified in the Central Plateau for cleanup consists of a buffer zone and an exclusive waste management use area.

Table 5.13.1 Cumulative Impacts of Other Projects and TWRS Alternatives

According to the report of the Hanford Future Site Uses Working Group, all future waste from cleanup activities would be placed in the exclusive waste management use area. The buffer zone is to reduce risks that could result from waste management in the exclusive use area. The report of the Hanford Future Site Uses Working Group does not constitute official DOE policy or guidance; however, DOE initiated the study as a part of the scoping for the Hanford Remediation Action EIS to help establish cleanup levels.

A comprehensive land-use plan is being coordinated with the Hanford Remedial Action EIS to further define the preferred alternative and is expected to be finalized in 1996. Therefore, pending availability of the plan, the Final Report of the Hanford Future Site Uses Working Group will be used as the baseline for purposes of analysis in the TWRS EIS.

The proposed Central Plateau exclusive waste management use area would consist of approximately 11,700 ha (28,800 ac), including about 6,700 ha (16,600 ac) for the buffer zone and about 4,900 ha (12,200 ac) for the exclusive waste management use area. About 2,300 ha (5,800 ac) of the proposed 4,900 ha (12,200 ac) exclusive waste management use area is relatively undisturbed land, which represents the maximum area of potential impact for the TWRS alternatives and the other proposed actions described in this section.

Virtually all proposed TWRS activities under the alternatives in this EIS would occur within the Central Plateau's exclusive waste management area or at two potential borrow sites to the west of the Central Plateau. All TWRS sites would impact some shrub-steppe habitat areas, some of which are currently disturbed. There are approximately 8,500 ha (21,000 ac) of shrub-steppe habitat on the Central Plateau. This area constitutes approximately 15 percent of the total remaining Hanford Site shrub-steppe habitat. Activities under all alternatives would occur largely in areas that are currently partially disturbed, except at the two potential borrow sites, where activities would occur in currently undisturbed areas. A third potential borrow site is located on partly disturbed land between the 200 East and West Areas.

Other major projects that would be substantial contributors to cumulative land use and habitat impacts on the Central Plateau include the Hanford Remediation Program, the Environmental Restoration Disposal Facility, and the replacement cross-site transfer system. Estimates for the Hanford Remedial Action Program indicate that about 2,150 ha (5,300 ac), including about 480 ha (1,200 ac) of shrub-steppe habitat, could be disturbed by the highest impact alternatives (Jacobs 1996). Much of the waste to be generated by the Hanford Remedial Action Program would be disposed of in the Environmental Restoration Disposal Facility. Remedial action waste would result from soil and groundwater cleanup, decommissioning and decontamination of structures, and closing treatment, storage, and disposal facilities. The Environmental Restoration Disposal Facility site would cover 495 ha (1,240 ac) on the Central Plateau. In addition, approximately 55 ha (135 ac) of habitat impacts would occur as a result of borrow site activities and 40 ha (100 ac) for a rail line right of way (DOE 1994h). The replacement cross-site transfer system (addressed in the Safe Interim Storage Record of Decision [60 FR 61687]) would remove 9 ha (22 ac) of shrub-steppe habitat, with a total land commitment of 30 ha (74 ac). Approximately 6 ha (15 ac) on the Central Plateau would be disturbed to accommodate disposal of waste from decommissioning the surplus reactors. The preferred alternative for the K Basins spent nuclear fuel could disturb an additional 3.5 ha (9 ac), all of which could be shrub-steppe habitat (DOE 1995j). Regionalized or centralized alternatives under the Waste Management Programmatic EIS would use an additional 72 ha (179 ac) of Hanford Site land.

The TWRS alternative with the greatest land-use impact would be the Phased Implementation alternative, which would impact about 6 percent (269 ha [664 ac]) of the exclusive waste management use area. While TWRS impacts to land use and biological resources may not by themselves be substantial, fragmentation of the Central Plateau's habitats by TWRS alternatives, other waste management actions, and remedial actions could have a cumulative impact greater than the sum of the individual impacts. Cumulative land-use impacts for the TWRS EIS Phased Implementation alternative and other major activities on the Central Plateau are shown in Table 5.13.2.

Radiation Dose and Health Effects

The cumulative population dose due to past Hanford Site operations from startup in 1944 through 1994 has been estimated to be 100,000 person-rem (estimated to one significant figure). Using the conversion factor of 2,000 person-rem per latent cancer fatality, the number of inferred cumulative latent cancer fatalities since startup would total about 50. In the same 50 years since startup, the population of interest (assuming a constant population of 380,000 and an average individual dose from naturally-occurring radiation of 0.3 rem per year) would have received about 5,000,000 person-rem from naturally-occurring radiation sources (natural radiation), which would result in about 2,500 latent cancer fatalities. In the same 50 years, about 27,000 cancer fatalities from all causes would have been expected in that population (DOE 1995j).

Table 5.13.2 Cumulative Land-Use and Habitat Impacts

The TWRS preferred tank waste alternative is the Phased Implementation alternative, which would take about 27 years to complete. The cumulative offsite population dose from this TWRS alternative would be about 388 person-rem, which infers that about 0.2 latent cancer fatalities would result. Other planned activities that could take place in that same 27-year time period include managing spent nuclear fuel stored at the K Basins, stabilization activities at the Plutonium Finishing Plant, and programmatic waste management actions. The spent nuclear fuel management preferred alternative was identified as the Drying/Passivation with Dry Storage alternative, which would take about two years to complete (DOE 1995j). Cumulative population dose from implementing the preferred alternative would be about 2 person-rem, which infers that no latent cancer fatalities would result. Cumulative population dose from the Plutonium Finishing Plant stabilization and removal activities would be approximately 14 person-rem (DOE 1996b). No latent cancer fatalities would be expected to result from that dose. The maximum cumulative population dose in the Hanford Site region from programmatic waste management alternatives would be approximately 220 person-rem (DOE 1995m). No latent cancer fatalities would be expected to result from that dose. Continued operations of the Washington Public Power Supply System's Plant-2 for the next 27 years (0.7 person-rem per year) (DOE 1995j) would result in an additional cumulative population dose of about 19 person-rem, which infers that no latent cancer fatalities would result. Assuming that other Hanford Site activities would continue for the next 27 years at a level about equal to the present (0.6 person-rem per year) results in an additional cumulative population dose of about 16 person-rem, which infers that no additional latent cancer fatalities would result. Thus, the long-term cumulative total population dose from the reasonably foreseeable activities on the Hanford Site would be about 659 person-rem. Less than one latent cancer fatality would be expected to result from that dose.

For perspective, over the next 27 years the population (380,000 people) would have received about 2,700,000 person-rem from natural background radiation. That dose would result in about 1,350 latent cancer fatalities. In the same 27 years, about 14,000 cancer fatalities from all causes would be expected among the population in the region of analysis (within 80 km [50 mi]). The long-term cumulative population doses and health effects are presented in Table 5.13.3.

Table 5.13.3 Cumulative Radiation Population Dose and Health Effects [1]

The maximally-exposed individuals would receive a cumulative annual average dose of about 0.7 mrem/yr, less than 1 percent of the 100 mrem/yr offsite dose limit (DOE 1996b).

Air Quality

Air emissions from constructing and operating facilities under the TWRS alternatives would overlap with those from ongoing Site operations and other activities on the Central Plateau including Environmental Restoration Disposal Facility operations and some Hanford Remedial Action program activities. These activities would result in cumulative air emissions.

The principal air quality impacts associated with the Environmental Restoration Disposal Facility would be from excavating disposal trenches, vehicle emissions, and fugitive dust from placing two truck loads of waste and clean fill in the trenches. The Environmental Restoration Disposal Facility would use appropriate dust suppression techniques to comply with air quality standards. Air quality impacts from Hanford Remedial Action program activities would be from excavating waste sites and transporting waste to the disposal facility.

Operating powerhouses on the Hanford Site are the primary source of criteria pollutants (particulates, nitrogen oxides, sulfur oxides, and carbon monoxide) in the Hanford Site baseline. The baseline criteria pollutant concentrations are available from estimates derived by modeling the Hanford Site operational emissions (PNL 1995). Table 5.13.4 presents the modeled baseline results along with the TWRS, Environmental Restoration Disposal Facility, and the Hanford Remedial Action program criteria pollutant impacts. The TWRS impacts are not for a single alternative but rather are the maximum values selected from among all the TWRS alternatives.

Table 5.13.4 Cumulative Air Quality Impacts

Groundwater Quality

Cumulative groundwater impacts need to be examined in the context of existing sources of contamination in the soil, vadose zone, and groundwater. The following contaminants were consistently detectable in soil on the Hanford Site: cobalt-60, strontium-90, cesium-137, plutonium-239, plutonium-240, and uranium. Soil concentrations for these radionuclides were higher near and within the Hanford Site boundaries compared to offsite concentrations (PNL 1993a). Contaminants in the vadose zone in the 200 Areas are primarily associated with past waste disposal practices using engineered structures such as cribs, drains, septic tanks and associated drain fields, and reverse wells (wells that do not penetrate to groundwater); percolation from ponds, ditches, and trenches such as B Pond and U Pond; solid waste burial in backfilled trenches; and unplanned releases such as leaks from SSTs. Contaminants include both radioactive materials (transuranic isotopes, uranium, and fission products) and nonradioactive materials (metals, volatile organics, semivolatile organics, and inorganics). In addition, the US Ecology Low-Level Radioactive Waste Disposal Facility located southwest of the 200 East Area is estimated to contain about 2.2 million curies of radioactive waste in backfilled trenches (Ledoux 1995). Reasonably foreseeable additions to contaminants in the vadose zone include future waste disposal at the 200 Area and US Ecology solid waste burial grounds and the placement of remediation waste in the Environmental Restoration Disposal Facility.

Groundwater beneath the 200 Areas and in plumes leading from the 200 Areas toward the Columbia River is contaminated with hazardous chemicals and radionuclides from past liquid disposal practices at levels that would exceed Federal drinking water standards if the groundwater was a source of drinking water as defined in the standards . Hazardous chemical contaminants present at levels that exceed drinking water standards include nitrates, cyanide, fluoride, chromium, carbon tetrachloride, trichloroethylene, and tetrachloroethylene. Radiological contaminants include iodine-129, tritium, cesium, plutonium, and strontium. Iodine-129 is present in the groundwater beneath the 200 Areas at levels that exceed standards up to 20 times. Other groundwater plumes from the 200 Areas tend to have lower levels than the iodine-129 levels; however, many of these contaminants would exceed drinking water standards if they were applicable .

Post-remediation health risks to the public from TWRS alternatives would result from contaminants in the groundwater. The first arrival of any contaminant at the interface between the vadose zone and groundwater would occur at times varying between 140 and 250 years following remediation for impacts associated with the No Action and Long-Term Management tank waste alternatives. The tank inventory would be released faster for these alternatives than for any of the other alternatives because it was assumed that there would be no engineered barriers to reduce infiltration or any attempt to remove or stabilize the tank waste. The first arrival time for contaminants from the other alternatives would occur about 2,000 years in the future and the peak concentrations would occur about 5,000 years in the future.

Cumulative radionuclide concentrations that could occur in the groundwater from a potential combination of contamination from past disposal practices, currently anticipated future waste disposal, and the contamination from the TWRS alternatives are discussed in Volume Four, Section F.4.5. Peak groundwater concentrations from the various potential sources could occur at different times and different locations. However, to maximize the potential cumulative impacts, the peak concentrations of the past and reasonably foreseeable future sources were assumed to combine with the peak concentrations from the TWRS alternatives. This resulted in a conservative bounding of the maximum potential cumulative groundwater impact for each TWRS alternative. A more detailed modeling of the potential cumulative impacts will be done in a future Hanford Site EIS. The results of the future analysis would probably indicate lower cumulative groundwater impacts than presented in this bounding analysis.

The highest cumulative groundwater concentrations occur for the No Action and Long-Term Management tank waste alternatives and the tank waste would be the dominant contributor to the predicted cumulative concentrations. The other alternatives would result in much lower cumulative radionuclides concentrations in the groundwater, and the dominant contributorswould be contamination from past disposal practices and tank leaks . The radiation dose and risk to the potential future user of the contaminated groundwater, the time at which it could occur, and the percent attributable to TWRS waste are presented in Table 5.13.5 for each alternative. The table is based on a hypothetical onsite farmer who is assumed to use the groundwater at the maximum cumulative point concentration for each alternative. The groundwater was assumed to be used for all purposes including drinking, washing, and gardening for 30 years. Future solid waste disposal at the 200 West Area solid waste burial ground and the Environmental Restoration Disposal Facility collectively would contribute about 5 rem of the hypothetical 30-year resident farmer doses presented. Less than 10 mrem of the hypothetical 30-year resident farmer dose was attributed to past and future solid waste disposal at the US Ecology solid waste burial ground.

Table 5.13.5 Cumulative Groundwater Radiation Dose and Health Effects

Cumulative radiation doses ranged from about 790 rem for the No Action (Tank Waste) alternative to about 51 rem for the ex situ alternatives. The in situ alternatives were somewhat higher than the ex situ alternatives. The groundwater impacts of the Ex Situ/In Situ Combination 1 and 2 alternatives were for the specific combinations of waste retrieval for disposal and waste disposed of in place chosen for detailed analysis. Other variations of the Ex Situ/In Situ Combination 1 and 2 alternatives could present higher or lower groundwater impacts ranging between the ex situ alternatives (51 rem) and the In Situ Fill and Cap alternative (68 rem). The cumulative radiation dose under the Long-Term Management alternative after administrative control was assumed to end would be about 480 rem. At 10,000 years after disposal, the potential dose from the cumulative contamination in groundwater would be about 3 rem for any alternative except for In Situ Fill and Cap, which would be about 6 rem.

Nitrate concentrations measured in the 200 Area wells in 1994 ranged up to 1,700 mg/L. In addition, nitrate remains in the vadose zone from past disposal practices and will migrate to groundwater over the next several decades. Because of its relatively high mobility, most of the nitrate associated with past liquid disposal practices has probably already entered the groundwater and the maximum concentrations from past disposal practices would have already occurred. This is supported by the fact that nitrate concentrations in the 200 Area groundwater are generally decreasing. Further, it is assumed that the groundwater will transport much of the nitrate from past disposal practices from the 200 Area before arrival of any potential contamination from the TWRS alternatives. Therefore, the nitrate from past disposal practices and from the TWRS alternatives was not expected to combine to give higher concentrations but will extend the time period over which nitrate will be present in the groundwater at potentially high concentrations. Detailed discussion of nitrate contamination from TWRS alternatives is presented in Section 5.2.1.

The maximum nitrate concentrations and the time at which they will be present in the groundwater are presented in Table 5.13.6. The potential nitrate concentrations ranged from 6,600 mg/L for the No Action (Tank Waste) alternative to about 5 mg/L for the Phased Implementation alternative. All other ex situ alternatives would also result in nitrate contamination of the groundwater of about 5 mg/L. The in situ alternatives ranged from about 130 mg/L for the In Situ Fill and Cap alternative to about 0 mg/L for the In Situ Vitrification alternative. Nitrate concentration under the Long-Term Management alternative after administrative control was assumed to end would be about 1,050 mg/L.

Socioeconomics

The socioeconomic impact analysis described in Section 5.6 assessed the impacts of the TWRS EIS alternatives on the Tri-Cities area. The socioeconomic impacts of the TWRS alternatives were measured against a baseline projection of economic activity and population growth that assumed the successful completion of scheduled milestones for Hanford Site cleanup and environmental restoration under the Tri-Party Agreement. Cumulative impacts from TWRS alternatives were analyzed against the baseline of steadily declining Hanford Site employment, which was projected to drop from approximately 15,000 in 1997 to approximately 5,600 in 2040. In that same time frame, nonfarm employment in the Tri-Cities area was projected to increase from approximately 68,000 to 89,000. The peak year impact of each TWRS EIS alternative on Hanford Site employment, Tri-Cities nonfarm employment, and housing prices is presented in Table 5.13.7.

Table 5.13.6 Cumulative Groundwater Nitrate Concentrations

If decisions were made that led to constructing and operating facilities at the Hanford Site not currently foreseen and reflected in the baseline, there would be additional employment, transportation, and infrastructure impacts to the Tri-Cities area.

5.14 UNAVOIDABLE ADVERSE IMPACTS

This section summarizes the potential unavoidable adverse impacts associated with the EIS alternatives. Identified are those unavoidable adverse impacts that would remain after incorporating all mitigation measures that were incorporated in the development of the EIS alternatives. Potentially adverse impacts for each of the alternatives are described in other portions of Section 5.0. In Section 5.20, additional practicable mitigation measures are identified that could further reduce the impacts described in this section

Table 5.13.7 TWRS-Induced Peak Year Changes in Employment and Home Prices

5.14.1 Impact Summary

Table 5.14.1 summarizes the impacts for each tank waste alternative presented in this EIS. Impacts for each capsule alternative are summarized in Table 5.14.2. For detailed information regarding the remediation activity impacts, refer to the relevant sections of the EIS where impacts are discussed in detail. The tables identify the various areas of potential impacts (water resources, air quality, socioeconomics) for each alternative.

5.14.2 Unavoidable Adverse Impacts for Tank Waste Alternatives

The potential unavoidable adverse impacts identified in Table 5.14.1 are summarized in the following text.

Geology and Soil

Total soil disturbance because of remediation would range from none for the No Action (Tank Waste) alternative to 66 ha (160 ac) for the Long-Term Management alternative and 200 ha (490 ac) for the Phased Implementation alternative. Permanent soil disturbance because of remediation activities would range from none for the No Action alternative to 38 ha (94 ac) for the Phased Implementation alternative.

All tank waste alternatives, except No Action and Long-Term Management, would involve excavating large volumes of borrow material at three potential borrow sites as part of the closure scenario.

Table 5.14.1 Summary of Environmental Impacts of the Tank Waste Alternatives

Table 5.14.2 Summary of the Environmental Impacts of the Capsule Alternatives

Borrow material excavation would leave shallow terrain depressions at the excavation sites and other land form changes such as removing portions of the exposed basalt cliffs at the potential Vernita Quarry borrow site (Section 5.1). There also would be permanent soil disturbance (loss of soil cover) at areas that would be covered with Hanford Barriers (tank farms and LAW vaults in the 200 Areas). Placing a Hanford Barrier over each of the 18 tank farms would occur under all tank waste alternatives, except for the No Action and Long-Term Management alternatives, and would cover 25 ha (62 ac). Barriers that would be placed over the LAW vaults under the Ex Situ Intermediate Separations, Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1 and 2 , and Phased Implementation alternatives would cover 5 to 14 ha (12 to 35 ac).

Air Quality

Even with the implementation of additional practicable mitigation measures, all TWRS EIS alternatives would result in substantial air emissions, although no applicable air quality standards would be exceeded. Construction and operation activities of all alternatives would result in increased levels of air emissions (Section 5.3). Construction activities would produce fugitive dust (particulates) and combustion emissions from the use of heavy equipment and motor vehicles. Operation activities would produce radionuclide emissions, combustion emissions, and hazardous air pollutants. Radionuclide emissions would include carbon-14, iodine-129, and cesium-137.

Water Resources

The vadose zone and groundwater aquifer beneath portions of the Hanford Site, including the 200 Areas, currently are contaminated at levels that exceed drinking water standards. Controls on the use of Hanford Site groundwater currently are in place and are expected to continue well into the future.

All tank waste alternatives would involve some release of waste into the currently contaminated vadose zone beneath the 200 Areas, and eventually into the underlying groundwater aquifer (Section 5.2). Under the No Action (Tank Waste) and Long-Term Management alternatives, potential contaminants released to the groundwater would result in water quality standards being exceeded for all four indicator contaminants (iodine-129, technetium-99, nitrite, and uranium-238) at 300 and 500 years into the future, but would be well within the standards at 2,500 years. This analysis assumed that the current drinking water standards would be applicable beyond 1,000 years.

All other tank waste alternatives would result in contaminant releases to the currently contaminated groundwater, although the releases would be at substantially lower levels than for the No Action and Long-Term Management alternatives. The No Action, Long-Term Management, In Situ Fill and In Situ Vitrification and Cap, Ex Situ/In Situ Combination 1 and Ex Situ/In Situ Combination 2 alternatives would exceed water quality requirements. The LAW vaults would meet water quality requirements. Residuals left in the tanks under the ex situ alternatives would not meet water quality requirements; however, the residuals would be a addressed in a future closure plan.

Land Use

Remediation activities would result in permanent land-use commitments that would range from zero for the No Action (Tank Waste) alternative to 38 ha (94 ac) for the Phased Implementation alternative. All alternatives could result in the permanent commitment of land in the 200 Areas to waste disposal uses (Section 5.7). While the TWRS alternatives' land use would be compatible with current land use and current plans for future land use of the 200 Areas, the committed areas would be inaccessible for alternative land use. The amount of land involved would be small compared to the total Central Plateau waste management area of the Hanford Site.

Transportation

All of the EIS alternatives would involve additional motor vehicle traffic, mostly from employees commuting to and from TWRS sites. For all tank waste alternatives except No Action, Long-Term Management, and In Situ Fill and Cap, there would be increased traffic congestion during daytime peak hours on Stevens Road north of Richland and on Route 4 west of the Wye Barricade (Section 5.10). This congestion would occur during the peak employment periods (2001 to 2004 for most alternatives), largely associated with construction activities, and would last for several years (Section 5.10). The various ex situ alternatives would involve the largest traffic volumes and thus would have the greatest potential adverse impacts.

Noise

Because the TWRS sites would be located in the interior of the Hanford Site and would be a long distance from populated offsite areas, the only unavoidable adverse noise impact would be temporary wildlife disturbances near construction sites from heavy equipment use (Section 5.9).

Visual Resources

As described in Section 5.8, constructing facilities and performing borrow site excavation activities under all tank waste alternatives, except No Action and Long-Term Management, would affect the visual environment, particularly from elevated locations onsite (e.g., Gable Mountain, Gable Butte, and Rattlesnake Mountain that are used by Native Americans for religious purposes) and from State Route 24 near the potential Vernita Quarry and McGee Ranch borrow sites. From ground level, the In Situ Vitrification alternative would involve constructing large tank farm confinement structures that would be somewhat visually intrusive for travelers on State Route 240. Facilities developed in the 200 East Area under all alternatives would be visible in the distant background from State Route 240 and from offsite elevated locations.

Biological and Ecological Resources

All tank waste alternatives, except No Action, would affect shrub-steppe habitat in the 200 Areas and at least one of the three potential borrow sites (Vernita Quarry, McGee Ranch, and Pit 30) (Section 5.4). Shrub-steppe is a habitat that is defined as a priority habitat by Washington State. In the affected shrub-steppe habitat areas, there would be a loss of plants, loss or displacement of wildlife species (e.g., birds, small mammals), and a resulting loss of food supplies for birds of prey and predatory mammals.

A small percentage (less than one-half of 1 percent) of the Hanford Site's total shrub-steppe area would be affected, and only individual species members potentially would be impacted, rather than the species as a whole. However, a number of plant and wildlife species of concern (species that are classified as candidates for listing as threatened or endangered, or as State monitor or sensitive species) potentially would be affected.

Cultural Resources

Prehistoric and historic materials and sites in the 200 Areas are scarce and the TWRS sites currently are heavily disturbed (the 18 tank farms) or partly disturbed (the proposed waste treatment facility sites). The potential Vernita Quarry and McGee Ranch borrow sites are considered potentially sensitive for both prehistoric and historic sites (Section 5.5). Important prehistoric sites may be encountered at Vernita Quarry and McGee Ranch, both of which potentially would be used during closure activities for all tank waste alternatives except the No Action and Long-Term Management alternatives.

Socioeconomics

All of the tank waste alternatives, except No Action, Long-Term Management, and In Situ Fill and Cap, would involve short-term socioeconomic impacts that would stem largely from rapid fluctuations in employment during construction (Section 5.6). These short-term impacts would be greatest for the Ex Situ Extensive Separations, Ex Situ No Separations, and Phased Implementation alternatives. For example, increased housing prices stemming from rapid increases in local population could have particularly adverse impacts on the access to affordable housing by low-income populations in the Tri-Cities. The increases in local population also would require hiring additional local police and fire department personnel and also would lead to increased enrollment in local schools.

Health Effects

The No Action (Tank Waste) alternative followed closely by the Long-Term Management alternative, would pose the highest post-remediation cancer risk of all the tank waste alternatives. For the No Action (Tank Waste) alternative, maximum cancer risks would be 1 in 1 for the Native American and the residential farmer respectively, at 300 years after 1995, resulting in 3,300 and 600 fatalities over 10,000 years. The In Situ Vitrification alternative would result in the lowest cancer risk of the various alternatives, with a 1 in 1,700 and 1 in 40,000 risk for theNative American and the residential farmer respectively, at 5,000 years from 1995 resulting in 3 and 1 fatalities over 10,000 years.

All alternatives would pose some risks of adverse health effects. The risks during remediation would be limited mainly to workers, with the greatest risk associated with onsite transportation of waste and separations and treatment operations . The Ex Situ No Separations, Ex Situ Intermediate Separations, and Phased Implementation alternatives would have the highest fatal cancer risk to onsite remediation workers. The other ex situ alternatives would have similar lower risks to workers, while the in situ alternatives would have the lowest risk of all alternatives (Section 5.11). These higher risks would be largely the product of the substantially higher number of person-years of labor required for retrieval, treatment, and disposal of an assumed 99 percent of the tank waste.

Accidents

All alternatives would involve potential accidents. This would include occupational and transportation accidents, both onsite and offsite, that could cause injuries, illness, and a small number of fatalities (mostly from traffic accidents). These types of injuries, illnesses, and fatalities would be directly dependent on the number of person-years of labor required to complete the alternative. Thus, the more person-years of labor the more injuries, illnesses, and fatalities. As described in Section 5.12, the Long-Term Management alternative would result in the largest and the In Situ Fill and Cap alternative the fewest total number of occupational injuries and illnesses (Section 5.12).

For all of the tank waste alternatives the number of cancer fatalities (factoring in the probability of the accident occurring) resulting from a radiological accident during operations would range from 2 (In Fill and Cap alternative) to 16 (No Action and Long-Term Management alternatives).

There also could be accidents resulting in exposure to hazardous chemicals. The various ex situ alternatives and the Ex Situ/In Situ Combination 1 and 2 alternatives would have higher hazardous chemical risks onsite and offsite than would the In Situ Vitrification, No Action, or Long-Term Management alternatives. The higher risk would be because of the greater extent of waste retrieval and treatment under these alternatives.

Cost

Financial resource commitments would range from a low of $7.0 to 8.8 billion for the In Situ Fill and Cap alternative to a maximum of $59.2 to 74.5 billion for the Ex Situ No Separations alternative.

Commitment of Resources

All of the tank waste alternatives would consume water, concrete (except No Action), and electricity; all except No Action would use borrow materials; all would use steel (except In Situ Fill and Cap); all ex situ alternatives and the In Situ Vitrification alternative would consume process chemicals. The No Action, Long-Term Management, and In Situ Fill and Cap alternatives would not use any process chemicals. The largest consumption of earthen borrow materials would occur under the Ex Situ No Separations (Vitrification) alternative; the greatest water consumption would be under the In Situ Vitrification alternative; and the greatest consumption of electricity would be under the Ex Situ Extensive Separations alternative. Although all of these resource consumption impacts would be within existing capacity, the resources would be unavailable for alternative uses.

5.14.3 Unavoidable Adverse Impacts for Capsule Alternatives

The unavoidable adverse impacts of the capsule alternatives identified in Table 5.14.2 are summarized in the following text.

Geology and Soil

A small area of soil would be permanently disturbed by the Onsite Disposal alternative. Other capsule alternatives would have no permanent impacts on .

Air Quality

Low levels of emissions of particulates, sulfur oxides, carbon monoxide, and nitrogen dioxides would occur during construction of facilities associated with all capsule alternatives except the No Action (Capsules) alternative. All construction phase and operations phase emissions would be within air quality standards.

Water Resources

No surface water or groundwater impacts would be expected for any of the capsule alternatives. Onsite Disposal would be the only alternative with potential to impact groundwater, but cesium and strontium would decay to nonhazardous progeny before any potential groundwater impacts could occur.

Land Use

Only the No Action and Onsite Disposal capsule alternatives would result in permanent commitment of land. The areas disturbed would be small, less than 2 ha (5 ac). The area impacted in both cases, however, would be within the 200 Areas and presently is designated for waste management.

Transportation

An increase in vehicular traffic of less than 50 vehicles per day during the morning commute would be expected for all capsule alternatives. These traffic volumes would not adversely impact traffic conditions on any transportation route.

Noise

None of the capsule alternatives would produce substantial onsite or offsite noise impacts. Noise levels would not exceed standards for any of the capsule alternatives.

Biological and Ecological Resources

Virtually all capsule alternative's activities would occur in currently disturbed areas. Minimal impacts would be expected from all alternatives except Onsite Disposal. Onsite Disposal would lead to a maximum loss of 1.8 ha (4.5 ac) of shrub-steppe habitat.

Cultural Resources

There would be a small potential to impact cultural sites during construction of the Onsite Disposal alternative's storage facility. Because the storage facility would be located in an currently disturbed area, the potential impacts would be small.

Socioeconomics

Small employment impacts would result from implementation of any capsule alternative. The greatest impact would be from the Vitrify with Tank Waste alternative, with peak year employment of less than 50 Site jobs and 100 total nonfarm jobs in the Tri-Cities. No adverse socioeconomics impacts would be expected for any capsules alternative.

Visual Resources

No offsite impacts to visual resources are anticipated for any capsule alternative.

Health Effects

No adverse health effects are anticipated for any of the capsule alternatives.

Accidents

For all alternatives, a relatively small number of occupational and transportation accidents would result in injury or illness. The Onsite Disposal alternative would have the highest potential for accidents among capsule alternatives. Injuries and illnesses resulting from occupational and transportation accidents would range from 18 for the Overpack and Ship and Vitrify with Tank Waste alternatives to 69 for the Onsite Disposal alternative.

Cost

Financial resource commitment would range from a low of $112 million for the No Action (Capsules) alternative to a high of $697 million for the Onsite Disposal alternative.

Commitment of Resources

The Onsite Disposal and Overpack and Ship alternatives would result in the consumption of water, concrete, and electricity. The Onsite Disposal alternative would result in the greatest consumption of electricity while the Overpack and Ship alternative would result in the greatest consumption of water. None of the alternatives would result in demands for resources that would adversely impact resource availability or cost.

5.15 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

For this EIS, short-term was considered the period of the EIS alternatives' construction and operation phases (scheduled to be completed by 2028) and the monitoring and maintenance phase that would continue throughout the 100-year institutional control period. Most short-term environmental impacts would occur during the construction and operations phases of each alternative. Under the No Action and Long-Term Management tank waste alternatives, the tank waste in their current form would be managed for 100 years. For this EIS, long-term referred to the period after the end of the 100-year institutional control period. This section describes both the natural environment (e.g., air, water, and biological resources) and the human environment (e.g., employment, population, public facilities, and services issues).

5.15.1 Short-Term Impacts

For all tank waste alternatives except No Action, there would be increased air emissions and noise, solid and liquid waste generation, and increased risks of accidents and illness, primarily to workers involved in implementing the alternatives. The ex situ alternatives, in cluding the Ex Situ/In Situ Combination 1 and Ex Situ/In Situ Combination 2 alternatives would involve more accidents than the in situ alternatives, mostly industrial and transportation accidents. The No Action and Long-Term Management alternatives would involve nearly the same number of accidents as the ex situ alternatives because their operations would last 100 years, by far the longest of all the tank waste alternatives. The No Action and Long-Term Management alternatives would be expected to lead to the highest number of latent cancer fatalities of 16 (factoring in the probability of the accident); Phased Implementation would have 5; Ex Situ Intermediate Separations, Ex Situ No Separations, Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1 and Ex Situ/In Situ Combination 2 alternatives would have 4 latent cancer fatalities; In Situ Vitrification alternative would have 3 latent cancer fatalities ; and In Situ Fill and Cap alternative would have 2 latent cancer fatalities. All alternatives would consume both natural and human-made resources (e.g., fuels, concrete, steel, and chemicals), but none of the alternatives would be expected to cause shortages or price increases as a result of their resource consumption.

Over the short-term, land areas would be committed to EIS alternatives' activities. This would affect biological resources under all tank waste alternatives except No Action, because shrub-steppe habitat would be disturbed. A portion of the areas that would be affected by the EIS alternatives currently is disturbed (e.g., the tank farms and parts of the proposed waste treatment facilities sites for the various ex situ alternatives and the Phased Implementation alternative). Access and uses for other purposes would be restricted, while these areas are being used for the EIS alternatives' construction and operation. Access to these areas has been restricted since the early 1940's.

The various ex situ alternatives, Phased Implementation, and Ex Situ/In Situ Combination 1 and 2 alternatives would have relatively similar short-term land requirements and biological resources impacts in the same areas of the Hanford Site. The in situ alternatives would have smaller land requirements because no large TWRS waste processing facility sites would be required. However, the In Situ Vitrification alternative would require a new power line transmission corridor development dispersed through the 200 Areas, and thus land-use impacts would be more dispersed.

With respect to effluents, emissions, and land requirements, the No Action (Tank Waste) and Long-Term Management alternatives would have the fewest short-term natural environment impacts of any of the tank waste alternatives because they would involve the lowest activity levels during both construction and operation. Effluents, emissions, biological impacts, and health effects of the various action alternatives would be fairly similar to each other.

In terms of the human environment, all of the EIS alternatives would involve the expenditure of Federal funds in the Tri-Cities. There would be increased employment and economic activity associated with these expenditures. This would result in increased population and population growth impacts such as increased traffic, impacts on the price and availability of housing, and impacts on public facilities such as schools. For all tank waste alternatives except No Action, Long-Term Management and Phased Implementation , the largest impacts would occur in the early period of the project, before 2010.

The impacts on the human environment of the EIS alternatives would be driven largely by their levels of employment. Because they would involve the least number of jobs, the In Situ Fill and Cap, No Action, and Long-Term Management tank waste alternatives would have the least short-term impacts. The No Action and Long-Term Management alternatives would have the longest lasting and most stable employment and related impacts because they would last for 100 years, whereas the other alternatives would be complete in approximately 30 years.

The Phased Implementation , Ex Situ Extensive Separations and Ex Situ No Separations alternatives would have the most intense short-term impacts on the human environment because they would have the sharpest short-term fluctuations in employment, population, and associated impacts on public services. Rapid growth in employment and population that drops off sharply, such as would be the case with these alternatives' construction phases particularly, can cause socioeconomic disruption as well as economic benefits. The Ex Situ Intermediate Separations, Ex Situ/In Situ Combination 1, Ex Situ/In Situ Combination 2, and In Situ Vitrification alternatives would have somewhat less intense construction phases, which would allow for better planning to accommodate the impacts of both increases and subsequent decreases in employment construction and operation. Effluents, emissions, and risks of the various action alternatives would be similar to each other.

5.15.2 Long-Term Impacts

The long-term impacts on the natural environment of the EIS alternatives would be related in large part to how much waste remained on the Hanford Site after the alternatives were fully implemented, and how much of the remaining waste had been treated (vitrified) or left untreated. Future decisions on the ultimate closure of the tank farms that are beyond the scope of this EIS would have an effect on long-term impact issues. The long-term impacts of the EIS alternatives also must be considered in the context of decisions to be made concerning other contamination in the 200 Areas that is unrelated to the waste tanks or capsules, such as from the large 200 Areas processing facilities. Regardless of which EIS alternative is selected, the vicinity of the tank farms and proposed tank waste treatment facilities still would be contaminated. This would affect long-term health risks and future land uses of the 200 Areas, which would be the primary areas of long-term impacts associated with the EIS alternatives.

The tank waste No Action and Long-Term Management alternatives would leave the waste totally unremediated. The capsules No Action alternative would have the same effect. The No Action, Long-Term Management and In Situ Fill and Cap alternatives would have the largest long-term health risk impacts of any of the EIS alternatives because contaminants would be released from the tanks into the groundwater at levels that would exceed drinking water standards and pose substantial health risks to future Site users. The tank farms would be permanently committed to waste management use, preventing use of the land for alternative purposes. Future users of the Hanford Site lands (Native Americans , residential farmers, workers, or recreational users) potentially would experience increased health risks over a time period extending thousands of years into the future.

All of the other EIS alternatives also would permanently commit small amounts of land to waste disposal use at the tank farms, and in some cases at waste treatment facility sites or onsite LAW vaults. The maximum permanent land commitment for remediation activities would be 38 ha (94 ac) for the Phased Implementation alternative. The permanently committed lands would be unavailable for alternative uses.

The alternatives also would have potential small long-term health effects on future Hanford Site users because of eventual contaminant release to the groundwater. However, these impacts would be fewer and further in the future than under the No Action, Long-Term Management , and In Situ Fill and Cap alternatives. Impacts would be fewer because less contamination would remain onsite and untreated. The Ex Situ/In Situ Combination 1 and Ex Situ/In Situ Combination 2 alternatives would leave the tank waste onsite and untreated. These two alternatives would have higher long-term health risks than the ex situ, Phased Implementation, or In Situ Vitrification alternatives, although risks would be lower than for the No Action or Long-Term Management. The In Situ Vitrification alternative would have the lowest long-term health effect potential of any of the EIS alternatives. The ranking of tank waste alternatives from greatest to lowest total health effect for the entire 10,000 years for the residential farmer scenario would be: No Action, Long-Term Management, In Situ Fill and Cap, Ex Situ/In Situ Combination 1, Ex Situ/In Situ Combination 2 , Ex Situ Intermediate Separations, Phased Implementation, Ex Situ Extensive Separations, Ex Situ No Separations, and In Situ Vitrification. Only the No Action, Long-Term Management, and In Situ Fill and Cap alternatives would have long-term health effects for the future downriver user of the Columbia River.

In terms of long-term human environment impacts, all of the tank waste alternatives except No Action and Long-Term Management would have similar and negligible impacts because there would be no long-term employment following the loss of institutional control in 100 years. For No Action and Long-Term Management, a post-remediation accident would result in fatalities. Also, under all disposal alternatives, post-remediation intrusion into waste remaining onsite would be highest for all alternatives that dispose of all or portions of the HLW onsite.

5.16 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The alternatives for managing, treating, and disposing of the Hanford Site tank waste and cesium and strontium capsules would involve the irreversible and irretrievable commitment of land, energy, materials, and financial resources. Table 5.16.1 presents a summary of resource commitments for the tank waste and capsule alternatives. More detailed comparisons of resource commitments are provided in Volume Two, Appendix B.

Depending on the alternative, managing, treating, and disposing of the Hanford Site tank waste could result in the permanent commitment of up to 49 ha (120 ac) of land, 3.3 E+04 gigawatts-hours (GWh) of electric energy consumption, 1.2 E+07 m^3 (1.7 E+07 yd^3) of borrow materials, 1.7 E+11 L (4.5 E+10 gal) of water, and 4.4 E+05 metric tons (mt) (4.8 E+05 tons) of steel. Although large quantities of resources would be required, the quantities used would not cause substantial impacts to the availability or cost of these resources to other potential users. The cost of implementing the tank waste alternatives could be from $7.9 to 62.5 billion, which would represent an irretrievable commitment of financial resources. The $ 62.5 billion cost would be for the Ex Situ No Separations alternative and would include $ 38.9 billion for HLW disposal at a geologic repository.

Resources that would be committed for the capsule alternatives would constitute only a small fraction of the resources required for tank waste alternatives. For example, land commitments would not exceed 2 ha (5 ac) and cost would not exceed $697 million.

Table 5.16.1 Irreversible and Irretrievable Commitment of Resources

Table 5.16.1 Irreversible and Irretrievable Commitment of Resources (cont'd)

5.17 CONFLICTS BETWEEN THE PROPOSED ACTION AND THE OBJECTIVES OF FEDERAL, REGIONAL, STATE, LOCAL, AND TRIBAL LAND-USE PLANS, POLICIES OR CONTROLS

This section describes the possible conflicts between the various EIS alternatives and Federal, State, local, government, and Tribal plans and policies. Additional analyses of land-use issues are included in Sections 4.7 and 5.7.

All EIS alternatives would include a combination of land uses including waste management; processing; and treatment, storage, and disposal. The Hanford Site Development Plan is the only currently available land-use planning document until the Comprehensive Land-Use Plan insis finalized in 1997/ins (Section 5.7). The Hanford Site Development Plan identifies Waste Operations and Research and Development as the only allowable uses within and between the 200 East and 200 West Areas (DOE 1993e). The EIS alternatives are thus consistent with the planned land uses for the 200 Areas, based on the available Hanford Site land-use planning documents.

The current and planned land uses designated by the Hanford Site Development Plan for areas surrounding the 200 Areas include the categories of Research and Development and Undeveloped Area. The Research and Development land-use category includes scientific and engineering technology development for irradiated waste, while the Undeveloped Area provides a transitional land use and buffer between the Waste Operations and other more sensitive use areas. Industrial and waste management uses have occurred in the 200 Areas and surrounding areas for over 40 years without land-use conflicts. Thus, all proposed EIS alternatives' activities in the 200 Areas would be compatible with the currently available Federal land-use plans for the Hanford Site.

The potential Vernita Quarry and McGee Ranch borrow sites are in areas identified as Undeveloped on the Hanford Site Development Plan's Future Land-Use Map (Figure 5.7.1). Use of the Vernita Quarry for the EIS alternatives would involve expanding an existing quarry, while McGee Ranch essentially would be newly developed as a borrow site (although one small, old borrow area exists at the McGee Ranch). The Washington State Department of Fish and Wildlife has asked DOE to preserve the McGee Ranch area as a wildlife corridor (Baker 1996). Planning for possible borrow sites for the TWRS program is still in its early stages, and will be addressed in future NEPA analysis.

As described in Section 4.7 and 5.7, there are various wildlife and recreational land uses that exist and are planned or proposed on and near the Hanford Site (e.g., the Fitzner Eberhardt Arid Lands Ecology Reserve and the proposed Wild and Scenic River designation for the Hanford Reach of the Columbia River). None of the EIS alternatives would impact proposed uses of those wildlife and recreational areas, and thus the alternatives are consistent with the land-use plans and policies that apply to the wildlife and recreational use areas.

5.17.1 State and Local Plans and Policies

The two local jurisdictions most directly concerned with Hanford Site land uses are Benton County, which contains the majority of the Hanford Site, and the city of Richland, which is located immediately adjacent to the Hanford Site and is in the process of annexing portions of the Hanford Site's 1100 Area.

Benton County is in the process of updating its comprehensive plan. This update will include a separate Hanford Comprehensive Plan that is expected to be compatible with the overall county plan, although this cannot be certain until the plan is released. Although all EIS alternatives involve uses compatible with the current DOE land uses of the 200 Areas, and with DOE's currently available land-use planning documents, it is not possible to evaluate compatibility with Benton County's land-use plans until the county's Hanford Comprehensive Plan is adopted. Adoption of the plan by Benton County Commissioners is expected by the end of 1996 (Fyall 1996).

The county's Draft Hanford Comprehensive Plan classifies the potential Vernita Quarry borrow site as Area Three (preservation area), where essentially no development activity would be allowed. The McGee Ranch is classified as

Area Two (multiple-use, onsite mitigation), where development activity would be allowed only with mitigation of environmental (mainly habitat) effects on the site. The Washington State Department of Fish and Wildlife has asked Benton County to designate McGee Ranch as a critical area (preservation area) (McConnaughey 1996, a). The 200 Areas, where most TWRS activities would occur under all alternatives, is classified as Area One (multiple-use, offsite mitigation), where development would be allowed with mitigation offsite (Fyall 1996)

The city of Richland also is currently updating its comprehensive plan. Richland's planning encompasses only the southern areas of the Site that are within the city's 20-year growth boundary. The plan is expected to call for expanding industrial and research and development uses in areas adjacent to the Hanford Site. There would be no conflict between this planned land use and the activities of any EIS alternatives. No other local jurisdiction's land-use plans or policies would be affected by any of the EIS alternatives

5.17.2 Tribal Nation Plans and Policies

Land-use conflict issues related to Tribal Nation concerns are described in Sections 5.5 and 5.19.

5.18 POLLUTION PREVENTION

Consistent with overall national policy (e.g., the Pollution Prevention Act of 1990), and specific DOE guidance (DOE Order 5400.1), Hanford Site programs are directed to incorporate pollution prevention into their planning and implementation activities. This includes reducing the quantity and toxicity of hazardous, radioactive, mixed, and sanitary waste generated at the Hanford Site; incorporating waste recycle and reuse into program planning and implementation; and conserving resources and energy. Guidelines are contained in the Hanford Site Waste Minimization and Pollution Prevention Awareness Program Plan (WHC 1995c). The major elements of the program are 1) establishing management support; 2) identifying and implementing pollution-prevention opportunities through a systematic assessment process; 3) setting and measuring the progress of waste reduction goals; 4) developing waste generation baseline and tracking systems; 5) creating employee awareness, training, and incentives programs; 6) championing Sitewide pollution prevention initiatives; and 7) supporting technology transfer, information exchange, and public outreach.

The TWRS alternatives are still in the early conceptual stages of the engineering and design process. To comply with the pollution prevention requirements outlined in the previous paragraphs, opportunities to reduce waste generation at the source, as well as for materials recycle and reuse, will be sought and incorporated into the engineering and design process for the selected alternative. Examples of pollution prevention and waste minimization concepts that have been incorporated into the EIS alternatives include the following

- For solvent extraction operations included in the Ex Situ Extensive Separations alternative, evaporation steps downstream of the process would recover solvents from aqueous streams that came in with contact organic solvents. When evaporator condensate contained solvent, the condensate would be sent to a decanter and the recovered solvent would be recycled to the solvent extraction system.
- The ex situ alternatives' melter off-gas treatment system would recycle excess condensate to the LAW feed evaporator for re-evaporation. Scrubbed melter off-gases then would be processed to recover sulfur dioxide, which would be converted to elemental sulfur and returned to the process.
- The Ex Situ Extensive Separations alternative would use a calcination process to allow the recovery and recycle of sodium hydroxide. Nitric acid would be recovered from the HLW denitrification processes and during various evaporation steps.
- Minimizing the use of water in retrieving waste from SSTs would prevent additional leakage of contaminants and reduce the volume of material sent to the TWRS evaporators. The retrieval system would be designed to use the absolute minimum liquid necessary to remove tank solids.
- All ex situ alternatives would use metal high-efficiency particulate air filters that would be recyclable rather than filters that were not reusable.

Energy conservation for each of the alternatives would be achieved primarily in three areas: process configuration, mechanical design, and electrical design. Energy conservation would be maximized by incorporating it into the process and facility design from the outset. Where possible, the process would be configured to conserve energy by using heat exchangers so the hot exit streams could heat cool incoming streams, which would conserve heating energy. Where cooling of process streams would be required, maximum use of cooling water would be employed, which would minimize the amount of refrigeration cooling to be used. Mechanical design would employ energy efficient compressors, pumps, and fans. Ducting would be designed for minimum pressure drop. Facilities would employ energy-efficient insulation and reflective panels where appropriate. Air conditioning systems would make efficient use of outside air. Electrical design would employ energy efficient electrical motors and actuators. The electrical power factor for the system would be maintained in balance, and capacitors would be used where required. Accurate electrical power metering of each system would indicate the major power consumers and give warning of unusually high energy consumption. This would allow corrective measures to be taken promptly.

5.19 ENVIRONMENTAL JUSTICE

Based on the 1990 census, the 80-km (50-mi) area surrounding the Hanford Site had a total 1990 minority population of 86,400 and a low-income population of 77,700. Hispanics residing predominantly in Franklin, Yakima, Grant, and Adams counties are the area's principal minority group. Native Americans reside principally on the Yakama Indian Reservation. The area's low-income population is dispersed throughout the 80-km (50-mi) region with the highest concentrations occurring in Franklin, Yakima, Grant, and Adams counties. Section 4.6.1 describes minority and Native American populations and low-income populations residing in the 80-km (50-mi) radius of the Hanford Site. Additional information regarding minority and Native American populations and low-income populations is provided in Volume Five, Appendix I.

For each of the areas of technical analysis presented in the EIS, a review of impacts to the human and natural environment was conducted to determine if any potentially disproportionate and adverse impacts on minority populations or low-income populations would occur. The review included potential impacts on land use, socioeconomics (e.g., employment, housing prices, public facilities, and services), water quality, air quality, health effects, accidents, and biological and cultural resources. For each of the areas of analysis, impacts were reviewed to determine if there were any potential disproportionate and adverse impacts to the surrounding population that would occur due to construction, routine operations, or accident conditions. If an adverse impact was identified, a determination was made as to whether minority populations or low-income populations would be disproportionately affected. The results of the review are presented in Table 5.19.1.

For the purposes of this EIS, disproportionate impacts are defined as impacts that would affect minority and Native American populations or low-income populations at levels appreciably greater than their effects on nonminority populations or non-low-income populations. Adverse impacts are defined as negative changes to the existing conditions in the natural environment (e.g., land, air, water, wildlife, vegetation) or in the human environment (e.g., employment, health, land use).

During consultation with affected Tribal Nations, representatives of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation expressed the view that impacts associated with all of the in situ and ex situ alternatives may adversely impact the cultural values of affected Tribal Nations to the extent that they involve disturbance or destruction of ecological and biological resources, alter land forms, or pose a noise or visual impact to sacred sites. The level of impact to cultural values associated with natural resources would be proportional to the amount of land disturbed under each of the alternatives.

Table 5.19.1 Environmental Justice Impact Analysis

Changes to land forms would result from the construction of barriers over the tank farms and LAW vaults. However, barriers would be constructed only under closure of the tank farms, which is outside the scope of this EIS. These disturbances would largely occur in areas already disturbed and would only be visible from locations such as Gable Mountain, Gable Butte, and Rattlesnake Mountain, which are sacred sites of the affected Tribal Nations. Additionally, facilities constructed under most of the alternatives would also be visible from these sacred sites. The facilities would be constructed in areas that already include several facilities of similar size and general configuration. Noise associated with construction and operation of the TWRS facilities would likely have very minor, if any, potential to impact Gable Mountain.

Under all of the alternatives, there would be no disproportionately high and adverse impacts to human health during routine operations or under accident scenarios, with the exception of a potential impact to Gable Mountain resulting from deposition of contaminants under certain accident scenarios. Such an accident is very unlikely to occur but could result in a limitation of cultural and religious practices on Gable Mountain until mitigation actions could be implemented to remediate any potential risks to human health. Under all other scenarios, there would be no risks to human health to existing populations from continued access to sacred sites and hence no disproportionately high or adverse impacts to minority, Native American, or low-income populations. However, the EIS does analyze potential post-remediation risks under various land-use scenarios. This assessment of risk indicates that under the closure scenario analyzed in the EIS for purpose of comparison of alternatives, post-remediation risks would exist under all land-use scenarios and that risks would be highest under the Native American scenario. Because closure is outside the scope of the TWRS EIS, future NEPA documentation will address risks associated with various closure alternatives. This analysis would be required to determine if any particular closure alternative would represent a disproportionately high and adverse impact on minority, Native American, or low-income populations. However, implementation of the No Action, Long-Term Management, In Situ Fill and Cap, In Situ Vitrification, and the In Situ portions of the Ex Situ/In Situ Combination 1 and 2 alternatives would preclude clean closure or modified clean closure of some or all of the tanks. For these alternatives, except for In Situ Vitrification, post-remediation health risks under the Native American scenario would be disproportionately high for Native American users of the site. Risk would be three to four times higher than under the future Site land uses analyzed. For the In Situ Vitrification alternative, risks would not be disproportionately high compared to risks under other land-use scenarios. For the alternatives involving extensive waste retrieval, the ex situ alternatives closure options that would reduce risks beyond those presented in the EIS would not be precluded. Therefore, future NEPA analysis of closure alternatives would address risks associated with various closure alternatives and potential disproportionate and adverse impacts.

Under all tank waste alternatives except the No Action and Long-Term Management alternatives, the result of implementing the alternative would be to lessen overall potential impacts to the human and natural environment resulting from future releases of tank waste into the environment. If tank waste is not stabilized and isolated (the in situ alternatives) or retrieved, immobilized, and disposed of (the ex situ alternatives), releases to the environment would pose long-term risks to biological and ecological resources and human health based on the analysis provided in Sections 5.4, 5.11, and 5.12 and Appendices D (Volume Three) and E (Volume Four). Therefore, actions to manage and dispose of tank waste would result in an overall beneficial impact to the environment compared to existing conditions or conditions that would exist in the future should no action be implemented.

Two areas of potentially disproportionate and adverse impacts on minority and Native American populations or low-income populations were identified. These impacts include 1) potential increases in housing prices that could adversely impact access to affordable housing by low-income populations; and 2) continued restrictions on access to portions of the 200 Areas that could restrict access to the 200 Areas by all individuals. Access restrictions also would apply to the Confederated Tribes and Bands of the Yakama Indian Nations and the Confederated Tribes of the Umatilla Indian Reservation, who have expressed an interest in access to and unrestricted use of the Hanford Site.

Housing Cost Impacts on Low-Income Populations

Housing prices in the Tri-Cities are projected to increase steadily from 1997 through 2040 under baseline conditions. All of the tank waste alternatives, except No Action, would result in additional increases in housing prices (Section 5.6.2.2). The levels of increase would vary substantially and housing prices would fluctuate depending on the levels of employment for each TWRS alternative as well as non-TWRS related fluctuations in Hanford Site and area employment. For example, the EIS analysis did not address the reduction of Hanford Site employment by 4,500 jobs that occurred in 1995, and future projections of baseline conditions were based on funding of the Hanford Site waste management and environmental restoration program as defined in the Tri-Party Agreement.

Additional reductions in Site employment resulting from funding reductions could minimize the potential adverse impacts on housing prices resulting from proposed TWRS activities. The No Action, Long-Term Management, and the In Situ Fill and Cap alternatives would have minor impacts on housing prices and hence would not adversely impact the access of low-income populations to affordable housing. The alternatives with the greatest potential impacts on housing prices include the following:

- In Situ Vitrification alternative - 9.3 percent increase in the average purchase price of a home above baseline conditions in 2001 (the peak year of impacts);
- Ex Situ Intermediate Separations alternative - 14.5 percent increase in the average purchase price of a home above baseline conditions in 2001 (peak year);
- Ex Situ No Separations alternative - 17.5 percent increase in the average purchase price of a home above

baseline conditions in 2000 (peak year);

- Ex Situ Extensive Separations alternative - 25.1 percent increase in the average purchase price of a home above baseline conditions in 2004 (peak year);
- Ex Situ/In Situ Combination 1 alternative - 8.8 percent increase in the average purchase price of a home above baseline conditions in 2001 (peak year) ;
- Ex Situ/In Situ Combination 2 alternative - 8 percent increase in the average purchase price of a home above baseline conditions in 2001 or 2002 (peak year);
- Phased Implementation alternative (Phase 1) - 12.9 percent increase in the average purchase price of a home above baseline conditions in 2000 (peak year); and
- Phased Implementation alternative (total alternative) - 19.9 percent increase in the average purchase price of a home above baseline conditions in 2011 (peak year).

For each of these alternatives, housing price increases would exceed baseline conditions for a number of years depending on employment levels and construction and operation schedules.

Higher housing prices related to the alternatives would have a negative impact on low-income home buyers and renters in the Tri-Cities. Historically, rental prices increase consistent with the price of single-family homes. Low-income families would be adversely and disproportionately impacted in their ability to purchase affordable housing or rent housing at affordable prices.

The baseline conditions used in the impact analysis of the alternatives on the housing market in the Tri-Cities assumed Hanford Site employment at levels projected in the Tri-Party Agreement and did not assume any increase in low-income housing or rental units or housing cost subsidies or assistance by Federal, State, or local low-income housing agencies or programs. Changes from these baseline conditions or other substantial changes in the Tri-Cities economy could substantially modify the net impact of the alternatives on the housing market. If the housing market in the Tri-Cities does not experience the levels of price increases shown in the EIS, the disproportionate impact on low-income communities would be reduced.

Continued Restrictions on Access to Portions of the 200 Areas

Access to the Hanford Site has been restricted since the Hanford Site was established in 1943. However, the Confederated Tribes and Bands of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation have expressed a desire to have access and use of the Central Plateau of the Hanford Site in the future. The Tribal Nations have also expressed an interest in long-term ownership of lands on the Hanford Site. All of the EIS alternatives would have long-term land-use impacts that would continue restrictions on access by all individuals, including Tribal Nation members, to portions of the 200 Areas permanently committed to waste management and disposal.

Approximately two-thirds of the land that would be restricted from future access is land that has previously been disturbed by Hanford Site activities, including the tank farms. Table 5.19.2 summarizes the extent of the land that would be subject to long-term land-use restrictions. The total land that would continue to be subject to access restrictions as a result of EIS alternatives represents less than 1 percent of the total Hanford Site and less than 2 percent of the 200 Areas (Section 5.7). The relatively small amount of land that would be subject to continued restrictions could result in small disproportionate impacts to Tribal Nation land use and ownership interests.

The amount of land that would be restricted from future access is based on land-use restrictions that would result from implementing the TWRS alternatives. Additional land-use restrictions and potential groundwater-use restrictions might be required based on the ultimate closure action implemented for the tank farms. However, future NEPA documentation will be prepared to address the closure action. That document will address various closure alternatives and analyze the associated impacts including land use and groundwater restrictions. The analysis would also address the extent to which any of the alternatives would pose a disproportionately high and adverse impact on minority, Native American, or low-income populations.

Table 5.19.2 Comparison of Land Area Requiring Continued Access Restrictions

The No Action and Long-Term Management alternatives would leave all tank waste intact in their current location and form indefinitely, thereby restricting land access and use indefinitely. All of the other tank waste alternatives would leave the tank farms in place following remediation. Under the closure scenario, the tanks would be covered with Hanford Barriers with varying amounts of waste remaining in the tanks. All of the alternatives would require long-term land-use restrictions. The In Situ Fill and Cap and In Situ Vitrification alternatives would leave essentially all waste in the tanks, requiring long-term land-use restrictions because all of the waste would be permanently disposed of onsite. The least amount of waste would remain onsite under the Ex Situ No Separations alternative because there would be no LAW disposed of onsite, as all waste retrieved from the tanks would be disposed of offsite. For the capsule alternatives, only the Onsite Disposal alternative would require future land access and use restrictions. However, because all of the tank waste alternatives would require future closure decisions, the final nature and extent of the land-use restrictions cannot be determined at this time.

The overall issue of access to the tank farm portions of the Central Plateau is linked to the ultimate land-use plan for the 200 Areas. Access to the tank farm areas would be limited by the level of cleanup accomplished for the surrounding area. The tank farms are in an area that currently is designated as a waste management area by DOE. DOE is preparing a Comprehensive Land-Use Plan for the Hanford Site, and final decisions regarding the level of cleanup required to support the land-use plan for the Central Plateau will impact the final decisions regarding the closure of the tank farms and future access to the 200 Areas.

5.20 MITIGATION MEASURES

This section describes measures to mitigate potential impacts of the alternatives in two areas. Section 5.20.1 summarizes measures that currently are included in the alternatives to prevent or mitigate environmental impacts. Section 5.20.2 summarizes additional measures that could be included in the alternatives to further reduce or mitigate potential environmental impacts described previously in other portions of Section 5.0 if deemed necessary. The section focuses on measures to mitigate potential impacts during remediation. Future NEPA documentation will specifically address in detail impacts and mitigation of post-remediation tank closure where, for example, most of the impacts of borrow site activities would occur.

5.20.1 Measures Included in the Alternatives

A large number of measures have been incorporated into all of the alternatives to ensure safe implementation, reduce environmental impacts, and meet all regulatory requirements (except as described in Section 6.0). The following measures apply to all of the alternatives for the tank waste and capsules except as indicated.

- All nuclear facilities would be designed, constructed, and operated in compliance with the comprehensive set of DOE or commercial requirements that have been established to protect public and worker health and the environment. These requirements encompass a wide variety of topics, including radiation protection, design criteria for nuclear facilities, fire protection, emergency preparedness and response, seismic events, and operations safety requirements.
- Measures would be taken to protect construction and operations personnel from occupational hazards. These measures include the following:
- Emphasis on safety awareness;
- Radiation and hazardous waste training;
- Use of appropriate personal protective equipment (e.g., gloves, eye protection, and respirators);
- Personal and environmental radiation monitoring and the application of administrative limits to restrict exposures to within regulatory limits and as low as reasonably achievable;
- Administrative controls for potentially hazardous areas;
- Use of hearing protection and monitoring exposure to occupational noise;
- Good housekeeping of work areas; and
- Preparing and implementing safety plans for all field work activities.
- Emergency response plans would be developed to rapidly respond to potentially dangerous unplanned events.
- Water and surfactants would be used to control dust emissions especially at borrow sites, gravel or dirt haul roads, and during construction earthwork.
- Areas for new facilities would be selected to minimize environmental impacts to the extent practicable, such as avoidance of undisturbed shrub-steppe habitat.
- Pollution control or treatment would be used to reduce or eliminate releases of contaminants to the environment and to meet regulatory standards. Among the measures included are the following:
  - Treating liquid through a variety of processes, including evaporation, prior to discharging the water into the subsurface;
  - Treating air emissions through the use of high-efficiency particulate air filters and scrubbers to reduce levels of air emissions to within regulatory standards;
  - Incorporating appropriate metal and concrete shielding to control exposures to workers from gamma radiation; and
  - Use of double liners, double-wall piping, and other double containment and backup systems to control leaks that might occur. Double containment is not included for the existing SSTs.
- Extensive environmental monitoring systems would be implemented to continually monitor potential releases to the environment including the following:
  - Air monitoring within buildings, certain tanks, and the ambient atmosphere;

    - Groundwater and vadose zone monitoring around the tank farms;
    - Comprehensive radiation monitoring during all construction and operation; and
    - Post-remediation monitoring and maintenance for up to 100 years for any radioactive and hazardous materials that remain onsite.
- All newly disturbed areas would be recontoured to conform with the surrounding terrain and would be revegetated with locally derived native plant species consistent with Sitewide biological mitigation plans.
- All shipments of radioactive or hazardous materials on public roads would be performed in compliance with all regulatory requirements including requirements for the following:
    - Maintaining manifests;
    - Using appropriate shipping containers;
    - Using trained and licensed transporters;
    - Using appropriate signs on vehicles;
    - Providing appropriate notices to potentially involved organizations; and
    - Using specially designed containers for shipment of HLW to reduce the possibility of public exposure in the extremely unlikely event of a release.
- Although much of the area proposed for the remedial activities is in areas currently disturbed, activities in some areas have the potential to impact historic, prehistoric, or cultural sites. These areas have not been fully surveyed because they are potential borrow sites subject to change during final design. The final selection of borrow sites would be made through future NEPA analysis . Historic, prehistoric, and cultural resource surveys would be performed for any undisturbed areas to be impacted and the following measures could be implemented.
- Prior to any ground disturbance activities, consultations would be conducted with the DOE Richland Operations Office Historic Preservation Officer, the Hanford Cultural Resource Laboratory, Washington State Historic Preservation Officer, and concerned Native American Tribal groups and governments.
- Avoidance of prehistoric and historic site areas identified would be the primary form of mitigation whenever practicable.
- An archaeological monitor would be onsite during ground disturbing activities of highly sensitive areas to ensure that construction impacts were limited to the remediation area only whenever practicable.
- If prehistoric or historic materials sites were encountered, construction activities would be stopped or diverted to other areas until the site was evaluated and appropriate consultations were conducted.

Consultation with Tribal Nations groups and governments would be performed early in the planning process to determine areas or topics of importance to these groups such as religious areas and potential resources of medicinal plants.

5.20.2 Potential Mitigation Measures

The following mitigation measures could be incorporated into one or more of the alternatives as indicated. A decision on which, if any, of these measures to incorporate would be made by DOE and the Washington State Department of Ecology (Ecology). The decisions would follow the public comment period and would be incorporated into the Mitigation Action Plan and the Record of Decision. The TWRS Mitigation Action Plan, which will be published with the Record of Decision, will describe the plan for implementing mitigation commitments made in the Record of Decision for the alternative selected for implementation.

Tank Waste

Under all tank waste alternatives except In Situ Vitrification, contaminant levels in the groundwater potentially would exceed safe levels . Potential health effects (incidences of cancer) could occur to anyone routinely consuming this water. This impact could be mitigated by placing restrictions on the use of the groundwater such as prohibiting the installation of wells for drinking water or irrigating crops. Potential impacts would last for more than 10,000 years, and the effectiveness of administrative controls in preventing or limiting the installation of wells over this length of time is uncertain. However, it should be noted that the area that would require administrative controls due to TWRS remediation contains groundwater that currently is contaminated at levels far above safe levels . Therefore, unless this existing contamination is remediated in the future, administrative controls would be necessary with or without the additional TWRS impacts to groundwater.

All of the tank waste alternatives, except the No Action and Long-Term Management alternatives, would include the placement of a Hanford Barrier over the tanks and the LAW vaults (when applicable) to reduce the amount of precipitation that would infiltrate the waste and leach contaminants into the groundwater. For the analysis performed in this EIS, a Hanford Barrier was used to bound impacts. A Hanford Barrier would be a 4.5-m (15-ft)-thick, earthen cap constructed primarily of 10 layers of soil, rock, and synthetic materials. It would be designed to inhibit the infiltration of precipitation, limit intrusion by plant roots and burrowing animals that could penetrate the Hanford Barrier, and inhibit inadvertent human intrusion into the waste. The Hanford Barrier would be expensive to construct and would require using a large volume of earthen materials from borrow sites. Using borrow sites would require disturbing shrub-steppe habitat. These impacts could be partially mitigated by substituting a different type of surface barrier for the Hanford Barrier, such as the type of barrier required for hazardous waste sites under RCRA. These barriers may be somewhat less effective than the Hanford Barrier but they may be adequate for some or all of the alternatives to protect the groundwater. Selection of a specific barrier design is a decision that will be made in the future when final decisions are made on closure of the tank farms. At that time, alternate barrier designs that may be less consumptive of resources could be examined. This mitigation measure could be especially applicable to the In Situ Vitrification alternative because the barrier would be needed to prevent human and wildlife intrusion and would not be needed to protect the groundwater from contamination .

All of the tank waste alternatives except No Action and Long-Term Management would include filling the tank void spaces with soil or rock. This would require the extensive use of earthen borrow sites, which would potentially disturb areas of shrub-steppe habitat. The tanks could be filled with contaminated soils excavated during closure activities or during the implementation of other Hanford Site remediation projects, which would reduce the amount of shrub-steppe habitat disturbed. Because a Hanford Barrier would be constructed over the tanks during closure (if closure as a landfill was selected), additional landfills would not need to be constructed for closure or the other soil remediation projects. Contaminated soil could also be used as the glass former for the In Situ Vitrification alternative, which would provide greater protection of the groundwater because the contaminants in the soil would be immobilized in the vitrified tank waste.

Subsurface barriers could be used with any of the alternatives to contain leakage and minimize the migration of waste away from the tank in the event of a leak. Subsurface barriers are impermeable layers that would be installed in the soil surrounding a tank to contain any leakage that might occur. Subsurface barriers could be used with any of the tank waste alternatives but would be most suitable for SSTs that would be retrieved under the ex situ alternatives. The SST waste retrieval primarily would be performed using hydraulic sluicing, which has a high potential for leakage. The possibility of using subsurface barriers resulted from the concern about the potential for leaks from the tanks during hydraulic sluicing for retrieval. Subsurface barriers would not prevent tank leakage but they would function to prevent leakage from migrating beyond the barrier and into the vadose zone. This would minimize the volume of soil contaminated by a leak, and result in easier cleanup of contaminated soils.

A number of subsurface barrier technologies exist that could be used during waste retrieval operations to minimize the potential for release of contaminants to the vadose zone (see Volume Two, Section B.9). Close-coupled subsurface barriers could be installed directly adjacent to the outer tank sides and bottom or offset from the tank. The close-coupled barriers would minimize the contamination of soils if a leak were to occur, and the offset barriers could be used to contain existing soil contamination and could have features to collect and recover tank leaks. Subsurface barrier technologies that have been investigated for use at the Hanford Site include: close-coupled injected chemical barriers, box-shaped chemical walls, v-shaped chemical barriers, freeze walls, and circulating air barriers (Treat et al. 1995). Some technologies such as freeze walls are active and would require continuous equipment operation to maintain the barrier integrity. Other technologies such as chemical barriers are passive and once installed would only require monitoring. The functional requirements potentially could be satisfied by any of the subsurface barrier technologies evaluated. Mitigation of waste leakage during retrieval would be evaluated as information is developed in support of tank closure and retrieval-based leakage criteria.

All of the alternatives that would retrieve tank waste assumed that a heel of waste equal to 1 percent of the tank contents would be left in the tank. This heel would not be immobilized and over a period of time would be dissolved by infiltrating water and transported to the groundwater. Mitigating the impacts from the tank residuals would involve immobilizing the residual waste to slow the release of contaminants from the residual waste. Broadcasting a dry grout mixture on the tank floor following retrieval would combine with any liquids remaining in the tanks and partially immobilize the contaminants. The grout would maintain the remaining solids at a high pH to further inhibit solid dissolution and would recrystallize over time to further stabilize the solids.

In situ vitrification is another technology that could be used as a mitigative measure to immobilize tank residuals and contaminated soils. In situ vitrification of residual waste and contaminated soil would immobilize contaminants in a waste form that would substantially reduce the long-term release of contaminants to the vadose zone.

Under the In Situ Fill and Cap alternative and the fill and cap portion of the Ex Situ/In Situ Combination 1 and 2 alternatives, there would be the potential for flammable gases (primarily hydrogen) to collect within the top of the tank and possibly under the asphalt layer of the Hanford Barrier. If this buildup occurred, and an ignition source such as sparks or heat from friction during an earthquake occurred, there would be a possibility that the gases could ignite or explode. This event could be mitigated by providing a mechanism for the gases to vent to the atmosphere. One way to accomplish this would be to include risers that extended from the tanks through the Hanford Barrier to the surface. These risers would allow the gases to vent to the surface. Because the generation of hydrogen gas and other flammable gases is decreasing over time, these risers could be plugged at the end of the administrative control period. In addition, when the tank was filled a hole could be cut in the top of the tank dome to provide adequate venting into the Hanford Barrier and a hole would be left in the asphalt layer of the Hanford Barrier, which would allow gas to vent to the surface. On reaching the surface, hydrogen would diffuse upward (it is less dense than air) and be dispersed into the atmosphere. Should an ignition source occur at the surface such as lightning, the ignition would not propagate downward through the soil into the tank. Flames would not propagate through small pore spaces such as those that would be in the soil at the top of the earthen barriers. Extensive tank waste characterization and engineering would be necessary to implement this mitigation measure.

An additional mitigative measure could be the engineered placement of catalytic recombiners in and near the tanks. The catalytic recombiners would promote the low-temperature reaction of hydrogen and oxygen to form water. The continual reaction of the hydrogen as it was formed could prevent its concentration from reaching flammable or explosive limits. The rate of generation of flammable gas has been decreasing over time and may be decreasing by one-half every 15 years as the heat-producing radionuclides decay and volatile organics are depleted.

A pressurized spray release resulting from a mispositioned jumper during a tank waste transfer is an accident that would be common to all tank waste alternatives. The LCF point estimate risk ranged from 2.0E+00 to 5.6E+00 among the alternatives for the bounding scenario and from 9.3E-02 to 2.6E-01 for the nominal scenario. A mitigative measure that could reduce the risk of a spray release would be to ensure that cover blocks were in place at all times when the jumper was in service during tank waste transfers. Ensuring that the cover blocks were in place would not prevent the accident from occurring, but it could mitigate the consequences of the accident by over five orders of magnitude.

A hydrogen deflagration in a DST or SST prior to or during remediation is an accident that would be common to all tank waste alternatives. The LCF point estimate risk ranged from 1.9E+00 to 1.6E+01 among the alternatives for the bounding scenario and from 3.2E-02 to 2.7E-01 for the nominal scenario. A mitigative measure that could reduce the risk of a hydrogen deflagration would be to install active ventilation systems and mixer pumps in those tanks that pose the risk. This mitigative measure could reduce the probability of the accident occurring and reduce the potential energy of the deflagration if the accident did occur, resulting in a direct reduction of the consequences.

For the In Situ Vitrification alternative, it was postulated that a double-ended break would occur in the off-gas line between the off-gas hood and the off-gas facility as a result of an earthquake. The LCF point estimate risk was 8.3E-01 for the bounding scenario and 3.3E-03 for the nominal scenario. Mitigative measures that could reduce the risk of this accident would be to install a seismic qualified off-gas duct system and seismic shut-off switches that could remove the power to the electrodes and to the off-gas exhaust system and reduce the consequences.

The retrieval accident in which a ventilation heater failed due to an electrical fault resulting from humid air plugging the HEPA filter and filter blow-out would be common to all the ex situ alternatives and the ex situ component of the Ex Situ/In Situ Combination 1 and 2 alternatives. The LCF point estimate risk was approximately 2.3E-03 for the bounding scenario and 8.8E-05 for the nominal scenario. A mitigative measure that could reduce the risk of this accident would be to install a pressure differential shut-off switch that would measure the pressure differential over the HEPA filters. This action could reduce the probability of the accident occurring.

For the In Situ Fill and Cap alternative and the fill and cap remediation portion of the Ex Situ/In Situ Combination 1 and 2 alternatives, it was postulated that a deflagration could occur while the tank was filled with gravel using a rock slinger. A spark from the gravel could ignite a hydrogen gas plume, subsequently overpressurizing the tank. The LCF point estimate risk for a hydrogen deflagration during the fill and cap operation was approximately 2.3E-03 for the bounding scenario and 1.2E-04 for the nominal scenario. A mitigative measure that could reduce the risk of this accident would be to use wet sand or grout as fill. This action could reduce the probability of the hydrogen ignition and therefore reduce the probability of the accident occurring.

These accidents will be evaluated in more detail in Final Safety Analysis Reports, which will provide the basis for safe operations.

With the exception of the No Action, Long-Term Management, and In Situ Fill and Cap alternatives, the schedule of activities for the tank waste alternatives would cause one or more boom-bust cycles in the local economy. These cycles would place a strain on the availability of housing and cause large upward and downward swings in housing prices. These cycles also could cause strains on local school districts. The careful scheduling of activities, primarily construction, could reduce the severity of the boom-bust cycle. It would be possible to build certain facilities in sequence rather than concurrently although this could cause small delays in the initiation or completion of the project and increases in project cost.

The calculation of impacts in this EIS is based on a representative location for process facilities. The representative location was chosen from three similar locations that were considered in a preliminary site selection process. However, this EIS does not support a decision on the final selection of a site for any facilities that would be constructed during remediation. The selection of the precise location of remediation facilities would be the subject of future NEPA analyses when more detailed information is available on the number, size, and configuration of the required facilities. The potential impacts to sensitive habitats would be one of the evaluation criteria used to select sites for required facilities.

All of the alternatives except the No Action alternative would disrupt shrub-steppe habitat. These impacts would be mitigated to the extent appropriate by implementing the following hierarchy of measures.

- Avoid shrub-steppe areas to the extent feasible by choosing alternative locations or configurations for project elements such as new power lines.
- Minimize impacts to the extent feasible, possibly by modifying facility layouts, design elements, altering construction timing, or by salvaging (transplanting) some resources.
- Restore temporarily disturbed areas, possibly by replanting indigenous species taken from other disturbed areas.

Mitigation of impacts to habitats of special importance to the ecological health of the region is most effective when planned and implemented on a Sitewide basis. Recognizing this, DOE is preparing a Sitewide biological management plan to protect these resources. Under this Sitewide approach, the potential impacts of all projects would be evaluated and appropriate mitigation would be developed based on the cumulative impacts to the ecosystem. Mitigation to reduce the ecological impacts from TWRS remediation would be performed in compliance with the Sitewide biological management plan. Mitigation would focus on disturbance of contiguous, mature sagebrush-dominated shrub-steppe habitat. Compensation (habitat replacement) would occur where deemed appropriate. Specific mitigation ratios, sites, and planting strategies (e.g., plant size, number, and density) would be defined in the Mitigation Action Plan, which would be prepared for specific facility siting decisions. The Mitigation Action Plan would be prepared in consultation with the Washington State Department of Fish and Wildlife and the U.S. Fish and Wildlife Service, with input from the Hanford Site's Natural Resources Trustees Council.

All facilities could be constructed using colors that conformed with surrounding visual resources. This would involve using earth tones such as sandstone and sage colors on all facilities practicable. This would reduce the background visual impacts from the air emission stacks, middle ground impacts from the large facilities, and all impacts from all facilities from elevated locations such as Gable Mountain.

All of the alternatives currently assume 16-m^3 (20-yd^3) trucks would be used to haul earthen material from the borrow sites to the TWRS sites. This would involve increased traffic congestion and high haulage cost. If a dedicated haul road was constructed, 30- to 60-m^3 (35- to 70-yd^3) trucks could be used to reduce these impacts.

Under all of the tank waste alternatives, except No Action, Long-Term Management, and In Situ Fill and Cap, there would be extremely heavy traffic congestion on the State Route 240 Bypass Highway near the intersection with Stevens Road on Route 4 west of the Wye Barricade and on Stevens Road north of Richland. The congestion would last for several years. These impacts could be partially mitigated by providing bus service to the 200 Areas, providing incentives to vanpool and carpool, or by staggering work start times to the extent practicable. Other mitigation measures could include modifications to Stevens Road such as adding turn lanes, sequencing traffic signals to improve traffic flow, modifying access approaches to certain facilities, or by widening Route 4 west of the Wye Barricade.

Two areas of potentially disproportionate, significant, and adverse impacts on minority populations or low-income populations were identified. These impacts include 1) increases in housing prices that could adversely impact access to affordable housing by low-income populations; and 2) continued restrictions on access to portions of the 200 Areas that could impede the ability Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation to exercise access, certain land-use treaty rights, and interest in future land ownership.

To mitigate the increased housing prices to low-income populations, the Federal or State government could provide grants for constructing additional low-income housing. Having additional low-income housing available would affect market conditions and tend to keep prices at lower levels. The Federal or State government could also provide grants for constructing low-income housing with guaranteed purchase and rental rates, which could issue low-interest rate home loans with qualifying requirements to low-income applicants.

To mitigate the impacts that continued access restrictions could have on the ability of Native Americans to exercise certain treaty rights, DOE could provide increased protection from disturbance for areas of special importance to the Native Americans, and allow and encourage Native American participation in the planning and mitigation phases of the project. DOE also could purchase and transfer title to lands outside of the 200 Area as compensation for continued access restrictions in the 200 Area.

All of the alternatives would involve traffic accidents and fatalities (six or more fatalities) because of the large number of employees and the long distance traveled by employees to reach the 200 Areas each work day. Although the accident and fatality rates would not be higher than the State-wide averages, the number of fatalities could be reduced by widening Route 4 west of the Wye Barricade, or by reducing the speed limits on Route 4.

All of the mitigative measures would have cost associated with them, and DOE and Ecology would consider the benefits of performing these measures against this cost, and the effect this additional cost might have on the availability of funding for other projects.

Cesium and Strontium Capsules

None of the capsule alternatives, except the Onsite Disposal alternative, would involve substantial environmental impacts so no mitigative measures specific to these alternatives were developed. The Onsite Disposal alternative would involve the disruption of shrub-steppe habitat and the same potential mitigation measures described for the tank waste alternatives could also be used to mitigate impacts on the shrub-steppe habitat for the Onsite Disposal alternative.

6.0 STATUTORY AND REGULATORY REQUIREMENTS

In response to the continued nationwide accumulation of spent nuclear fuel, high-level radioactive waste, other hazardous wastes, and a growing public awareness and concern for public health and safety, Congress has passed numerous laws including the Nuclear Waste Policy Act. The purpose of these laws was to establish a national policy and program that would provide reasonable assurance that the public and the environment would be adequately protected from the hazards posed by these wastes. The action by Congress was influenced by a national consensus that the potential hazards of spent nuclear fuel and high-level waste (HLW) needed to be permanently isolated from the human environment with minimal reliance on institutional controls. Permanent isolation consists of containing the waste within engineered and natural barriers that would be likely to contain the material for a very long time. Minimal reliance on institutional controls means the isolation would not be dependent on ongoing maintenance of facilities, human attention, or commitment by government or other institutions. The national consensus has been reflected in the Northwest by strong support from the U.S. Department of Energy (DOE), Federal and State agencies, Tribal Nations, and citizens and stakeholders to clean up the Hanford Site.

It is DOE's policy to conduct its operations in an environmentally safe and sound manner in compliance with applicable environmental statutes, regulations, and standards. Statutory, regulatory, and permit requirements potentially applicable to the management and disposal of Tank Waste Remediation System (TWRS) tank waste and cesium and strontium capsules are described in this section.

6.1 RELEVANT ENVIRONMENTAL REQUIREMENTS

In 1994 DOE committed to a standards-based management program for "protecting the environment and the safety and health of the public and workers" and for "demonstrating good stewardship of resources" (DOE 1994k). This new program included the "necessary and sufficient" approach in which DOE and its contractor(s) would determine the set of standards appropriate for a facility, a site, or an activity. Applicable requirements contained in Federal, State, and local laws and regulations must be part of the set of standards. The DOE and its contractor(s) would have considerable latitude to agree on other standards that are needed. Current and new DOE Orders would not automatically be invoked. This program is an effort by DOE to appropriately apply human health and environmental standards to specific projects rather than applying all requirements to all projects without considering whether or not the requirement adds any value. However, DOE and its contractor(s) cannot use the necessary and sufficient process to set aside requirements from other agencies. Applicable requirements contained in Federal, State, and local laws and regulations must be part of the necessary and sufficient set.

This section describes the Federal, Washington State, and DOE regulations and requirements that may apply to the proposed action and alternatives considered in this Environmental Impact Statement (EIS). Table 6.1.1 summarizes these requirements.

Table 6.1.1 Relevant Federal Environmental Statutes and Regulations

6.1.1 Federal Environmental Statutes and Regulations National Environmental Policy Act of 1969, as amended (42 United States Code [USC] §4321 et seq.)

The National Environmental Policy Act (NEPA) establishes a national policy to promote awareness of the consequences of human activities on the environment and analysis of potential environmental impacts during the planning and decision-making stages of proposed Federal actions. NEPA requires all Federal agencies to prepare a detailed statement on the potential environmental effects that a major proposed Federal action may have on the quality of the human environment.

This EIS has been prepared in response to those NEPA requirements and policies. It identifies reasonable alternatives for the proposed action and the potential environmental consequences of each alternative. The EIS has been prepared according to the Council on Environmental Quality regulations for implementing the procedural provisions of NEPA as listed in Title 40 Code of Federal Regulations (CFR) 1500 through 1508, and DOE NEPA Implementing Procedures (10 CFR 1021).

Atomic Energy Act of 1954, as amended (42 USC §2011 et seq.)

The Atomic Energy Act authorizes DOE to establish standards to protect health or minimize dangers to life or property for activities under DOE's jurisdiction. Through a series of DOE Orders, an extensive system of standards and requirements has been established to ensure safe operation of facilities. The Nuclear Regulatory Commission (NRC), which also has regulatory responsibilities under the Atomic Energy Act for establishing standards for the commercial disposal of radioactive waste, has established regulations for radioactive waste that can be disposed of in near-surface disposal sites (10 CFR 61) and for radioactive waste requiring geologic disposal (10 CFR 60). Under authority of the Atomic Energy Act, the U.S. Environmental Protection Agency (EPA) has implemented standards for managing and disposing of spent nuclear fuel, HLW, and transuranic waste (40 CFR 191). 40 CFR 191 would apply if HLW is disposed of on the Hanford Site.

Clean Air Act, as amended (42 USC §7401 et seq.)

The Clean Air Act is intended to protect and enhance the quality of the nation's air resources and to promote public health and welfare and the productive capacity of its population. Section 118 of the Clean Air Act requires that each Federal agency, with jurisdiction over any property or facility that might result in the discharge of air pollutants, comply with all Federal, State, interstate, and local requirements regarding the control and abatement of air pollution.

The Clean Air Act requires the EPA to establish National Ambient Air Quality Standards to protect public health, with an adequate margin of safety, from any known or anticipated adverse health effects of a regulated pollutant (42 USC 7409). The Clean Air Act also requires establishing national standards of performance for new or modified stationary sources of atmospheric pollutants (42 USC §7411), and permitting of specific emission increases to prevent a deterioration in air quality (42 USC §7470). Hazardous air pollutants, including radionuclides, are regulated separately (42 USC §7412). Air emissions are regulated by the EPA in 40 CFR 50 through 99. In particular, radionuclide emissions are regulated by the EPA under the National Emissions Standard for Hazardous Air Pollutants Program (40 CFR 61).

The Clean Air Act Amendments of 1990, which amended the Federal Clean Air Act of 1977, require that the EPA develop a national Air Operating Permit Program, which would require each state to develop an Air Operating Permit Program to identify all sources of regulated pollutants. Regulated pollutants include criteria pollutants (oxides of nitrogen, sulfur oxides, total suspended particulates, carbon monoxide, particulate matter less than 10 microns in size, and lead) plus 189 other hazardous air pollutants. In July 1992, the EPA responded to this directive by promulgating 40 CFR 70.

In November 1994, the EPA approved the Washington State Air Operating Permit Regulation, promulgated as Washington Administrative Code (WAC), Chapter 173-401. This permit became effective December 1994. DOE has applied for a Sitewide Air Operating Permit.

Safe Drinking Water Act, as amended (42 USC §300 [F] et seq.)

The primary objective of the Safe Drinking Water Act is to protect the quality of the public water supplies and all sources of drinking water. The implementing regulations, which are administered by the EPA unless delegated to the states, establish standards applicable to public water systems. Public water systems are defined as water systems that serve at least 15 service connections used by year-round residents, or regularly serve at least 25 year-round residents. These regulations establish maximum contaminant levels (including those for radionuclides) in public water systems.

The Safe Drinking Water Act requirements have been implemented by the EPA in 40 CFR 100 through 149. Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program.

Clean Water Act, as amended (33 USC §1251 et seq.)

The Clean Water Act, which amended the Federal Water Pollution Control Act, was enacted to restore and maintain the chemical, physical, and biological integrity of the nation's water. The Clean Water Act regulates the discharge of pollutants to navigable waters of the United States. Section 313 of the Clean Water Act requires all branches of the Federal Government, engaged in any activity that might result in a discharge or runoff of pollutants to surface waters, to comply with Federal, State, interstate, and local requirements.

The Clean Water Act establishes guidelines and limitations for effluents from point-source discharges and authorizes the EPA to implement the National Pollutant Discharge Elimination System Permitting Program. The National Pollutant Discharge Elimination System Permitting Program is administered by the Water Management Division of the EPA pursuant to regulations in 40 CFR 122 et seq.

Resource Conservation and Recovery Act, as amended (42 USC §6901 et seq.)

The treatment, storage, and disposal of hazardous and nonhazardous waste are regulated under the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act (RCRA), the Hazardous and Solid Waste Amendments of 1984, and the Federal Facility Compliance Act, which are described separately from RCRA in this section. RCRA sets forth requirements for generators and transporters of hazardous waste and also establishes a specific permit program for treatment, storage, and disposal of hazardous waste. The EPA regulations implementing RCRA are found in 40 CFR 260 through 280. Washington State regulations implementing the Washington State Department of Ecology's (Ecology) hazardous waste program are described in Section 6.1.2.

Comprehensive Environmental Response, Compensation, and Liability Act, as amended (42 USC §9601 et seq.)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides a statutory framework for the cleanup of waste sites containing hazardous substances and, as amended by the Superfund Amendments and Reauthorization Act, provides an emergency response program in the event of a release or threat of release of a hazardous substance to the environment. Using the Hazard Ranking System, Federal and private sites are ranked and may be included on the National Priorities List. CERCLA requires Federal facilities having such sites to undertake investigations and remediation as necessary. CERCLA also includes requirements for reporting releases of certain hazardous substances in excess of specified amounts to Federal and State agencies. CERCLA could be applicable in the event of a release of hazardous substances to the environment. The implementing regulations for CERCLA are found in 40 CFR 300.

Federal Facility Compliance Act (42 USC §6921 et seq.)

The Federal Facility Compliance Act waives sovereign immunity for RCRA violations at Federal facilities. However, provisions in the act postpone compliance with RCRA mixed waste storage regulations at DOE sites. Instead DOE is required to prepare Site Treatment Plans for developing required treatment capacity for mixed waste stored or generated at each facility unless a State-enforceable agreement for RCRA compliance is put into effect. The Federal Facility Compliance Act provides that DOE will not be subject to fines and penalties for violating prohibitions on land disposal of mixed waste as long as it is in compliance with an approved Site Treatment Plan and meets all other applicable regulations. The Hanford Federal Facility Agreement and Consent Order, also known as the Tri-Party Agreement (Ecology et al. 1994), among Ecology, EPA, and DOE constitutes a State-enforceable agreement that meets the Federal Facility Compliance Act requirements.

Occupational Safety and Health Act of 1970, as amended (29 USC §651 et seq.)

The Occupational Safety and Health Act establishes standards to enhance safe and healthful working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration and the U.S. Department of Labor. While the Occupational Safety and Health Administration and EPA both have mandates to reduce exposures to toxic substances, the Occupational Safety and Health Administration's jurisdiction is limited to safety and health conditions in the workplace environment. DOE implements these standards at the Hanford Site through DOE Orders 3790.1B, 5483.1A, and 5480.1B.

Noise Control Act of 1972, as amended (42 USC §4901 et seq.)

Section 4 of the Noise Control Act of 1972 directs all Federal agencies to carry out, to the fullest extent within their authority, programs within their jurisdictions in a manner that furthers the national policy of promoting an environment free from noise that may jeopardize health and welfare.

Emergency Planning and Community Right-to-Know Act of 1986 (42 USC 11001 et seq.) (Also known as Superfund Amendments and Reauthorization Act [SARA] Title III)

Under Subtitle A of this Act, Federal facilities, including those owned by DOE, provide information, such as specific chemical inventories used or stored and accidental releases that occur from these facilities to the State Emergency Response Commission and the Local Emergency Planning Committee to ensure that emergency plans sufficiently respond to unplanned releases of hazardous substances.

Nuclear Waste Policy Act of 1982 (42 USC §10101 et seq.)

The Nuclear Waste Policy Act established a national policy for disposal of HLW and spent nuclear fuel in a geologic repository, and directed DOE to characterize the Yucca Mountain site in Nevada for suitability as the site of a first United States repository. The Act authorizes disposal of HLW and spent nuclear fuel, in the first repository, subject to a limit on repository capacity and the payment of appropriate fees. The Act specifically instructs the NRC to limit the potential first geologic repository to 70,000 metric tons (mt) (77,000 tons) of heavy metal or a quantity of solidified HLW resulting from the reprocessing of such a quantity of spent nuclear fuel until such time as a second geologic repository is in operation. For planning purposes, DOE assumes that some or all of the Hanford Site HLW that satisfies the repository's acceptance criteria could be placed in the potential geologic repositories developed under the Nuclear Waste Policy Act.

Sufficient information is not available to determine at this time whether the Yucca Mountain site is a suitable candidate for geologic disposal of spent nuclear fuel and high-level radioactive waste. DOE, however, is in the early planning stages for a repository EIS, which will be prepared pursuant to the Nuclear Waste Policy Act. DOE has issued a formal notice of its intent to prepare this analysis. The repository EIS would evaluate potential environmental impacts, based on the best available information and data, that would be associated with the repository's development and operation, and to support the Secretary of Energy's final recommendation to the President, as required by the Nuclear Waste Policy Act. The repository EIS would examine the site-specific environmental impacts from construction, operation, and eventual closure of the repository, including potential post-closure radiological effects to the environment and would assess the impacts of transporting spent nuclear fuel and HLW to a repository.

The Nuclear Waste Policy Act provides that any repository for the disposal of high-level radioactive waste resulting from atomic energy defense activities only shall be subject to licensing under Section 202 of the Energy Reorganization Act of 1974 (42 USC §5842). Further, Section 202 of the Energy Reorganization Act authorizes NRC licensing of facilities authorized for the express purpose of long-term storage of high-level radioactive waste that are not used for, or are not a part of, research and development activities. Therefore, to the extent that any decision based on this EIS requires defense HLW to be placed in a repository constructed under the Nuclear Waste Policy Act or a facility subject to licensing under Section 202 of the Energy Reorganization Act, such a repository or facility would be subject to licensing by the NRC. NRC regulations governing the licensing of a geologic repository are contained in 10 CFR 60.

The Nuclear Waste Policy Act of 1982 directed EPA to promulgate waste standards pursuant to the Atomic Energy Act. EPA responded on September 19, 1985, by issuing the Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Wastes (final rule) in 40 CFR 191. Over a period of years, 40 CFR 191 was vacated and remanded by the court in response to petitions for review. Certain sections of 40

CFR 191 were reinstated and on December 20, 1993, EPA promulgated the current final rule including a revised Section 191.15, Individual Protection Requirements and a new Subpart C, Environmental Standards for Ground-Water Protection. The final rule announcement (58 FR 66398) notes that 40 CFR 191 does not apply to the candidate Yucca Mountain site .

The final 40 CFR 191 rule consists of three subparts. Subpart A established dose limits for members of the public including doses resulting from management and storage of spent nuclear fuel and high-level or transuranic waste at any disposal facility operated by DOE that is not regulated by NRC or by agreement States . Subpart B establishes containment requirements, assurance requirements, and individual protection requirements for disposal systems for spent nuclear fuel, HLW, and transuranic waste. This part specifies a 10,000-year design objective, discusses requirements for institutional controls, monitoring performance of the disposal system, designation by records, markers, and passive controls, avoidance of resource areas, and finally retrievability of wastes. Subpart C establishes groundwater protection standards for underground sources of drinking water for disposal systems for spent nuclear fuel, HLW, and transuranic waste.

The rule was developed primarily for mined geologic repositories. However, EPA states that "Although developed primarily through consideration of mined geologic repositories, 40 CFR 191 ... applies to disposal of the subject wastes by any method with three exceptions." The standards do not apply to ocean disposal or disposal that occurred before the 1985 standards. The groundwater protection requirements of Subpart C may not apply to disposal systems located within a quarter mile of an underground source of drinking water.

40 CFR 191 could apply to some waste that would be disposed of onsite under the TWRS alternatives. If the waste that is disposed of onsite is classified as high-level or transuranic radioactive waste, 40 CFR 191 would apply. It would not apply to waste classified as incidental or low-activity waste (LAW). It would not apply to TWRS HLW assumed to be disposed of at the potential geologic repository at Yucca Mountain, Nevada. Much of the DST waste is considered HLW and onsite disposal would be subject to the requirements of 40 CFR 191. The NRC has not determined the classification of SST waste or residual waste that cannot be recovered from the tanks (see Section 6.2.1, Tank Waste Classification). Depending on how these wastes are classified, 40 CFR 191 may or may not apply to in situ disposal of these wastes. In support of the repository program, waste acceptance system requirements are being developed (DOE 1995q) that would be applicable to any HLW emplaced in the repository. These include requirements for waste form, waste characteristics, waste composition, waste container specifications, and records.

Pollution Prevention Act of 1990 (42 USC §13101 et seq.)

The Pollution Prevention Act establishes a national policy for waste management and pollution control that focuses first on source reduction, followed sequentially by environmentally safe recycling, treatment, and disposal. Disposal or releases to the environment should only occur as a last resort. DOE requires each site to establish site-specific goals to reduce generation of all waste types.

National Historic Preservation Act, as amended (16 USC §470 et seq.)

The National Historic Preservation Act requires that sites with national historic value be placed on the National Register of Historic Places. There are no permits or certifications required under the National Historic Preservation Act. However, if a Federal activity may impact a historic property resource, consultation is required with the President's Advisory Council on Historic Preservation. The consultation will normally result in the generation of a Memorandum of Agreement, including stipulations that must be followed to minimize adverse impacts. Coordination with the State Historic Preservation Officer is also part of the consultation process undertaken to ensure that potentially important sites are properly identified and appropriate mitigative actions are implemented.

Archaeological Resource Protection Act, as amended (16 USC §470 aa et seq.)

The Archaeological Resource Protection Act provides for the preservation of historical and archaeological data (including relics and specimens) that might otherwise be irreparably lost or destroyed as a result of actions by any

Federal agency or its contractors. If a Federal agency finds that its activities may cause irreparable loss or destruction of important scientific, prehistorical, historical, or archaeological data, the agency must notify the U.S. Department of Interior and may request the Department undertake the recovery, protection, and preservation of such data. This Act requires a permit for excavating or removing archaeological resources from public or Tribal lands. Excavations must be undertaken for the purpose of furthering archaeological knowledge in the public interest, and resources removed remain the property of the United States.

American Indian Religious Freedom Act of 1978 (42 USC §1996)

The American Indian Religious Freedom Act was enacted to protect and preserve the rights of Native Americans to believe, express, and exercise their traditional religions. The Act also requires that Federal actions avoid interfering with access of Native Americans to sacred locations and traditional resources that are integral to the practice of traditional religions.

Native American Graves Protection and Repatriation Act of 1990 (25 USC §3001)

The Native American Graves Protection and Repatriation Act established Federal agency responsibility for inventories and summaries of cultural items, including associated funerary objects, unassociated funerary objects, sacred objects, and cultural patrimony items, in Federal collections. Agencies are given procedural directions for planned excavation when cultural items may be present or discovered.

Endangered Species Act, as amended (16 USC §1531 et seq.)

The Endangered Species Act is intended to prevent the further decline of endangered and threatened species and restore these species and their habitats. The Endangered Species Act is jointly administered by the U.S. Department of Commerce and the U.S. Department of Interior. Section 7 of the Endangered Species Act requires Federal agencies proposing action to consult with the U.S. Fish and Wildlife Service to determine whether endangered and threatened species or their critical habitats are known to be in the vicinity of the proposed action.

Migratory Bird Treaty Act, as amended (16 USC §703 et seq.)

The Migratory Bird Treaty Act is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. This Act regulates the harvest of migratory birds by specifying things such as the mode of harvest, hunting seasons, and bag limits. Federal agencies proposing action are required to consult with the U.S. Fish and Wildlife Service regarding impacts to migratory birds and to evaluate ways to avoid or minimize impacts in accordance with the U.S. Fish and Wildlife Service Mitigation Policy.

Bald and Golden Eagle Protection Act, as amended (16 USC §668-668d)

The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere in the United States (Section 668, 668c). A permit must be obtained from the U.S. Department of Interior to relocate a nest that interferes with resource development or recovery operations.

Wild and Scenic Rivers Act, as amended (16 USC §1271 et seq. 71:8301 et seq.)

The Wild and Scenic River Act was enacted to protect selected rivers that possess outstanding scenic, recreational, geological, fish and wildlife, historical, cultural, or other similar values. These rivers are to be preserved in free-flowing condition to protect water quality and promote other conservation activities. The Act authorizes creating a national wild and scenic rivers system, designating rivers that are initially a part of that system, and developing standards for adding new rivers to the system.

6.1.2 Washington State Environmental Statutes and Regulations

Washington State environmental requirements applicable to the proposed action and alternatives evaluated in this EIS are administered by Ecology and the Washington State Department of Health. These requirements are described in the following sections.

Washington State Environmental Policy Act (Chapter 43.21C Revised Code of Washington)

The Washington State Environmental Policy Act (SEPA) and its implementing regulations (WAC 197-11) require any Washington State or local agency to analyze all reasonable alternatives and their potential environmental impacts prior to taking an action that may significantly impact the environment. The SEPA action necessitating this EIS is the issuance of State permits required for this proposal. Because SEPA and NEPA (Section 6.1.1) are very comparable in their purpose, intent, and procedures, Ecology and DOE are co-preparing this EIS in compliance with the requirements of SEPA and NEPA.

Hazardous Waste Management Act (Chapter 70.105 Revised Code of Washington)

The Hazardous Waste Management Act and its implementing regulations (WAC 173-303) apply to the management of all dangerous and mixed waste at the Hanford Site. The EPA has delegated the RCRA base program to Ecology, which gives Ecology the authority to regulate mixed waste in Washington State (Section 6.1.1). The Tri-Party Agreement provides the framework for applying the State's requirements for dangerous waste treatment, storage, and disposal units at the Hanford Site. WAC 173-303 specifies requirements for design, permitting, operation, and closure of dangerous and mixed waste management sites.

Washington Clean Air Act (Chapter 70.94 Revised Code of Washington)

Ecology regulates releases of nonradioactive pollutants while the Washington State Department of Health regulates radioactive pollutants to the air under the WAC 173-400 and 173-460. These regulations require that new sources of toxic air pollutants comply with requirements for measurement of emissions and best available control technologies for potential toxic releases to the environment.

Water Pollution Control Act (Chapter 90.48 Revised Code of Washington)

The Water Pollution Control Act and its implementing regulations (WAC 173-200 and 173-216) require that a permit be obtained for any discharge to the soil column, and the quality of the groundwater in the vicinity be protected and not degraded. Protecting groundwater quality involves applying all known, available, and reasonable methods of prevention, control, and treatment. Both toxic pollutants and radionuclides are included in the groundwater quality standards for the State. WAC 173-201A establishes surface water quality standards for Washington State and requires that toxic substances that have the potential to adversely affect water uses not be introduced into surface waters of the State above natural background levels. EPA retains regulatory authority over the National Pollutant Discharge Elimination System program for the Hanford Site under 40 CFR 122-136. WAC 173-226 provides the basis for a general waste discharge permit program for the State. The WAC 173-226-100 prohibits the discharge of any high-level radioactive waste into State waters.

6.1.3 DOE Regulations and Directives

Through the authority of the Atomic Energy Act, DOE is responsible for establishing comprehensive programs at its facilities to protect health, safety, and the environment. Formerly, DOE carried out this responsibility by directing the activities of its employees and contractors with a series of DOE Orders. Since August 1994, DOE has begun shifting to a system of regulations and directives, in a standards-based management approach, to ensure the excellence in performance that DOE expects of its employees and contractors (DOE 1994k). Directives include orders, policy statements, contractor requirements documents, and manuals to give advice on how to implement requirements. A necessary and sufficient process will be used by DOE and its contractor to decide what directives apply to a particular facility, activity, or site.

DOE regulations are generally found in Title 10 CFR. For purposes of this EIS, relevant regulations include 10 CFR 820, Procedural Rules for DOE Nuclear Activities; 10 CFR 830, Nuclear Safety Management; 10 CFR 834, Radiation Protection of the Public and the Environment (Draft); 10 CFR 835, Occupational Radiation Protection; 10 CFR 1021, Compliance with the National Environmental Policy Act; and 10 CFR 1022, Compliance with Floodplains/Wetlands Environmental Review Requirements. As DOE issues formal regulations, and as the standards-based management approach continues to be implemented, some DOE Orders are no longer needed, while others need to be consolidated. Thus, the new directives are in transition. In September 1995, DOE canceled 58 orders. Nevertheless, the remaining directives give DOE expectations for the environment, safety, and health, These are DOE Policy 450.2, Identification, Implementation, and Compliance with Environment, Safety, and Health Requirements (DOE 1995n) and DOE Order 231.1, Safety and Health Reporting Requirements (DOE 1995o).

DOE Policy 450.2 is a policy statement that sets forth the framework for identifying, implementing, and complying with environment, safety, and health requirements so that work is performed in the DOE complex in a manner that ensures adequate protection of workers, the public, and the environment. This framework is an integral part of DOE's commitment to a standards-based management system. This policy statement reaffirms the commitments in the DOE Nuclear Safety Policy Statement (September 9, 1991) and the DOE Environment, Safety, and Health Policy Statement (July 20, 1993), including the commitments to excellence and continuous improvement in all DOE operations. DOE Order 460.1 establishes onsite packaging and transportation safety requirements (DOE 1995p). DOE Order 231.1 directs the collection and reporting of information on the environment, safety, and health that is required by law or regulation to be collected, or that is essential for evaluating DOE operations and identifying opportunities for improvement needed for planning purposes within DOE (DOE 1995o).

DOE Order 5820.2A establishes policies, guidelines, and minimum requirements for managing radioactive or mixed waste facilities (DOE 1988). Specific requirement limits include 1) external exposure to waste and concentrations of radioactive material that may be released into surface water, groundwater, soil, plants, or animals and is limited to an effective dose equivalent not to exceed 25 millirems/year to any member of the public; and 2) atmospheric releases that are required to comply with the limits specified in 40 CFR 61. Limits are imposed on the cumulative effective dose received by an individual intruder at any time after 100 years, when there is an assumed loss of active institutional control. DOE's historic planning strategy has been to dispose of the majority of their HLW in a national repository. However, DOE does not view disposal in a national repository as being legally required, and DOE intends to determine the appropriate disposition of HLW on a case-by-case basis. For purposes of disposal, DOE Order 5820.2A differentiates between new and readily retrievable existing HLW and HLW that is not readily retrievable. The order provides for new and readily re trievable existing waste to be processed and the HLW fraction disposed of in a geologic repository. For HLW that is not readily retrievable , the order provides for evaluation of such methods as in-place stabilization as well as possible retrieval and processing as stated for new and readily re trievable HLW.

DOE Order 1230.2, American Indian Tribal Government Policy (DOE 1992d), issued April 8, 1992, commits to consult with tribal governments to ensure that tribal rights and concerns are considered before DOE takes actions that may affect tribes. DOE also commits to avoid unnecessary interference with traditional tribal religious practices.

6.1.4 Federal Transportation Regulations

In addition to the packaging and transportation requirements in DOE Orders, offsite shipping of radioactive materials on public right-of-ways is regulated by the NRC and the U.S. Department of Transportation. Table 6.1.2 summarizes applicable Federal regulations for transporting nuclear material.

Table 6.1.2 Summary of Major Federal Transportation Requirements

6.1.5 Tri-Party Agreement

The Tri-Party Agreement, signed by DOE, Ecology, and EPA on May 14, 1989, is an agreement to clean up radioactive and hazardous waste at the Hanford Site over a 30-year period. The Tri-Party Agreement establishes an action plan for clean up that addresses priority actions, methods for resolving problems, and milestones. The Tri-Party

Agreement sets milestones to achieve coordinated cleanup of pthe Hanford Site and provides for the enforcement of these milestones to keep the program on schedule. In addition, the Tri-Party Agreement establishes the applicability of RCRA and CERCLA and their amendments to the Hanford Site.

In January 1994, the Tri-Party Agreement was amended to incorporate the revised TWRS program technical strategy, which includes remediation of single-shell tank (SST) and double-shell tank (DST) waste. The requirements in the Tri-Party Agreement reflect the plan for remediating the tank waste for purposes of analysis in this EIS. DOE has committed to comply with requirements of the Tri-Party Agreement related to managing tank waste at the Hanford Site. These tank-farm specific requirements are being assessed in the TWRS EIS and compared to other alternatives for tank waste remediation as well as to the No Action alternative. The Tri-Party Agreement does not address the encapsulated cesium and strontium. The major requirements of the Tri-Party Agreement schedule related to TWRS are shown in Table 6.1.3. DOE, Ecology, and EPA negotiated additional amendments to the agreement in 1996. The primary changes to the agreement are to 1) incorporate DOE's proposed approach for contracting with private companies to perform certain aspects of the TWRS activities; and 2) combine the LAW pretreatment and LAW vitrification milestones.

Table 6.1.3 Tri-Party Agreement Schedule of Tank Waste Milestones

6.2 ABILITY OF TANK WASTE ALTERNATIVES TO COMPLY WITH REGULATORY REQUIREMENTS

Section 6.1 describes relevant Federal and State laws and regulations, permits, compliance agreements, and DOE Orders that may be applicable to the alternatives addressed in the EIS. Review of the prequirements has raised a number of regulatory issues that could affect the regulatory compliance status of certain alternatives. Section 6.2.1 describes the regulatory issues. The list of permits and approvals that may be required to implement the alternatives is provided in Table 6.2.1. In many cases, specific operating requirements or pollution control equipment would be required to ensure compliance with air and water quality regulations.

However, certain alternatives may not be fully compliant with existing regulations or may require regulatory relief (modification or waiver of regulations) to be compliant. Specific items of compliance or noncompliance are described in Section 6.2.2 for each of the tank waste alternatives. The key requirements that may affect the compliant implementation of alternatives include the following:

- DOE, NRC, and EPA disposal requirements for LAW, HLW, and mixed waste;
- RCRA and State of Washington Hazardous Waste Management Act requirements for the treatment, storage, and disposal of hazardous waste; and
- HLW capacity limitations and waste acceptance criteria of the potential national geologic repository.

These are key regulatory requirements that govern remediation of the tank waste. The ability of the alternatives to meet these requirements is an important factor in the evaluation and comparison of the alternatives.

Table 6.2.1 Potential Permits and Approvals Needed for Tank Waste and Capsule Alternatives

6.2.1 Waste Disposal Regulatory Issues

A number of regulatory issues have been identified that, depending upon how they are resolved, could affect the ability to implement one or more of the tank waste alternatives. Some issues, such as classification of tank waste, are the subject of ongoing discussions with regulatory authorities.

Tank Farm Closure

Under the Tri-Party Agreement, both SSTs and DSTs are RCRA hazardous waste management units that will be eventually closed under State Dangerous Waste regulations (WAC 173-303). The three existing options for closure in accordance with the Hanford Site Dangerous Waste Permit (No. WA7890008967) are 1) clean closure, involving removal of all waste and waste constituents, including tanks, debris, contaminated equipment, and contaminated soil and groundwater; 2) modified closure, which permits closure to a specified level to be determined in consultation with the regulatory authority, a period of institutional controls, and periodic assessments to determine the effectiveness of the closure; and 3) closure as a landfill with waste remaining in-place and corrective action taken for contaminated media under post-closure requirements. All options would require the submittal to and approval of closure plans by Ecology. Although closure is not within the scope of this EIS, the decisions made on how to treat and dispose of the tank waste may impact the choice of closure activities. Implementing one of the in situ alternatives precludes clean closure options for the treatment, storage, and disposal unit, and post-closure monitoring and maintenance would be required. Implementing one of the ex situ alternatives does not preclude any closure option.

RCRA Permit Modification

Facilities used to treat tank waste would be RCRA-permitted treatment units that may generate radioactive or hazardous emissions. Effluent treatment systems would be included in these units where required to ensure that any airborne emissions and liquid effluents would meet air and water quality standards. The Hanford Site Dangerous Waste Permit requires all air emissions from treatment, storage, or disposal units to comply with all applicable Federal and State regulations pertaining to air emission controls, including but not limited to WACs 173-400, 173-460, and 173-480. In addition, the Dangerous Waste Permit requires that the permittee obtain all other necessary permits for work performed under the Dangerous Waste Permit. This is interpreted to mean that the requirements of WACs 173-216, 173-226, and 173-201A also apply to any wastewater or other liquid discharges from treatment facilities. Therefore, before any technologies could be implemented, the Hanford Site Dangerous Waste Permit would need to be modified with the approval of Ecology.

Hanford Site Air Operating Permit Modification

DOE has applied for a Sitewide Air Operating Permit under the Washington State Air Operating Permit Regulation. WAC 173-401-650(1) allows the facility to identify reasonably anticipated operating scenarios. Operating scenarios included in the permit can be implemented without a permit revision. These operating scenarios must comply with all applicable requirements and any terms or conditions of the permit. Once DOE has determined what TWRS alternative will be implemented, the activities will be examined for new source review applicability, and Notices of Construction will be prepared as needed. Specific Notice of Construction requirements may require a permit modification.

National Pollutant Discharge Elimination System Permit Modification

The Clean Water Act applies to all discharges to waters of the United States. At the Hanford Site, the regulations are applied through a National Pollutant Discharge Elimination System Permit governing effluent discharges to the Columbia River. The Hanford Site currently has two of these permits, which specify discharge points (called outfalls), effluent limitations, and monitoring requirements. One permit (No. WA000374-3) is for eight outfalls and the other permit (No. WA002591-7) is for one outfall associated with the 300 Area Treated Effluent Disposal Facility. Any actions that would result in a new or increased discharge to waters of the United States would require a permit modification or a new permit.

Tank Radioactive Waste Classification

The disposal or storage of radioactive waste is regulated by DOE and the NRC pursuant to the Atomic Energy Act and the Energy Reorganization Act. DOE's guidance for classifying waste is contained in DOE Order 5820.2A, Radioactive Waste Management (DOE 1988). The order classifies waste into HLW, low-level waste (LLW), transuranic waste, hazardous waste, and mixed waste. WAC 173-303-040 defines mixed waste. Waste designation procedures under WAC 173-303-070 are also applicable. NRC guidance on waste classification is contained in 10 CFR 60 (Disposal of High-Level Radioactive Wastes in Geologic Repositories) and in 10 CFR 61 (Licensing Requirements for Land Disposal of Radioactive Waste). HLW is defined in 10 CFR 60 as 1) irradiated reactor fuel, 2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel, and 3) solids into which such liquid wastes have been converted. LLW is classified as A, B, C, and greater-than-Class C in 10 CFR 61.55. Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides whose potential hazard will persist long after such precautions such as institutional controls, waste form, and deep disposal have ceased to be effective. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective. DOE LLW disposal is not regulated by the NRC; however, NRC rulings regarding waste treatment and waste feed limitations will affect classifying waste that is subject to HLW disposal requirements.

Proper classification of waste from each tank is required to determine what regulations or DOE Orders are applicable to the waste streams. It is also necessary to determine the disposal requirement to be applied to residual waste left in tanks after retrieval. Tank waste remaining after the removal of the practicable amount of HLW does not fit the DOE definition of LLW (DOE 1988) because this waste was initially derived from spent nuclear fuel. Therefore, to preserve the distinction and the origin of this waste, the DOE (Hanford Site) terminology for this waste is LAW. Design specifications for HLW and LAW treatment will require that waste forms meet applicable criteria (DOE 1995q) for disposal in the potential geologic repository, or as LAW for onsite disposal.

Section 202 of the Energy Reorganization Act of 1974 requires NRC to regulate and license facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive waste, generated by DOE, which is not used for, or part of, research and development activities. Thus, it is important to determine which tank waste is HLW and must be disposed of at a licensed facility. The Nuclear Waste Policy Act defines HLW as:

- The highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and
- Other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation.

The Hanford Site underground storage tanks contain HLW, transuranic waste, and mixed waste. In the current storage mode they are managed as HLW and are listed as HLW in the Integrated Data Base Inventory. Criteria must be formalized as to the extent to which the HLW in the tanks must be separated for the residual waste to be determined to be LAW by the NRC . DOE disposal of LAW is not regulated by the NRC.

DOE and the NRC have had formal discussions on the way tank waste is classified and how the LAW portion might be regulated. These consultations were carried out in the context of the previously planned grouted LAW, but the logic may be applied to vitrified LAW as well (although DOE would need to solicit an opinion from the NRC). The NRC's likely position on classifying Hanford Site tank waste may be inferred from the Denial of Petition (58 Federal Register [FR] 12344, March 4, 1993), which documents DOE and NRC consultations. In the Denial of Petition, NRC cites and summarizes documents that discuss principles derived from the U.S. Atomic Energy Commission's overall regulatory objectives that led to the promulgation of 10 CFR 50, Appendix F in 1970. Among other things, these principles state that "a high degree of decontamination capability" will be achieved, implying that the facility should separate for disposal as much of the radioactivity as possible using processes that are technically and economically practical. Residual radioactive contamination also must be sufficiently low as to not endanger public health and safety.

In 58 FR 12344, the NRC cited a previous finding that DOE's former plans for handling DST waste (as presented in the Hanford Defense Waste EIS [DOE 1987]) were consistent with the NRC's principles of waste decontamination and protection of the public. As such, NRC stated that the waste materials resulting from the process described by DOE for the treatment of DST waste would be incidental waste, provided that the largest practical amount of total radioactivity attributable to first cycle solvent extraction waste be segregated for disposal as HLW. The residual waste after processing, to be disposed of as incidental waste, would not exceed the applicable concentration limits for Class C low-level waste, as defined in 10 CFR 61 .

In 58 FR 12344, the NRC did not provide a view on the waste classification of SST waste. NRC indicated that "the appropriate classification of some Hanford waste remains to be determined--specifically, any SST waste...A case-by-case determination of the appropriate waste classification might be necessary." As such, some consideration may be required for the regulation of SST waste by the NRC. The NRC did not address the classification of residual waste that could not be recovered from the tanks or the contaminated equipment used for waste management or remediation and disposal. These are closure issues that require further discussion among DOE, Ecology, and NRC.

Therefore, classification of some tank waste is subject to the results of ongoing waste characterization studies and regulatory decision making. The current planning basis for the applicability of NRC regulations to the alternatives has several components depending on the alternative. For the in situ alternatives and the in situ component of the combination alternative the planning basis includes the following.

- Most DST waste is currently designated HLW. In situ disposal of this waste would be subject to NRC licensing.
- SSTs contain HLW , which may be classified on a case-by-case basis as LAW or incidental waste. The NRC would make the classification determination. In situ disposal of this incidental waste would not be subject to NRC regulation or licensing.

For the ex situ alternatives and the ex situ component of the combination alternative, the planning basis includes the following.

- HLW components would be separated out and disposed of in a geologic repository. The repository would be subject to NRC regulations including licensing.
- HLW processing facilities and immobilized HLW storage facilities at the Hanford Site would not be regulated or licensed by the NRC unless the facilities are owned by a private entity such as is proposed under the privatization initiative.
- It is assumed that residual waste remaining in the tanks after retrieval of as much of the waste as practicable would be classified as incidental waste (not HLW) and would be disposed of in-place as LLW. The NRC would make the classification determination. Disposal of incidental waste would not be subject to NRC regulation or licensing.
- LAW remaining after processing the high-level tank waste to remove as much of the high-level radioactivity as practicable could be classified as incidental waste as previously indicated by the NRC (58 FR 12344). It is assumed that this waste will not be greater than Class C LLW. Onsite disposal facilities (vaults) for this waste would not be subject to NRC regulation or licensing.
- Waste disposed of under the Ex Situ/In Situ Combination 1 and 2 alternatives would follow the combined planning basis described earlier for the various components.

In summary, the tank waste alternatives that involve a separations process for Hanford Site tank waste would be designed to produce HLW and LAW streams. Current design assumptions are that at least 90 percent of the activity would be in the high-level stream. The concentrated activity stream would be classified as HLW and could be disposed of in the potential geologic repository. The LAW stream, based on the NRC's published opinion, could be classified as incidental waste and subject to less stringent disposal requirements for LAW, if it does not exceed the Class C LLW requirements.

Onsite Disposal of Low-Activity Waste

Onsite disposal of LAW would be consistent with DOE's policies and requirements for low-level radioactive waste management and disposal activities. LAW disposal vaults would be regulated under DOE Order 5820.2A. DOE Order 5820.2A establishes performance objectives for LAW disposal as well as radiological performance assessment requirements. The DOE Order provides guidance on waste characterization, waste acceptance criteria, disposal site selection, facility design, operations and closure/post closure. EPA is considering the need for additional regulation of DOE LAW facilities. At this time, however, DOE LAW facilities are not subject to regulation either by EPA or the NRC. The LAW could be disposed onsite in compliance with Tri-Party Agreement and DOE requirements.

Onsite Storage of High-Level Waste

DOE requirements for storage of HLW are defined in DOE Order 5820.2A. This order specifies that all HLW shall be considered to be radioactive mixed waste and subject to both the Atomic Energy Act and RCRA. Thus, in addition to meeting all applicable DOE radiation protection standards, HLW storage facilities must be RCRA compliant. With respect to mixed waste, DOE retains authority over the radiological components while EPA retains authority over the hazardous component s . Designs for HLW storage facilities must meet the requirements of DOE Order 6430.1 (General Design Criteria) and 40 CFR 264 (requirement for RCRA treatment, storage, and disposal facilities).

Disposal of High-Level Waste

The Nuclear Waste Policy Act of 1982 provided for the development of repositories for disposal of HLW and commercial spent nuclear fuel and required the President to evaluate the use of commercial repository capacity for the disposal of defense high-level nuclear waste. In February 1985, the then Secretary of Energy submitted a memorandum to the President recommending "that the Department proceed with plans and actions to dispose of defense waste in a commercial repository." In an April 1985 Presidential Memorandum, the President approved proceeding on the basis of the recommendation. Subsequently, in September 1988, DOE issued DOE Order 5820.2A, which stated requirements to process and dispose of DOE's new and readily retrievable HLW in a geologic repository and to consider options such as in-place stabilization or retrieval, processing and disposal in a geologic repository for permanent disposal of a singly contained tank waste.

The Nuclear Waste Policy Act Amendments of 1987 ordered termination of activities at all geologic repository candidate sites other than the Yucca Mountain site and required that the Secretary of Energy report to the President and Congress between January 1, 2007 and January 1, 2010 on the need for a second repository. Therefore, the current planning basis for disposal of DOE's new or readily retrievable HLW is for disposal at a geologic repository, which may be Yucca Mountain should that site be shown to be acceptable and approved as a geologic repository.

Waste Acceptance System Requirements

Of the many waste acceptance requirements that are being developed, a few are of particular relevance to implementation of the alternatives for disposal of tank waste or encapsulated cesium and strontium presented in this EIS. They include the following requirements (DOE 1995q):

Waste Form

Particulate waste forms shall be consolidated (e.g., by incorporation into an encapsulating matrix) to limit the availability and generation of particulates. This requirement affects the acceptability of the encapsulated strontium fluoride and calcined HLW, both of which are compacted powders. The waste form shall not contain explosive, pyrophoric, or chemically reactive materials in an amount that could compromise the repository's ability for waste isolation or the ability to satisfy the performance objectives. This requirement affects the acceptability of the encapsulated cesium chloride and strontium fluoride, which are potentially corrosive.

The standard canistered HLW form shall be borosilicate glass sealed inside stainless steel canister(s) with a concentric neck and lifting flange. A footnote to this requirement states that other standard HLW forms will be defined in subsequent revisions of the waste acceptance requirements. Waste forms such as soda-lime glass or calcined HLW waste forms produced under the Ex Situ No Separations alternative could be considered if they can be fully qualified for licensing but may be subject to delayed acceptance. Delayed acceptance would occur after a license is granted.

Repository Capacity

The repository shall not accept in excess of 70,000 mt (77,000 tons) uranium or equivalent in the first repository prior to operation of a second repository. Within this capacity ten percent, or 7,000 mt (7,700 tons) heavy metal, has been set aside for disposal of HLW and DOE spent nuclear fuel. How DOE intends to allocate the 7,000 mt (7,700 tons) heavy metal capacity has not been decided (i.e., spent nuclear fuel first with the balance from HLW; Savannah River waste before Hanford Site waste). However, for purposes of analysis in the EIS, it is assumed that 2,465 (approximately equal to 7,000 mt [7,770 tons]) waste packages from the Hanford Site could be disposed of in the potential geologic repository.

Repository Availability

The repository shall have the capability to accept spent nuclear fuel beginning in 2010 and HLW beginning in 2015 for disposal at the geologic repository at a specified receipt rate. The current repository program planning assumption is that any DOE material (vitrified HLW or spent nuclear fuel) qualified and selected for emplacement in the first repository would be disposed beginning in 2015. The disposition of remaining DOE spent nuclear fuel and vitrified HLW not emplaced in the first repository would not be decided until DOE makes a recommendation on the need for a second repository. This decision would consider such factors as the physical and statutory limits of the first repository.

Mixed Waste

DOE Order 5820.2A states that unless demonstrated to the contrary, all HLW shall be considered to be radioactive mixed waste and subject to the requirements of the Atomic Energy Act and RCRA. DOE has determined that HLW that contains hazardous characteristics or RCRA listed waste may not be disposed of in the potential first geologic repository.

Hanford Site high-level radioactive waste and cesium and strontium capsules contain hazardous, characteristic, and/or listed wastes. Hanford Site tank waste is both characteristic waste and listed waste under RCRA, and the encapsulated cesium and strontium are characteristic waste (the characteristic of corrosivity) under RCRA (once they are determined to be waste). Any alternative that includes disposal offsite must include all necessary requirements to treat, and/or delist, the waste prior to shipment. The DOE generator of HLW, and DOE as a whole, will continue to examine every technical and regulatory option for the disposal of high-level radioactive waste and cesium and strontium capsules. Such options may include pursuing treatability variances and/or delisting options in the appropriate regulatory agencies, working to ensure the safe management of radioactive mixed waste through current modifications to the Hazardous Waste Identification Rule promulgated by EPA (60 FR 66344), or through changes in statute. In any case, appropriate Federal and State agencies (including the receiving state for ex situ options) will be consulted. Treatment standards and delisting must be approved by the receiving state, in addition to Washington State.

6.2.2 Regulatory Compliance

This section describes the ability of each tank waste alternative to enable DOE to comply with Federal and State regulations. The permits and approvals that are potentially required for the alternatives are listed in Table 6.2.1. Implementation of the alternatives would in some cases require regulatory relief. Regulatory relief includes amendment of existing permits, renegotiation of the Tri-Party Agreement, or changes in Federal or State laws or regulations. A summary of potential regulatory relief that might be required to implement each of the tank waste alternatives is presented in Table 6.2.2.

6.2.2.1 No Action Alternative (Tank Waste)

Under the No Action alternative the waste would continue to be stored in underground tanks. No action would be taken to remediate the waste.

Table 6.2.2 Regulatory Relief Requirements - Tank Waste Alternatives

Hazardous Waste Management and Disposal

The SSTs do not meet RCRA or State Hazardous Waste Management Act requirements for storing hazardous waste. While the DSTs meet these requirements, parts of the tank waste transfer system do not. The RCRA land disposal restrictions require that established treatment requirements be met prior to land disposal of hazardous waste. Implementation would require an amendment to the Hanford Site Dangerous Waste Permit and possibly modification of the Washington Administrative Code .

Radioactive Waste Management and Disposal

Implementing this alternative would not comply with the requirements of DOE Order 5820.2A and would be inconsistent with the planned disposal of other HLW in a potential geologic repository. In addition, this alternative may require changes to the requirements for disposal of high-level radioactive waste if no closure action is taken.

Air Quality Standards

Implementing this alternative would not result in violation of air quality standards.

Water Protection Standards

Implementing this alternative would not meet the water protection requirements of 40 CFR 191 (without treating the water) in the future when the tanks are assumed to degrade resulting in migration of the waste if no closure action is taken. Final closure action would be addressed in a closure plan and may result in lower levels of water contamination.

6.2.2.2 Long-Term Management Alternative

Under the Long-Term Management alternative, the tank waste would continue to be stored in underground tanks. The SST waste would have minimal free liquids and would be left in place and monitored. Ultimate decisions on the treatment and disposal of the tank waste, as well as decisions regarding tank closure, would be deferred until some future date. DST waste would be monitored, retrieved, and placed into new DSTs at 50-year intervals.

Hazardous Waste Management and Disposal

The SSTs do not meet RCRA or State Hazardous Waste Management Act requirements for storing hazardous waste. The DSTs do meet these requirements but parts of the tank waste transfer system do not. The RCRA land disposal restrictions require that established treatment requirements be met prior to land disposal of hazardous waste. Implementation would require an amendment to the Hanford Site Dangerous Waste Permit and may require modification of the Washington Administrative Code.

Radioactive Waste Management and Disposal

This alternative would be implemented so as to comply with DOE, NRC, and State Hazardous Waste Management Act requirements for the storage of HLW. This alternative would not comply with the requirements of DOE Order 5820.2A and would be inconsistent with the planned disposal of other HLW in a potential geologic repository. Implementation of this alternative may require changes to the requirements for disposal of HLW if no closure action is taken.

Air Quality Standards

Implementing this alternative would not result in violation of air quality standards.

Water Protection Standards

Implementing this alternative would not meet the water protection requirements of 40 CFR 191 (without treating the water) in the future when the tanks are assumed to degrade resulting in migration of the waste. This alternative would require changes to the groundwater protection requirements if no closure action is taken. Final closure action would be addressed in a closure plan and may result in lower levels of water contamination.

6.2.2.3 In Situ Fill and Cap Alternative

Under this alternative waste would be disposed of in place, no treatment would be performed, the tanks would be filled with gravel, and the tank farm would be capped with a Hanford Barrier.

Hazardous Waste Management and Disposal

Implementing this alternative would not meet the land disposal restrictions of the State Dangerous Waste Regulations (including the requirements of RCRA) because the hazardous characteristics of the waste would be retained. Implementation would require an amendment to the Hanford Site Dangerous Waste Permit and may require modification of the Washington Administrative Code . This alternative would preclude clean closure of the tanks under

RCRA.

Radioactive Waste Management and Disposal

Near-surface disposal of any readily retrievable HLW would not meet the requirements of DOE Order 5820.2A and would be inconsistent with the planned disposal of other HLW in a potential geologic repository. Implementation of this alternative would require changes to the requirements for disposal of HLW if additional closure action is not taken.

Air Quality Standards

Implementing this alternative would not result in violation of air quality standards. A new source review would need to be conducted to determine if a Prevention of Significant Deterioration Permit would be required.

Water Protection Standards

Implementing this alternative would not meet the water protection requirements of 40 CFR 191 (without treating the water). Water quality requirement exceedances are based on the combination of the alternative and the representative closure scenario included in the analysis. Final closure actions would be addressed in a closure plan and may result in lower levels of water contamination.

6.2.2.4 In Situ Vitrification Alternative

Under this alternative all waste would be immobilized with in situ vitrification and disposed of in place.

Hazardous Waste Management and Disposal

This alternative is designed to stabilize the tank waste in a manner that would remove its hazardous characteristics. Implementation would require an amendment to the Hanford Site Dangerous Waste Permit and may require modification of the Washington Administrative Code . This alternative would preclude clean closure of the tanks under RCRA.

Radioactive Waste Management and Disposal

Near-surface disposal of any readily retrievable HLW would not meet the requirements of DOE Order 5820.2A and would be inconsistent with the planned disposal of other HLW in a geologic repository. In addition, this alternative would require changes to the requirements for the disposal of HLW.

Air Quality Standards

Implementing this alternative would meet the air quality standards. A new source review would need to be conducted to determine if a Prevention of Significant Deterioration Permit would be required.

Water Protection Standards

Implementing this alternative would not meet the requirements of 40 CFR 191 (without treating the water). Water quality requirement exceedances are based on the combination of the alternative and the representative closure scenario included in the analysis. Final closure actions would be addressed in a closure plan and may result in lower levels of water contamination.

6.2.2.5 Ex Situ Intermediate Separations Alternative

Under this alternative, all of the waste that could be practicably removed (assumed to be 99 percent) would be recovered and separated into HLW and LAW fractions and vitrified. The LAW would be disposed in an onsite near-surface disposal facility and the HLW would be shipped offsite to a potential geologic repository.

Hazardous Waste Management and Disposal

Implementation would require an amendment to the Hanford Site Dangerous Waste Permit.

Radioactive Waste Management and Disposal

This alternative would meet the requirements for the disposal of HLW and LLW. The EPA is considering a rule to further regulate LLW disposal facilities; the final design of the onsite LAW disposal facility may be impacted by the EPA rule (40 CFR 193). The Waste Acceptance System Requirements Document (DOE 1995q) for the potential first geologic repository limits the total quantity of defense HLW for all of DOE activities. The 3,050 waste packages that would be produc ed under this alternative would exceed the assumed Hanford Site portion of the limit.

Air Quality Standards

Implementing this alternative would not result in violation of air quality standards. A new source review would need to be conducted to determine if a Prevention of Significant Deterioration Permit would be required.

Water Protection Standards

Implementing this alternative would not meet the dose limit requirements of 40 CFR 141 (without treating the water) due to conservative assumptions regarding release of residuals remaining in the tanks after retrieval. Incidental waste disposed of in vaults would meet water protection requirements. Residuals left in tanks would not meet the water protection requirements if additional closure action is not taken. However, tanks and residuals would be addressed in a future closure plan.

6.2.2.6 Ex Situ No Separations Alternative

Under this alternative, all waste that could be practicably removed (assumed to be 99 percent) would be recovered and vitrified. The HLW would be shipped offsite to a potential geologic repository.

Hazardous Waste Management and Disposal

The calcine waste form may not qualify as the Best Demonstrated Available Technology for treatment under RCRA. Implementation would require an amendment to the Hanford Site Dangerous Waste Permit.

Radioactive Waste Management and Disposal

This alternative would meet the requirements for the disposal of HLW and LLW. The EPA is considering a rule to further regulate LLW disposal facilities; the final design of the onsite LAW disposal facility may be impacted by the EPA rule (40 CFR 193). The 10,300 to 29,100 waste packages that would be produced under the Ex Situ No Separations alternative would exceed the assumed Hanford Site portion of the potential first geologic repository limit. The compacte d particulate waste form of the calcination option under this alternative would not meet the current waste acceptance system requirements for the potential first geologic repository, which requires incorporating particulate waste into an encapsulating matrix. Neither soda-lime glass or calcine are currently an approved standard waste form.

Air Quality Standards

Implementing this alternative would not result in violation of air quality standards. A new source review would need to be conducted to determine if a Prevention of Significant Deterioration Permit would be required.

Water Protection Standards

Implementing this alternative would not meet the dose limit requirements of 40 CFR 141 (without treating the water) due to conservative assumptions regarding release of residuals remaining in the tanks after retrieval. Incidental waste disposed of in vaults would meet water protection requirements. Residuals left in tanks would not meet the water protection requirements if additional closure action is not taken. However, tanks and residuals would be addressed in a future closure plan.

6.2.2.7 Ex Situ Extensive Separations Alternative

Under this alternative, all waste that could be practicably removed (assumed to be 99 percent) would be recovered and separated into HLW and LAW fractions and vitrified. The LAW would be disposed of in an onsite near-surface disposal facility and the HLW would be shipped offsite to a potential geologic repository.

Hazardous Waste Management and Disposal

Implementation would require an amendment to the Hanford Site Dangerous Waste Permit.

Radioactive Waste Management and Disposal

This alternative would meet the requirements for disposal of HLW and LLW. The EPA is considering a rule to further regulate LLW disposal facilities; the final design of the onsite LAW disposal facility may be impacted by the EPA rule (40 CFR 193). The 143 waste packages that would be produced under the Ex Situ Extensive Separations alternative is well within the assumed Hanford Site portion of the potential first geologic reposit ory limit .

Air Quality Standards

Implementing this alternative would not result in violation of air quality standards. A new source review would need to be conducted to determine if a Prevention of Significant Deterioration Permit would be required.

Water Protection Standards

Implementing this alternative would not meet the dose limit requirements of 40 CFR 141 (without treating the water) due to conservative assumptions regarding release of residuals remaining in the tanks after retrieval. Incidental waste disposed of in vaults would meet water protection requirements. Residuals left in tanks would not meet the water protection requirements if additional closure action is not taken. However, tanks and residuals would be addressed in a future closure plan.

6.2.2.8 Ex Situ/In Situ Combination Alte rnative 1

Under this alternative approximately one-half of the waste by volume would be recovered and treated, consistent with the Ex Situ Intermediate Separations alternative. Approximately 90 percent of the waste constituents that contribute to risk would be contained within this material. The other half of the waste would be disposed of in situ, consistent with the In Situ Fill and Cap alternative.

Hazardous Waste Management and Disposal

Implementing the in situ portion of this alternative would not meet the land disposal restrictions of RCRA because the hazardous characteristics of the waste remaining in the tanks would be retained. Implementation would require an amendment to the Hanford Site Dangerous Waste Permit and may require modification of the Washington Administrative Code .

Radioactive Waste Management and Disposal

Near-surface disposal of any readily retrievable HLW would not meet the requirements of DOE Order 5820.2A (DOE 1988) . Implementing this alternative would be inconsistent with the planned disposal of other HLW in a potential geologic repository. In addition, this alternative would require changes to the requirements for disposal of HLW if additional closure action is not taken. The ex situ portion of the alternative would meet the requirements for the disposal of HLW and LLW. The approximately 2,130 waste packages that would be produced under the Ex Situ/In Situ Combination 1 alternative would be within the assumed Hanford portion of the potential first geologic repository limit .

Air Quality Standards

Implementing this alternative would meet the air quality standards. A new source review would need to be conducted to determine if a Prevention of Significant Deterioration Permit would be required.

Water Protection Standards

Implementing this alternative would not meet the dose limit requirements of 40 CFR 141 or 40 CFR 191 (without treating the water). The ex situ portion would follow the discussion for the ex situ alternatives and the in situ portion would follow the discussion for the in situ alternatives.

6.2.2.9 Ex Situ/In Situ Combination Alternative 2

Under this alternative, approximately one-third of the waste by volume would be recovered and treated, consistent with the Ex Situ Intermediate Separations alternative. Approximately 85 percent of the waste constituents that contribute to risk would be contained within this material. The other two-thirds of the waste would be disposed of in situ, consistent with the In Situ Fill and Cap alternative.

Hazardous Waste Management and Disposal

Implementing the in situ portion of this alternative would not meet the land disposal restrictions of RCRA because the hazardous characteristics of the waste remaining in the tanks would be retained. Implementation would require an amendment to the Hanford Site Dangerous Waste Permit and may require modification of the Washington Administrative Code.

Radioactive Waste Management and Disposal

Near-surface disposal of any readily retrievable HLW would not meet the requirements of DOE Order 5820.2A (DOE 1988). Implementing this alternative would be inconsistent with the planned disposal of other HLW in a potential geologic repository. In addition, this alternative would require changes to the requirements for disposal of HLW if additional closure action is not taken. The ex situ portion of the alternative would meet the requirements for the disposal of HLW and LLW. The approximately 1,230 waste packages that would be produced under the Ex Situ/In Situ Combination 2 alternative are within the assumed Hanford portion of the potential first geologic repository limit.

Air Quality Standards

Implementing this alternative would meet the air quality standards. A new source review would need to be conducted to determine if a Prevention of Significant Deterioration Permit would be required.

Water Protection Standards

Implementing this alternative would not meet the dose limit requirements of 40 CFR 141 or 40 CFR 191 (without treating the water). The ex situ portion would follow the discussion for the ex situ alternatives and the in situ portion would follow the discussion for the in situ alternatives.

6.2.2.10 Phased Implementation Alternative

Under this alternative, all of the waste that could be practicably removed (assumed to be 99 percent) would be recovered and separated into HLW and LAW fractions and vitrified. The LAW would be disposed of in an onsite near-surface disposal facility, and the HLW would be shipped offsite to a potential geologic repository. One separations and demonstration-scale LAW vitrification facility, and one separations, LAW vitrification, and HLW vitrification facility would be constructed to test the process. Following completion of Phase 1, a full-scale separations, LAW, and HLW vitrification facility would be constructed to remediate the remaining tank waste.

Hazardous Waste Management and Disposal

Implementation would require an amendment to the Hanford Site Dangerous Waste Permit.

Radioactive Waste Management and Disposal

This alternative would meet the requirements for the disposal of HLW and LLW. The EPA is considering a rule to further regulate LLW disposal facilities; the final design of the onsite LAW disposal facility may be impacted by the EPA rule (40 CFR 193). The 3,050 waste packages that would be produced under the Phased Implementation alternative would exceed the assumed Hanford portion of the potential first geologic repository limit.

Air Quality Standards

Implementing this alternative would meet the air quality standards. A new source review would need to be conducted to determine if a Prevention of Significant Deterioration Permit would be required.

Water Protection Standards

Implementing this alternative would not meet the dose limit requirements of 40 CFR 141 (without treating the water) due to conservative assumptions regarding release of residuals remaining in the tanks after retrieval. Incidental waste disposed of in vaults would meet water protection requirements. Residuals left in tanks would not meet the water protection requirements if additional closure action is not taken. However, tanks and residuals would be addressed in a future closure plan.

6.3 ABILITY OF CESIUM AND STRONTIUM CAPSULE ALTERNATIVES TO COMPLY WITH REGULATORY REQUIREMENTS

6.3.1 Regulatory Issues

Presently, the encapsulated cesium and strontium are in storage and may have a beneficial value as irradiation or heat sources. This discussion of the disposal of the capsules includes the underlying assumption that these by-products remain HLW for purposes of permanent disposal once they have been determined to have no beneficial value. The final classification of the cesium and strontium will be made in consultation with the NRC when and if they are determined to be waste.

These radionuclides were originally removed from the tank HLW to reduce the generation of heat which was a potential threat to the integrity of the tanks. They therefore meet part (A) of the Nuclear Waste Policy Act HLW definition that refers to any solid material derived from liquid waste produced from reprocessing that contains fission products in sufficient concentrations [Section 2.(12)(A)]. Also, because of the highly concentrated form of the encapsulated cesium and strontium, they could also be candidates for disposal in a geologic repository under Part (B) of the Nuclear Waste Policy Act HLW definition relating to "other highly radioactive that the commission . . . determines by rule requires permanent isolation [Section 2.(12)(B)]." At this time no such ruling has been made for the encapsulated cesium and strontium.

They are subject to the radioactive waste management requirements of DOE Order 5820.2A and the Safety Requirements for the Packaging and Transportation of Hazardous Wastes (DOE Order 5480.3), as well as the relevant requirements listed in Tables 6.1.1 and Table 6.1.2. In addition to these requirements, the encapsulated cesium and strontium, if overpacked or vitrified, would have to meet the waste acceptance criteria for the potential geologic repository including treatment and/or delisting if they are determined to be mixed waste under RCRA.

6.3.2 Regulatory Compliance

This section describes the ability of each capsule alternative to enable DOE to comply with Federal and State regulations. The permits and approvals that are potentially required for the alternatives are listed in Table 6.2.1. Implementation of the alternatives would in some cases, require regulatory relief. Regulatory relief includes amendment of existing permits or changes in Federal or State laws or regulations. A summary of potential regulatory relief that might be required to implement each of the capsule alternatives is presented in Table 6.3.1.

6.3.2.1 No Action Alternative (Capsules)

Under this alternative, the capsules would

7.0 SCOPING, PUBLIC PARTICIPATION, AND CONSULTATIONS

The Tank Waste Remediation System (TWRS) scoping process provided interested Federal and State agencies, Tribes, and members of the public an opportunity to identify issues or concerns to be analyzed in the TWRS Environmental Impact Statement (EIS). The Council on Environmental Quality (CEQ) and Washington Administrative Code (WAC) regulations require an early and open process to determine the scope of an EIS (10 Code of Federal Regulations [CFR] Parts 1500 through 1508 and WAC 197-11). The purpose of the scoping process was to determine the scope and issues to be analyzed in the Safe Interim Storage of Hanford Tank Waste EIS (DOE 1995i) and the TWRS EIS. The scoping process also identified and eliminated from detailed study areas of potential impacts that were identified as less important and narrowed the discussion of such potential impacts to a brief presentation of why they were not included. The scoping process for the TWRS EIS is described in Section 7.1.1.

Federal agencies, Washington State, and local agencies are required by the National Environmental Policy Act (NEPA), CEQ, and Washington State Environmental Policy Act (SEPA) regulations to involve the public in the decision making process associated with proposed actions that have potentially significant impacts on the human environment. Public participation activities give the public both access to information and the opportunity to participate meaningfully in the decision making process throughout the EIS preparation and at key EIS milestones. The public participation program for the TWRS EIS is described in Section 7.2.

Federal agencies as part of the NEPA process and State agencies as part of the SEPA process also consult with appropriate Tribal Nations and Federal, State, and local agencies. Various Federal and State agencies have responsibilities for certain geographic areas, natural resources, or environmental regulations that may be impacted by the proposed action. Federal and State laws regarding cultural, historical, and archaeological sites as well as treaties and intergovernmental agreements require consultation with Tribal Nations that may be impacted by the proposed action. Section 7.3 describes U.S. Department of Energy (DOE) and Washington State Department of Ecology (Ecology) consultations with applicable agencies and Tribal Nations. Volume Five, Appendix J contains formal consultation letters from DOE and Ecology, and the associated response received.

Section 7.4 describes the public comment process for the Draft EIS and information about how comments were submitted and then considered by DOE and Ecology when preparing the Final EIS . Section 7.4 describes how public comments provide issue-specific information to the decision makers and how to follow comments through the decision process.

7.1 SCOPING SUMMARY

On January 28, 1994, DOE published a Notice of Intent in the Federal Register announcing its intent to prepare the TWRS EIS and the Safe Interim Storage EIS (59 FR 4052). The Safe Interim Storage EIS has been completed (DOE 1995i). The Notice of Intent also announced DOE's intent to conduct a series of public scoping meetings on the proposed actions in accordance with CEQ regulations and DOE Implementing Procedures (10 CFR 1021). After publishing the Notice of Intent, DOE and Ecology agreed to co-prepare the two EISs (MOU 1994).

7.1.1 The Public Scoping Process

During the 45-day scoping period, which ended on March 15, 1994, DOE and Ecology invited all interested parties to submit comments or suggestions concerning the scope of the issues, alternatives, and environmental impacts to be analyzed within each EIS . The public was also invited to attend scoping meetings, at which both oral and written comments were accepted on each proposed EIS. The agencies placed advertisements in local newspapers to announce the public scoping meetings. The newspapers and advertisement dates are included in the Implementation Plan for the

TWRS EIS (DOE 1995b).

The purpose of the scoping meetings was to inform the public about the proposed action and the nature and content of the decision-documents to be prepared. These meetings also allowed the public an opportunity to identify, for the record, areas of potential impacts that should be considered by DOE and Ecology in preparing the EIS. The public scoping meetings dates and locations are included in the Implementation Plan for the TWRS EIS.

A verbatim transcript was made by a court reporter of all oral comments from each meeting. Written comments were accepted at the meetings and throughout the comment period. Copies of all transcripts and comment letters are available in the DOE Reading Rooms and Information Repositories listed in Table 7.1.1.

The initial scope of the TWRS EIS was provided in the Notice of Intent and at each public scoping meeting. The scope called for consideration of impacts associated with the following actions:

- Continue tank waste and encapsulated cesium and strontium management;
- Retrieve single-shell tank (SST) and double-shell tank (DST) waste;
- Process the waste into high-level waste (HLW) and low-activity waste (LAW) streams;
- Immobilize the HLW stream and store the treated material until a potential geologic repository is available; and
- Immobilize the LAW stream and dispose of it or put it into retrievable onsite storage.

The analysis of impacts for implementing the No Action alternative was also included in the scope of the EIS.

Table 7.1.1 DOE Reading Rooms and Information Repositories

7.1.2 Public Scoping Process Results

The EIS scoping process provided an opportunity for interested parties to address both the TWRS EIS and the Safe Interim Storage EIS. The scoping process resulted in comments that were relevant only to the TWRS EIS, relevant only to the Safe Interim Storage EIS, or relevant to both of the EISs. The Implementation Plan for the TWRS EIS summarizes and responds to those scoping comments relevant only to the TWRS EIS as well as those scoping comments applicable to both EISs (DOE 1995b).

DOE and Ecology's responses to scoping comments are summarized in the Implementation Plan for the TWRS EIS, which is available at the DOE Reading Rooms and Information Repositories listed in Table 7.1.1. These documents are also available upon request by calling 1-800-321-2008 or writing to Carolyn Haass, DOE TWRS EIS NEPA Document Manager, U.S. Department of Energy, P.O. Box 1249, Richland, Washington 99352, or Geoff Tallent, Ecology TWRS EIS Project Lead, Washington State Department of Ecology, P.O. Box 47600, Olympia, Washington 98504-7600.

Those issues raised during the public scoping process and analyzed in the TWRS EIS are listed in Table 7.1.2. All the topics originally identified in the Notice of Intent have been addressed in this EIS.

Table 7.1.2 Issues Identified During Public Scoping and Analyzed in the TWRS EIS

7.2 EIS PUBLIC PARTICIPATION PROCESS

A Notice of Availability of the Draft EIS was published in the Federal Register and advertisements were placed in local newspapers (61 FR 16248) . These notifications also informed the public of the comment period for the Draft EIS and the schedule for public hearings . Copies of the Draft EIS were distributed to interested individuals, public interest groups, agencies, and Tribes. The public comment period extended from April 12 to May 28, during which time the public and others had the opportunity to submit written comments on the Draft EIS. Additionally, DOE and Ecology conducted a series of five public comment hearings and meetings at which the public had the opportunity to submit oral and written comments. During and after the comment period, DOE and Ecology held consultation meetings with Tribal Nations and agencies to address issues associated with the Draft EIS . DOE and Ecology considered comments on the Draft EIS prior to completing the Final EIS. The Final EIS include s a list of public comments and the responses to comments from DOE and Ecology (Volume Six, Appendix L) . The Final EIS has been distributed to the public and others and placed for public inspection in DOE Reading Rooms and Information Repositories, as listed in Table 7.1.1.

The decision regarding the proposed action will not be made until at least 30 days following the publication of the Final EIS Notice of Availability. DOE and Ecology will prepare a Record of Decision, which will be published in the Federal Register and be available for public inspection in DOE Reading Rooms and Information Repositories. A Mitigation Action Plan will be prepared to analyze any commitments to mitigate environmental impacts contained in the Record of Decision. Copies of the Mitigation Action Plan will also be available for public inspection at the locations listed in Table 7.1.1.

The goal of the TWRS EIS public participation program is to create an open and accessible decision making process that results in TWRS decisions that are technically feasible, environmentally sound, health and safety-conscious, and that address public concerns and values. Provisions for meaningful and informed public involvement within the TWRS decision making process will help achieve this goal. A detailed discussion of the goal and objectives is presented in the Implementation Plan for the TWRS EIS (DOE 1995b).

The following documents, activities, and avenues of communication for the TWRS EIS have and will continue to encourage direct two-way communication between the agencies and those stakeholders, Trib al Nation s, and Federal, State, and local agencies interested in the TWRS EIS and the decisions to be made.

Notice of Availability

In addition to the Notice of Availability that was published in the Federal Register for the Draft EIS and Final EIS .

Public Notification

Public notices (advertisements in local newspapers, broadcasts via radio or television stations, and mailings) are used to announce DOE and Ecology activities and plans and to encourage public involvement in the TWRS EIS decision making process.

Stakeholders, Agencies, Tribal Nations, and Media

Direct notification via phone calls, facsimile, press releases, Notices of Availability, or mailings are used to announce DOE and Ecology decisions and major project milestones (e.g., the public comment period for the Draft EIS, availability of the Final EIS . Copies of the Record of Decision will be provided to agencies, Tribal Nations, and interested stakeholders.

Briefing of DOE Headquarters, DOE Richland Operations Office, and Ecology Advisory Boards and Committees

DOE Headquarters, DOE Richland Operations Office, and Ecology have established communication channels with advisory boards and committees to provide public input into agency policies, programs, and decisions. These boards and committees, including the Hanford Advisory Board , the Environmental Management Advisory Board, and the Defense Nuclear Facility Safety Board , have provide d input into the TWRS EIS.

Public Comment Period

The public comment period provided an opportunity for interested Tribal Nations, agencies, public interest groups, and the public to provide their input on the proposed action and environmental impact analysis contained in the EIS. The public comment period for the Draft EIS began on April 12, 1996 and ended on May 28, 1996.

Public Hearings

Public hearings and meetings were held in conjunction with the public comment period for the Draft EIS. Public hearings were announced a minimum of 15 days prior to any hearing and diverse channels of communication were used to reach the broadest possible audience.

Administrative Record and DOE Reading Rooms and Information Repositories

The Administrative Record for the TWRS EIS is maintained under the direction of DOE Richland Operations. The Administrative Record contains an index of all documents in the record, guidance documents, final reports, technical information, comments by the public and agencies, DOE and Ecology's responses to comments, decision documents, and other documents used as a basis for analysis during the development of the EIS. These documents, including an index of the Administration Record files, may be found in the DOE Reading Rooms and Information Repositories listed in Table 7.1.1.

Toll-Free Telephone Line, Hanford Cleanup at 1-800-321-2008 (Hanford Hotline)

A toll-free telephone number is available to provide stakeholders with an opportunity to ask questions and obtain information about the TWRS EIS.

Hanford Home Page

TWRS EIS documents have been and will continue to be made available on the Internet via the Hanford Home Page (www.Hanford.gov). Documents placed or to be placed on the Hanford Home Page include the Draft EIS, Final EIS, Record of Decision, meeting notices, fact sheets, and press releases.

7.3 CONSULTATIONS WITH TRIBAL NATIONS AND FEDERAL, STATE, LOCAL, AND REGIONAL AGENCIES

To ensure full compliance with NEPA and SEPA regulations and to help keep concerned agencies informed of DOE actions, the consultations listed in Table 7.3.1 were conducted. Consultations consisted of written correspondence regarding the proposed action, alternatives, environmental impacts, regulatory requirements, issues of concern, and information available from Federal, State, and local agencies and Tribal Nations. Copies of formal consultation letters are contained in Volume Five, Appendix J.

Table 7.3.1 Agency and Tribal Nation Consultations

In addition to written consultation, and when appropriate, DOE and Ecology consulted agencies and Tribal Nations to clarify areas of potential impacts, attain an understanding of concerns, and receive information provided by the agencies and Tribal Nations. Meetings or other consultations were held with the following Tribal Nations, organizations, and agencies:

- Benton County, Washington;
- Community Council, Benton and Franklin Counties, Washington;
- Confederated Tribes and Bands of the Yakama Indian Nation;
- Confederated Tribes of the Umatilla Indian Reservation;
- Defense Nuclear Facility Safety Board;
- Environmental Management Advisory Board;
- Hanford Advisory Board;
- Hanford Natural Resources Trustee Council;
- National Academy of Sciences;
- Nez Perce Tribe ;
- U.S. Environmental Protection Agency;
- Washington State Department of Fish and Wildlife; and
- Washington State Department of Health.

In addition to consultations conducted prior to and following the release of the Draft EIS and Final EIS , DOE and Ecology provided consulting agencies and Tribes with copies of the documents for review. The Record of Decision will also be provided to Tribal Nations and agencies.

7.4 PUBLIC COMMENT PROCESS FOR THE TWRS DRAFT EIS

Distribution of the Draft EIS

Beginning on April 4, 1996 and continuing through the end of the comment period on May 28, 1996, DOE and Ecology distributed in excess of 850 copies of all or portions of the Draft EIS. Distribution included copies sent to local, State, and Federal agencies and elected officials; Tribal Nations; and interested stakeholders. A copy of the EIS and supporting documents was made available at five DOE Reading Rooms and Information Repositories (Seattle, Spokane and Richland, Washington; Portland, Oregon; and Washington, D.C.). The Draft EIS was posted on the Hanford Home Page.

Notice of Availability

On April 12, 1996, a Notice of Availability for the Draft EIS was published in the Federal Register (61 FR 16248).

Public Notification

The public was notified of the availability of the Draft EIS for review, the public comment period, and the dates and locations of public meetings through a variety of channels of communication.

- On April 8, 1996, officials from DOE and Ecology held a press conference for regional and national media to announce the start of the comment period and the availability of the Draft EIS for review and public comment. The press conference generated extensive coverage in the local and regional newspapers.
- The press release announcing the start of the public comment period was placed on the Hanford Home Page.
- An EIS fact sheet was mailed on April 12, 1996 to more than 1,200 individuals on the Hanford Tri-Party Agreement mailing list. The fact sheet summarized the EIS, listed the locations of information repositories where the document was available for public review, informed readers of the dates and locations of public hearings and meetings, and informed readers how a copy of the EIS could be obtained.
- On April 12, 1996, copies of the EIS and supporting documents were made available for public review in five DOE Reading Rooms and Information Repositories.
- On April 12, 1996, public notification advertisements on the start of comment period and meeting dates and locations were published in newspapers in Seattle, Spokane, and Richland, Washington; Portland and Hood River, Oregon; and Washington, D.C.
- On April 12, 1996, information on the Draft EIS and comment period was posted on the Hanford Calendar (revised and distributed weekly throughout the comment period).

Hearings and Meetings

DOE and Ecology sponsored five public hearings and meetings on the Draft EIS. Meetings were held in Seattle on May 22, 1996, Spokane on May 15, 1996, and Pasco, Washington on May 2, 1996; Portland, Oregon on May 9, 1996; and Arlington, Virginia on May 7, 1996. At the public meetings, information was provided to attendees regarding the Draft EIS, representatives from DOE and Ecology responded to questions from attendees, and oral and written comments were submitted by attendees. Comments were recorded and a transcript of each comment is available for review at DOE Reading Rooms and Information Repositories.

In addition to notifications regarding the meetings that were included in information disseminated on the start of the comment period and notification of the availability of the Draft EIS for review, the following activities were completed:

- Display advertisements were placed in general circulation newspapers in the region near the hearing or meeting sites the week prior to the hearing or meeting.
- Post cards were mailed to individuals living in the region surrounding the hearing or meeting locations.

A press release was issued to the media in the region surrounding the hearing or meeting to announce the meeting time, date, and location.

- Hearing or meeting times, dates, locations, and formats were coordinated with public interest groups (Heart of America Northwest, Hanford Energy Action League, and Government Accountability Project), State agencies (Oregon Department of Energy), and the Hanford Advisory Board to maximize attendance.
- Meeting times, dates, and locations were included in Hanford Happenings and Hanford Update.

Consultation Meetings

Meetings, formal and informal, were held during and following the comment period with the following agencies, Tribal Nations and advisory groups to receive input on the Draft EIS:

- Hanford Advisory Board, Waste Management Committee Meeting, Seattle, Washington;
- Yakama Indian Nation, Richland, Washington;
- Nez Perce Tribe, Lapwai, Idaho;
- Hanford Advisory Board, Richland, Washington;
- Community Council, Richland, Washington;
- Washington and Oregon Congressional Delegation, Washington, D.C.;
- Environmental Management Advisory Board, Arlington, Virginia;
- U.S. Environmental Protection Agency, Seattle, Washington;
- Confederated Tribes of the Umatilla Indian Reservation, Mission, Oregon;
- Defense Nuclear Facility Safety Board, Richland, Washington; and
- National Academy of Sciences, Washington, D.C.

In addition to the above meetings, other communication or meetings were held with the technical staff of the following organizations, agencies, or Tribal Nations to support submission of comments and review of the EIS and to receive additional technical information for inclusion in the Final EIS:

- Yakama Indian Nation, Richland, Washington;
- Nez Perce Tribe, Lapwai, Idaho;
- Confederated Tribes of the Umatilla Indian Reservation, Mission, Oregon;
- Benton County, Washington;
- National Academy of Sciences, Washington, D.C.;
- Heart of America Northwest; and
- Hanford Energy Action League.

DOE also requested that the National Academy of Science review the Draft EIS to determine its adequacy to support decision making for the TWRS program. DOE has consulted with the National Academy of Science review committee since the publication of the Draft EIS and responded to initial comments and questions during preparation of the Final EIS. DOE intends to consider final comments by the National Academy of Science in the Record of Decision for the TWRS program.

7.5 COMMENTS ON THE DRAFT EIS

The Draft EIS was provided for public comment from April 12 to May 28, 1996. During this time, 5 public hearings and workshops were held and approximately 750 written and oral comments were received from more than 350 individuals, agencies, stakeholders, Tribal Nations, and organizations provided comments. In response to these comments and emerging technical information that was not available when the Draft EIS was published, a number of changes have been incorporated into the Final EIS.

DOE and Ecology prepared Appendix L, Draft EIS Comments and Agency Responses, to address and respond to public comments on the Draft EIS. In addition, DOE considered comments from the public, agencies, and Tribal Nations, along with other factors such as programmatic need, short- and long-term impacts, technical feasibility, and cost, in arriving at DOE's preferred alternative. Appendix L contains the comments on the EIS received during the public comment period and DOE and Ecology responses to those comments. In compliance with the provisions of the NEPA and CEQ regulations [40 CFR 1502.14(e)], public comments on the Draft EIS were assessed and considered both individually and collectively by DOE and Ecology. Some comments resulted in modifications to the EIS. Other responses contained an explanation of the reasons that the comments did not warrant any further response or modification to the EIS.

As required in the CEQ regulations, the Final EIS identifies DOE's and Ecology's preferred alternatives. The preferred alternatives were identified based on consideration of environmental impacts, regulatory compliance, DOE and Waste Management programmatic missions, public comments, and DOE policy. Public, agency, and Tribal Nation input considered in DOE's and Ecology's identification of preferred alternatives included concerns, preferences, and opinions regarding the activities addressed in the EIS, as well as expectations of DOE in making the decisions on environmental restoration and waste management programs at the Hanford Site.

A major purpose of NEPA is to promote efforts that will prevent or eliminate damage to the environment by ensuring informed decision making on major Federal actions that significantly affect the quality of the human environment. This EIS has been revised, as appropriate, in response to comments. Comments were received on a wide variety of issues including:

- General and specific preferences for one or more of the alternatives;
- The cost estimates presented in the Draft EIS;
- The characterization and modeling of vadose zone and groundwater contamination;
- How repository fees were calculated and the assumption that HLW would be disposed of at an offsite repository;
- The sufficiency of characterization data to support retrieval and treatment of the waste;
- Calculation of post-remediation risk to a Native American Site user;
- Calculation of potential accident risks;
- The extent of waste retrieval from the tanks;
- Consideration of closure in the scope of the EIS;
- Consideration of impacts to cultural and natural resources; and
- Consideration of alternatives that would not comply with Federal and State laws and regulations.

Based on review of public comments along with consultations held with commenting agencies and State and Tribal governments, primary EIS enhancements include the following.

- Discussion and analysis associated with the disposal of HLW at the potential national geologic repository were reviewed, clarified by separating the discussion and analysis from other components of the alternatives, and current data and formulas for calculating costs were added to Volumes One and Two, as appropriate. DOE has refined the cost estimates for disposal of HLW at the offsite geologic repository. Changes were made in the number of canisters as well as the cost-estimating methodology, which impacted the HLW disposal fees. The size of the HLW canisters was increased to reduce the number of HLW packages requiring disposal. Repository disposal fee estimates were performed using the current disposal fee methodology along with revised canister projections. This approach to estimating disposal fees is a refinement over the estimates presented in the Draft EIS, which were based on a fixed cost per canister for all alternatives.
- The option of longer interim onsite storage of immobilized HLW pending availability of an offsite geologic repository was included in the Final EIS.
- In Volume One, Section 5.11 and Volume Three, DOE revised the risk analysis to include a Native American subsistence user scenario. This exposure scenario was developed at the request of and in consultation with the Yakama Indian Nation, Nez Perce Tribe, and Confederated Tribes of the Umatilla Indian Reservation. This scenario represents a Native American who might engage in both a traditional Native American lifestyle and contemporary lifestyle activities such as irrigated farming.
- Additional consultation with the affected Tribal Nations is reflected in the environmental justice analysis and throughout the EIS, as appropriate.

As committed to in the Draft EIS and in response to comments on the Draft EIS, a discussion of emerging data regarding vadose zone contamination beneath the tanks resulting from past leaks has been added to the Final EIS in

Volume One, Sections 4.2 and 5.2, Appendix F, and Appendix K. The data were unavailable for inclusion in the EIS at the time the Draft EIS was published. Much of the data presented in the Final EIS are based on preliminary analysis of the vadose zone contamination, and thus the EIS presents several scenarios that are currently under review by DOE and Ecology regarding the cause, nature, and extent of the contamination. Cesium-137 and other radioactive contaminants from past leaks from the tanks have recently been found at greater depths below the tanks than previously known. This means that some of the contaminants that were expected to move very slowly towards the groundwater have moved more quickly than previously anticipated. The mechanisms for how these contaminants have moved more quickly than anticipated are not fully understood, and DOE has implemented a program to determine the mechanism(s) for this transport. The Final EIS presents a discussion of the data collected to date, potential mechanisms for the transport of the contaminants, and how each mechanism might affect the impacts presented in the Final EIS. Potentially this issue could affect closure of the tank farms and the measures taken to control leaks during retrieval.

Other enhancements to the EIS included modifying the Phased Implementation alternative. The Draft EIS included one full-scale separations and immobilization facility during Phase 2 (full-scale production). This was modified for the Final EIS to include two smaller facilities that together would process the same volume of waste as the large facility shown in the Draft EIS. This change was made to ensure that the EIS bounded the impacts associated with the phased approach for the implementing extensive retrieval alternatives. Accident discussions and analysis were reviewed and emerging data were added to Volume One, Section 5.12 and Appendix E. The EIS was also revised to reflect 1995 Site environmental monitoring and reporting (PNL 1996).

Additional analysis was performed to assess the volume of HLW that would be expected for the ex situ alternatives. This analysis provided an improved planning basis for the volume of HLW that would require interim onsite storage and offsite disposal at a geologic repository. Refinements in the alternatives and revised tank waste inventory were also made. These refinements included 1) adding provisions for 50 years of onsite storage of HLW for those alternatives that included the disposal of HLW in a geologic repository; 2) using dedicated trains to ship HLW to a geologic repository; 3) increasing the amount of contaminants that could potentially be released during certain accidents; 4) adding 22 curies of iodine-129 to the tank waste inventory; and 5) refinements in the amount and source of construction materials and other resource requirements. Also, the Draft EIS contained an analysis of uncertainties for each relevant component of the environment (e.g., risk, waste inventory, groundwater migration) in the applicable section of the EIS. For the Final EIS, the evaluation and discussion of uncertainties was expanded and presented together in Volume Six, Appendix K.

Finally, DOE expanded the EIS analysis of a variation to the Ex Situ/In Situ Combination alternative (known as Ex Situ/In Situ Combination 1 alternative in the Final EIS) presented in the Draft EIS. This alternative was described in the Draft EIS in the cover letter and preface to Volume One and is called the Ex Situ/In Situ Combination 2 in the Final EIS. The Ex Situ/In Situ Combination 2 alternative is similar to the Ex Situ/In Situ Combination 1 alternative that was fully assessed in the Draft EIS, except that the waste would be retrieved from 25 tanks rather than 70 tanks. Both of these alternatives are based on the retrieval of the wastes that would provide the greatest contribution to long-term health risk. The discussion and analysis for this alternative are presented in Volume One and Appendix B.

The changes and refinements described previously resulted in relatively small adjustments in the resource commitments and the calculated environmental and human health impacts. The only large change in impacts resulted from the reevaluation of an energetic fire in a hydrogen generating tank for all of the alternatives and the costs associated with the disposal of the HLW for the ex situ alternatives. Overall, the relative relationship of the impacts between alternatives did not substantially change except that the potential operational accidents for the No Action and Long-Term Management Alternatives would be substantially higher than the other alternatives.

8.0 LIST OF PREPARERS

This section describes the persons responsible for preparing and reviewing the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS). Su pport for preparing the EIS was provided to the U.S. Department of Energy (DOE) Richland Operations Office. The EIS was prepared with assistance from Jacobs Engineering Group Inc. and its subcontractors, Advanced Science, Inc. and Environmental Sciences and Engineering, Inc. The environmental analyses were based largely on engineering data prepared by the Hanford Site Management and Operations contractor and Jacobs Engineering Group Inc. and reviewed by DOE. The DOE, Washington State Department of Ecology (Ecology), and Jacobs Engineering Group Inc. staff and its subcontractor staff who contributed to preparing the EIS are listed in Table 8.1.1. Table 8.1.2 provides brief biographic sketches of preparers from DOE, Ecology, and Jacobs Engineering Group Inc. and its subcontractors.

Table 8.1.1 List of EIS Preparers

Volume and Section	Preparers

EIS NEPA Document Manager	Carolyn Haass (DOE)
EIS Ecology Project Manager	Geoff Tallent (Ecology)
EIS Project Manager	Marc Nelson
EIS Summary	Dave Nichols and Marc Nelson
Volume One	
1.0 Introduction	Dave Nichols
2.0 Purpose and Need for Action	Carolyn Haass (DOE) and Geoff Tallent (Ecology)
3.0 Description and Comparison of Alternatives	David Murray, Colin Henderson, Marc Nelson, and Larry Selby
4.0 Affected Environment	Arrie Bachrach
Geology	Phillip Rogers
Water Resources	Phillip Rogers, Charlene Regenhardt, Keith Fuchser, and Eileen Poeter
Meteorology and Air Quality	John Shrock and John Kuhn
Biological and Ecological Resources	Larry Dean and Clifford Duke
Cultural Resources	Tirzo Gonzales
Socioeconomics	David Serot, Keith Lusk, Arrie Bachrach, and Dave Nichols
Land Use	Ray Hrenko
Visual Resources	Keith Lusk and Arrie Bachrach
Noise	William Elzinga
Transportation	Keith Lusk and Arrie Bachrach
5.0 Environmental Consequences	Marc Nelson and Arrie Bachrach
Geology	Phillip Rogers
Water Resources	Phillip Rogers, Charlene Regenhardt, Keith Fuchser, Eileen Poeter, and Marc Nelson
Meteorology and Air Quality	John Shrock, John Kuhn, and William Glover
Biological and Ecological Resources	Larry Dean, Bill Bosan, and Clifford Duke
Cultural Resources	Tirzo Gonzales
5.0 Socioeconomics	David Serot, Arrie Bachrach, and Keith Lusk
Land Use	Ray Hrenko and Arrie Bachrach
Visual Resources	Keith Lusk and Arrie Bachrach
Noise	William Elzinga
Transportation	Arrie Bachrach

Anticipated Health Effects	Alex Nazarali, Michael Harker, Bill Bosan, Doug Evans, and Andy Stanley
Accidents	Michael Harker and Bill Bosan
Cumulative Impacts	Phil Bramson and William Glover
Unavoidable Adverse Environmental Impacts	Arrie Bachrach and Dave Nichols
Relationship Between Short-term Uses of the Environmental and Long-term Productivity	Arrie Bachrach
Irreversible and Irretrievable Commitments of Resources	Arrie Bachrach, William Glover, and Colin Henderson
Conflicts Between the Proposed Plan and Land-Use Plans or Controls	Ray Hrenko
Pollution Prevention	Arrie Bachrach and David Murray
Environmental Justice	Dave Nichols
Mitigation Measures	Marc Nelson
6.0 Statutory and Regulatory Requirements	Phil Bramson, Marc Nelson, William Glover, and Barbara Morson
7.0 Scoping, Public Participation, and Consultations	Dave Nichols and Doug Brown
8.0 List of Preparers	Maura Oldfield
Volume Two	
A. TWRS EIS Waste Inventory Data	Colin Henderson and David Murray
B. Description of Alternatives	David Murray, Jim Goodwin, Colin Henderson, Dave Stein, Joseph Scott,
	Ronald Weed, and Larry Selby
C. Alternatives Considered but Rejected from Further Evaluation	David Murray
Volume Three	
D. Anticipated Risks	Alex Nazarali, Clifford Duke, Andy Stanley, Mitch Pelton, Joan Young,
	Doug Evans, Bill Bosan, and Loretta Crow
Volume Four	
E. Risk from Accidents	Michael Harker
F. Groundwater Modeling	Phillip Rogers, Charlene Regenhardt, Greg Wroblicky, Keith Fuchser,
	Eileen Poeter, and Kent Bostick
Volume Five	
G. Air Modeling	John Shrock and John Kuhn

H. Socioeconomic Impact Modeling	David Serot
I. Affected Environment	Arrie Bachrach (with supporting principals identified for Section 4.0)
J. Consultation Letters	Dave Nichols
K. Uncertainties Analysis	Alex Nazarali, David Duran, Clifford Duke, Phil Bramson, Colin Henderson, Phillip Rogers, Michael Harker, and Marc Nelson
Volume Six	
L. Draft EIS Comments and Agency Responses	Marc Nelson, Colin Henderson, Alex Nazarali, Phillip Rogers, David Murray, Michael Harker, Loretta Crow, Mamie Brouwer, Doug Evans, Ronald Weed, Arrie Bachrach, and Dave Nichols
EIS Document Production, Editing, and Graphics	Maura Oldfield, Norma Sanchez, Mig Owens, Michelle Johnson, Marie Marquis-Anderson, Claudia Holguin, John Lawrence, Geri Bertelson, Loretta Crow, Mitch Pelton, Ron Allingham, and Carrie Meyer

Table 8.1.2 Biographical Sketches of EIS Preparers

Name	**Degree(s), Registrations, and Experience**	**Years Experience**
Bachrach, Arrie	MS, BA, Political Science	22
Managed and prepared over 50 EIRs for Federal, State, and local governments and private industry. Prepared environmental documents for DOE Office of Civilian Radioactive Waste Management and Uranium Mill Tailings Remedial Action Project.		
Bosan, Bill	PhD, Pharmacology and Toxicology; BS, Biological Sciences; BA, Chemistry.	12
Managed/prepared human health and environmental risk assessments at CERCLA/RCRA sites for DOD and private clients.		
Bostick, Kent	PHg, CGWP; MS, Groundwater Hydrology; BS, Soil Science	20

Managed Hydrology Group on Uranium Mill Tailings Remedial Action Project preparing NEPA documents for 24 sites. Experience in unsaturated, saturated flow, and contaminant transport modeling; emphasis on waste isolation. Contributed to mixed-waste disposal cell designs for Los Alamos National Laboratory and Parks Shallow Land Disposal Facility.

Bramson, Phil	BA, Engineering Physics	36

Managed preparation of NEPA documents including EISs for Hanford Site's TWRS and Defense Waste projects, and DOE Headquarters' New Production Reactor EIS. Managed Battelle's Environmental Protection Department at Pantex Plant.

Brouwer, Mamie	BA, Botany	16

Managed environmental information and quality assurance tasks for 25 DOD installations and DOE sites nationwide. Program Manager for environmental information management systems supporting the Navy and Air Force.

Brown, Doug	BA, Computer Information Systems	3

Supported stakeholder development, public hearings, and comment period for the Spent Nuclear Fuels Programmatic EIS. Supported development of the data management plan for the public comment period for the Waste Management Plan at INEL.

Callahan, Mike	BS, Chemical Engineering; BA, Chemistry; PE	16

Performed air emission analysis and assessed oil and gas production facilities for 5 EIR/EIS projects. Specialist in industrial operations, waste generation, air emission control, off-gas treatment and wastewater associated with remediation activities.

Crow, Loretta	BA, Biology	10

Technical editor and document production coordinator for engineering studies, remedial investigations, feasibility studies, and work plans including documents for DOD Navy sites.

Dean, Larry	BS, Wildlife Management	23

Managed multidisciplinary team preparing NEPA documents including the Preliminary Draft Hanford Remedial Action EIS. Prepared environmental documents for DOE's Hanford and Fernald sites.

Duke, Clifford	PhD, Botany; MA, Public Policy; BA, Biology and Environmental Sciences	15

Provided ecological risk assessment support for an RI/FS and an EIS at the DOE Fernald Site. Developed the framework and analytical methodology for the baseline ecological risk and impacts section of the Hanford Remedial Action EIS.

Duran, David	PhD, MS, BS, Chemistry	10

Senior toxicologist in support of CERCLA/RCRA RI/FSs. Managed and authored four human health and ecological risk assessments under the NAVY CLEAN for DOD. Performed Monte Carlo uncertainty analysis at the Hanford Site.

Elzinga, Bill	MS, BS, Biology	15

Performed EAs and EISs for EPA, U.S. Fish and Wildlife Service, and Army Corp of Engineers, including required NEPA elements (i.e., natural resources, air, noise, socioeconomics). Manager of aquatic surveillance program at Weldon Springs.

Evans, Doug	MS, BS, Geology	9

Analyzed impacts to geologic and water resources for the Hanford Remedial Action EIS. Conducted field investigations and prepared environmental documents for Environmental Restoration programs at DOE's Hanford and Fernald sites.

Fromm, Carl	BS, Chemical Engineering	23

Performed engineering/economic evaluations for pollution prevention and environmental controls for DOE, DOD, and private clients. Developed computer model for estimating effects of changing capacity on capital cost for alternative technologies.

Fuchser, Keith	BS, Aerospace Engineering	7

Supported environmental monitoring, impact assessment, disaster planning and response, land parcel mapping, and facilities management projects. Experience includes vadose zone and groundwater model applications and geographic analysis.

Glover, William A.	MS, Nuclear Engineering; BS, Astrophysics; PE	19

Directed multidisciplinary staffs for NEPA assessments for DOE's Uranium Mill Tailings Remedial Action Project. Participated in license review of a low-level radioactive waste disposal site and requirements review at DOE's Fernald Site.

Gonzalez, Tirzo	MA, Candidate, Historic Preservation; BA, Visual Arts	12

Conducted archaeological studies at the DOE Kaui Test Facility in Hawaii, coordinated field studies for a proposed missile launch facility, and contributed to the establishment of a cultural resources Geographical System database for the Hanford Site.

Goodwin, Jim	BS, Metallurgical Engineering	36

Project Manager for engineering and construction of process plants for industry and the project manager for $150 million upgrades project at DOE's Fernald Site.

Haass, Carolyn	BS, Mineral Engineering Chemistry/Metallurgical Engineering	13

TWRS Environmental Program Manager for DOE Richland Operations Office. Responsible for TWRS NEPA compliance, permitting (RCRA, Clean Air Act, and Clean Water Act), environmental compliance, closure, waste minimization, Tri-Party Agreement, and development of the TWRS environmental strategy.

Harker, Michael R.	BS, Zoology	14

Provided accident and risk analyses for various DOE Safety Analysis Reports, including the Hanford Site Plutonium Finishing Plant Safety Analysis Reports. Lead risk analyst for the Hanford Site Solid Waste Burial Ground Safety Analysis Reports.

Henderson, Colin	BS, Mechanical Engineering; PE	9

Developed engineering design changes and documentation for facility upgrades and resolution of non-compliance issues as a Systems Engineer at DOE's Hanford Site.

Hrenko, Ray	BS, Environmental Sciences	14

Prepared over 50 land-use plans and contributed to 35 EISs and 50 EAs. Managed the land use and recreation sections of the White Sands Missile Range EIS and supported the land use sections of DOD Nuclear Electric Propulsion Space Test EIS.

Kuhn, John	BS, Environmental Engineering Sciences; EIT	3

Conducted dispersion modeling in support of two EISs and various permit applications. Conducted dispersion modeling and impact assessment of hypothetical accidental releases in support of a RCRA Part B Permit for a hazardous waste facility.

Lober, Robert	MS, Environmental Soil Science; BS, Soil Science	17

Developed soil quality indicators for environmental and agronomic assessments, evaluated reclamation strategies for disturbed lands, and researched solute movement within the vadose zone of disturbed soils and groundwater transport modeling. Supported the TWRS Environmental Compliance program.

Lusk, Keith	MA, BA, Economics	8

Supported the land use sections of the DOD Nuclear Electric Propulsion Space Test EIS and Draft Hanford Remedial Action EIS for DOE's Hanford Site. Technical reviewer for DOE's Draft New Production Reactor EIS.

Meyer, Carrie	BA, English	5

Provided technical editing and publication support for various scientific and technical documents, including Safety Analysis Reports, Engineering Studies, Environmental Assessments, and Facility Effluent Monitoring Plans for DOE's Hanford Site.

Morson , Barbara	BS, Wildlife Management	17

Manager for RCRA facility permitting, compliance and corrective action, pollution prevention projects, and supported emergency response and preparedness planning for oil and chemical releases, site rankings, and CERCLA investigations.

Murray, David	DSc, MS, BS, Metallurgical Engineering; PE	22

Manager for process and environmental projects at DOE's Savannah River Site. Supervised analysis of waste management data for DOE's Pantex Plant. Developed feasibility studies for treatment of radioactive waste at DOE's Weldon Spring Site.

Nazarali, Alex	MS, Radiological Science-Health Physics; MS, Nuclear Engineering	8

Author of 3 EIS risk sections for DOE (Hanford Site and Waste Isolation Pilot Project) and 4 EAs and Safety Assessments. Member of DOE's Radiological Assistance Team and Massachusetts Nuclear Incident Advisory Emergency Response Team.

Nelson, Marc	BS, Geology	20

Project manager for 4 EISs and 14 Environmental Assessments. Managed Regulatory Compliance and Waste Management Departments for 3 DOE projects including the Fernald Site, Uranium Mill Tailings Remedial Action Project, and the Weldon Spring Remedial Action Project. Project and Site Manager for 5 DOE projects and 1industrial remediation project.

Nichols, Dave	BA, Political Science and Communications	13

Managed public involvement tasks for DOE, EPA, DOD, and industry (air, water, and wetlands) projects. Supported DOE's New Production Reactors Draft EIS hearing plan and the Fernald Site's public involvement Requirements Identification Document and revised Community Relations Plan.

Oldfield, Maura	BA, English	7

Provided technical editing and publications support for DOE Hanford Site scientific, technical, programmatic, and environmental restoration documents including Tank Characterization Reports, Data Quality Objective Documents, Multi-Year Program Plans, Facility Effluent Monitoring Plans, and Environmental Reports.

Pelton, Mitch	BS, Computer Science, Software Engineer	3

Managed data compilation and integrated geographic, textual, and risk information, for the Hanford Remedial Action EIS. Supported the development and testing for the Multimedia Environmental Pollutant Assessment System.

Poeter, Eileen	PhD, Engineering; MS, Engineering Science; BS, Geology; PE	20

Associate Professor at Colorado School of Mines. Previously an Assistant Professor at Colorado School of Mines and at Washington State University. Conducted research projects for DOE, DOD, other Federal agencies, and private firms.

Regenhardt, Charlene	BS, Geology; BS, Math and Computer Science	13

Project manager for several Environmental Assessments and supported site characterizations and investigations at numerous CERCLA sites. Experienced with groundwater and vadose zone models, computer programming, and statistical applications.

Rogers, Phillip	MS, Water Resources; BA, Civil Engineering; PE	18

Managed environmental projects including the 100-BC-5 Groundwater RI/FS Work Plan for the B Reactor and Basalt Waste Isolation Project at the Hanford Site. Supported groundwater projects at DOE's Hanford, Pantex, and Rocky Flats sites.

Scott, Joseph	PhD, BS, Chemical Engineering; PE	11

Manager of lead technical resource divisions for feasibility studies, remedial action plans, and remedial designs for projects for DOE, Army Corp of Engineers, and DOD, including radiological, metal, and chemical contaminated soil and groundwater.

Selby, Larry	BA, General Science; BS, Geologic Engineering	30

Thirty years cost estimating experience. Forty years of civil engineering and construction industry experience.

Serot, David	PhD, MA, BA, Economics	17

Conducted review of Hanford Site area economy for the Tri-Cities Industrial Development Council and feasibility study for the Tri-Cities Enterprise Association. Developed scenarios describing potential economic trends & energy requirements for DOE.

Shrock, John	MSES, Environmental Impact Assessment; BS, Physics	19

Performed air dispersion modeling for a variety of sources and pollutants for regulatory development, permitting, model validation, accident release studies, and risk assessments. Supported the Illinois Department of Nuclear Safety.

Stein, David	BS, MS, Chemical Engineering; MBA	29

Performed engineering evaluations for a CERCLA investigation at the DOE Weldon Spring Site involving remediation of radiologically and chemically contaminated media and completed several engineering studies for DOD and commercial clients. Evaluated vitrification and calcination processes for remediation of tank waste at the Hanford Site.

Tallent, Geoff	BS, Environmental Studies	6

Managed two State Environmental Policy Act/NEPA EISs for Hanford Site projects. Coordinated interdisciplinary team reviews and approvals of the TWRS EIS. Representative for Ecology on the Hanford Natural Resources Trustee Council.

Weed, Ronald	BS, MS, PhD Candidate, Chemical Engineering; PE	39

Developed resource summary for TWRS EIS. Performed safety analysis and licensing at commercial nuclear facilities. Supported the waste tank ventilation program and restart of the 242-A Evaporator and PUREX Plant for the Hanford Site. Performed restart analysis for systems at Rocky Flats. Holder of nuclear decontamination solutions and process patents.

Wroblicky, Greg	MS, BA, Earth and Planning Sciences; BA, Biology	4

Wrote environmental reports on landfill options and performance of the DOE Pantex Plant. Performed manual modeling for groundwater containment flow and remedial options for CERCLA investigation of a DOD Navy Base.

Young, Joan	MS, Engineering Management; BS, Chemical Engineering	17

Task manager for Hanford Mission TWRS Integrated Technology Planning. Supported the risk assessment for the Hanford Remedial Action EIS. Over 17 years of DOE Hanford Site experience in risk and technical project support.

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ACRONYMS AND ABBREVIATIONS

DST	double-shell tank
EIS	Environmental Impact Statement
LANL	Los Alamos National Laboratory
MUST	miscellaneous underground storage tank
SST	single-shell tank
TRAC	Track Radioactive Component
TWRS	Tank Waste Remediation System
VOC	volatile organic compounds

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length

cm	centimeter
ft	foot
in	inch
km	kilometer
m	meter
mi	mile

Area

ac	acre
ft^2	square foot
ha	hectare
km^2	square kilometer
mi^2	square mile

Volume

cm^3	cubic centimeter
ft^3	cubic foot
gal	gallon
L	liter
m^3	cubic meter
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard

Mass

g	gram
kg	kilogram
lb	pound
mg	milligram
mt	metric ton

Radioactivity

Ci	curie
MCi	megacurie (1.0E+06 Ci)
mCi	millicurie (1.0E-03 Ci)
μCi	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

Electricity/Energy

A	ampere
J	joule
kV	kilovolt
kW	kilowatt
MeV	million electron volts
MW	megawatt
V	volt
W	watt

Temperature

°C	degrees Centigrade
°F	degrees Fahrenheit

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APPENDIX A
TWRS EIS WASTE INVENTORY DATA

A.1.0 INTRODUCTION

This appendix provides the inventory of waste addressed in this Environmental Impact Statement (EIS). The inventories consist of waste from the following four groups:

- Tank waste;
- Cesium (Cs) and strontium (Sr) capsules;
- Inactive miscellaneous underground storage tanks (MUSTs); and
- Anticipated future tank waste additions.

The major component by volume of the overall waste is the tank waste inventory (including future tank waste additions). This component accounts for more than 99 percent of the total waste volume and approximately 70 percent of the radiological activity of the four waste groups identified previously. Tank waste data are available on a tank-by-tank basis, but the accuracy of these data is suspect because they primarily are based on historical records of transfers between tanks rather than statistically based sampling and analyses programs. However, while the inventory of any specific tank may be suspect, the overall inventory for all of the tanks combined is considered more accurate. The tank waste inventory data are provided as the estimated overall chemical masses and radioactivity levels for the single-shell tanks (SSTs) and double-shell tanks (DSTs). The tank waste inventory data are broken down into tank groupings or source areas that were developed for analyzing groundwater impacts.

The waste inventory data in this appendix are from the following documents:

- Single-Shell and Double-Shell Tank Waste Inventory Data Package for the Tank Waste Remediation System Environmental Impact Statement (WHC 1995d);
- Disposition of Cesium and Strontium Capsules Engineering Data Package for the Tank Waste Remediation System Environmental Impact Statement (WHC 1995h); and
- Status Report on Inactive Miscellaneous Underground Storage Tanks (Rasmussen 1995).

A.2.0 WASTE INVENTORY DATA

A.2.1 TANK WASTE INVENTORY

The tank inventory data are presented in Tables A.2.1.1, A.2.1.2, and A.2.1.3. Table A.2.1.1 lists the current waste volumes stored in the SSTs, DSTs, and inactive MUSTs. Table A.2.1.2 lists the chemical constituents in the SSTs and DSTs, and Table A.2.1.3 lists the estimated radionuclide inventory for the SSTs and DSTs. The chemical inventory for the SSTs is categorized by waste types found in the tanks: sludge, saltcake, and liquid. The DST chemical inventory is presented as soluble and insoluble components. The soluble portion of the DST waste inventory was estimated using solubility factors, which were calculated using tank sampling and historical data. These solubility factors represent the amount of each component assumed to be soluble in water. The insoluble portion of the DST waste inventory is assumed to remain in a solid form during sludge washing operations.

Data showing the division of the constituents between the soluble and insoluble portion of the SST waste do not exist.

Based on estimates of tritium contained in the tank waste, the Effluent Treatment Facility is expected to process 242-A Evaporator condensate containing 2,360 curies (Ci) of tritium (reflecting decay to December 31, 1999) during its operational life. Processing the wastewater from the K and N Basins would add about 10 percent to this total (DOE 1994e).

A.2.1.1 Tank Aggregated Source Areas

The DSTs and SSTs represent 177 potential sources of contaminant release. These sources were grouped together into source areas (tank groupings) for groundwater modeling purposes. Each tank grouping contains between one and three tank farms. The tank farms were grouped together based on tank configuration, tank proximity, and groundwater flow direction. The inventory from the individual tank farms was then combined to create a waste inventory by source area (Pelton 1995). The SST and DST farms were maintained in separate source areas to support different release scenarios developed for the alternatives. Grouping the tank waste inventory together into source areas, based on tank configuration, geographic proximity, and groundwater flow direction, resulted in eight tank groupings, three in the 200 West Area (two SSTs and one DST) and five in the 200 East Area (three SSTs and two DSTs).

The tank farms were grouped into the source areas identified in Table A.2.1.4 and Figure A.2.1.1. The chemical species and estimated radionuclide inventory for the SST groups are shown in Tables A.2.1.5 and A.2.1.6. The chemical species and estimated radionuclide inventory for the DST groups are shown in Tables A.2.1.7 and A.2.1.8.

A.2.2 CESIUM AND STRONTIUM CAPSULE INVENTORY

The quantities, heat loading, and radioactivity levels for the Cs and Sr capsules are presented in Table A.2.2.1. The chemical form of the Cs in the capsules is cesium chloride (CsCl) and the chemical form of the Sr in the capsules is strontium fluoride (SrF_2). The combined total capsule volume is approximately 2 cubic meters (m^3) (70 cubic feet [ft^3]) (WHC 1995h).

The Cs content of the capsules is primarily Cs-137, which has a half-life of 30.17 years. Cesium-137 decays into the stable isotope barium-137. The Sr capsules contain mainly Sr-90, which has a half-life of 28.6 years. Strontium-90 decays to yttrium-90 and then to the stable isotope zirconium-90. The reduction in the number of curies, heat load, and concentration over time is due to the radioactive decay of the Cs and Sr into stable daughter products.

A.2.3 INACTIVE MISCELLANEOUS UNDERGROUND STORAGE TANK WASTE INVENTORY

Approximately 40 of the 60 total MUSTs in the Central Plateau that are associated with tank farm operations are inactive MUSTs with inventory that is included in the waste inventory subject to treatment and disposal under the Tank Waste Remediation System (TWRS) (Figures A.2.3.1 and A.2.3.2).

Table A.2.3.1 presents the volume of liquid and solids in the inactive MUSTs (Rasmussen 1995). The total volume of waste in these tanks approximately 448,000 liters (L) (118,000 gallons [gal]), which is less than one-half of 1 percent of the waste volume contained in the SSTs. Definitive characterization data do not exist for the inactive MUSTs, but because they received the same waste products that are contained in the tanks, the concentration of constituents is also expected to be approximately the same.

A.2.4 FUTURE TANK WASTE ADDITIONS

Waste projections for future tank waste additions are shown in Table A.2.4.1. This waste is expected to be added to DSTs after being reduced in water content in the 242-A Evaporator. The majority of the future waste additions would come from decontamination and decommissioning activities at inactive facilities on the Hanford Site. This waste would be classified as dilute, noncomplexed waste (does not contain complexing organics) that are low-level liquid waste. The 100 Area final (terminal) cleanout waste is classified as double-shell slurry feed, which is waste that is concentrated in the evaporator to a point just below the sodium aluminate saturation boundary (Hanlon 1995). Some future tank waste additions may be high-level waste or mixed waste that would come from cleanout of existing Site facilities. These future waste additions would be typical of the types of waste currently stored in the tanks.

The potential relocation of the K Basins sludge to the DSTs would result in the addition of approximately 54 m^3 (1,930 ft^3) of sludge to these tanks. The sludge contains spent nuclear fuel, corrosion products, small pieces of spent nuclear fuel (primarily uranium), iron oxides and aluminum oxides, concrete grit, fission and activation products from the spent nuclear fuel, and other materials such as sand and dust from the outside environment. The discovery of polychlorinated biphenyls in the sludge may affect the ability of the tank farms to accept the sludge. This waste would add approximately 11,000 Ci to the DSTs. This would include approximately 5,200 Ci of plutonium-241 (Pu-241), 260 Ci of plutonium-239 (Pu-239), 1,280 Ci of Sr-90, and 970 Ci of Cs-137. Following basin cleanout, the sludge plus about 1,200 m^3 (43,000 ft^3) of water would be transported to the DSTs for waste management, treatment, and disposition.

A.3.0 TANK INVENTORY DATA DISCUSSION

Obtaining representative sample data from the tanks is a very expensive and potentially hazardous activity because the tanks contain high levels of radioactive constituents and because the tank contents are heterogeneous. The SST chemical waste inventory data were derived using historical tank data based on the normalized Track Radioactive Component (TRAC) data. TRAC is a model that was developed to estimate tank waste radioactive inventories. The TRAC model output was later modified to account for known processing parameters and was then identified as normalized TRAC data.

The DST chemical and radiological waste inventories were developed using tank sample data in combination with historical tank data. DST radionuclide estimates were based on existing laboratory data and characterization reports. The isotopes presented in this appendix for DSTs were those consistently reported by laboratories, which is why the number of isotopes reported for DSTs is different than SSTs.

The waste inventory data used in developing the alternatives and their associated impacts were derived from model predictions and sample analysis. While the waste is currently undergoing additional characterization and the inventory may be revised as a result of ongoing analyses, the inventory used in the EIS is not expected to result in the discrimination for or against any of the alternatives presented.

There is considerable uncertainty associated with these inventory data. Additional tank characterization is required before final design of any alternative can take place. However, for the purposes of conceptual design, the concept of a nominal waste feed stream based on overall tank waste inventory can be used to develop plant capacities, project plant performance, and provide initial equipment sizing. The use of a nominal feed allows each of the proposed alternatives to be developed conceptually to a point where they can be analyzed in this EIS. This approach does not preclude the need for additional characterization.

A.3.1 OTHER TANK CHARACTERIZATION PROGRAMS

Several ongoing activities are involved with collecting and analyzing data on tanks contents. Each of these efforts is an attempt to provide more detailed and accurate tank waste inventory data.
The following are ongoing programs:

- Tank Characterization Program - Sampling and analysis of tank waste;
- Los Alamos National Laboratory (LANL) - Historical estimates based on observed waste stream data and process knowledge to develop inventory; and
- Historical Tank Content Estimates - Compiling available historical data.

The Tank Characterization Program, further addressed in Appendix B, gathers waste samples from each of the tanks for analysis. This program, which is based on data needs, is responsible for collecting and analyzing tank waste to satisfy the data requirements for tank safety issues and remediation process design. Ongoing waste characterization program activities to improve the estimates for tank waste inventory include 1) waste sampling and laboratory analysis; 2) data interpretation; and 3) historical review. The historical review provides a basis and background in data interpretations on waste management activities.

The LANL waste characterization effort consists of a series of spreadsheet-based computer models that derive composition estimates for the waste streams distributed to the tanks. When reconciled with the waste transaction records, these waste streams will provide an estimated accounting of the waste present in each tank as a function of time. Initial indications are that these model estimates, in their current form, are moderately successful in predicting certain bulk waste properties and inventories (WHC 1994f). Initial modeling results have been completed for all of the SSTs (solids inventory only) and DSTs. This program is ongoing, with plans to develop the model for the tank farm operations to track the tank waste inventory.

The Historical Tank Content Estimates are a series of documents being prepared by the current Management and Operations contractor that combine available historical tank data with the characterization data estimated by LANL (Agnew 1994). These documents will compile the tank waste volumes, photographs, temperatures, waste types, and waste inventory estimates over time (WHC 1994g, h, and WHC 1995b, o). Historical Tank Content Estimates have been initially released for all of the SSTs and DSTs. This is an ongoing program and current planning includes updating these documents during 1996.

A.3.2 LOS ALAMOS NATIONAL LABORATORY TANK WASTE CHARACTERIZATION DATA

The estimation of tank contents using the LANL model is expected to be completed by October 1996. At present, the LANL model has been used to estimate the composition of the solids (sludge plus saltcake) in the SSTs, and the composition of the solids and liquid in the DSTs. There are enough data from the LANL model to make a comparison with the inventory data package that is used in the EIS (WHC 1995d). Tables A.3.3.1 and A.3.3.2 compare the metric tons of chemicals and the metric tons or curies of radionuclides that are reported for the inventory data package and the LANL model (Agnew 1994, WHC 1994g, h, and WHC 1995b, o). The comparison of chemical constituents is limited to those chemicals that are common to both inventories.. The comparison of radionuclides is restricted to those that are reported for the LANL model.

A general comparison of the amounts reported by the LANL model and the data package shows that the LANL model routinely reports amounts that are several times greater than the corresponding amounts from the data package. This result is observed for both chemicals and radionuclides. However, when the LANL model reports are complete, the total differences may be less. The derivation of the LANL model and the generation of the inventory data are both sufficiently complex that the source of the differences between the two are not readily explained. However, it is possible to address the two inventory sources in the light of their effect on the EIS. The EIS uses inventories as the basis for calculating risks, both during the remediation phase of the alternatives and during the post-remediation phase. Risks during remediation arise primarily from releases to the atmosphere. Risks during post remediation are caused by releases to groundwater.

Risks during remediation are caused primarily from exposure to Cs-137, Sr-90, iodine-129 (I-129), and carbon-14 (C-14) for radionuclides and volatile organic compounds (VOCs) for chemicals. The LANL model shows only Cs and Sr, so it cannot be used to calculate the risks for I-129 and C-14. The LANL model indicates a Cs content in the SSTs that is over four times that reported in the data package. In the case of Sr, the LANL model indicates twice as much in the DSTs than the data package reports.

Neither the LANL model nor the data package report VOCs, so another data source was used for these chemicals. If data from the LANL model were used for the EIS, calculations would show somewhat higher risks during remediation because of increased Cs and Sr quantities.

Risks during post remediation are caused by mobile elements migrating through groundwater. The mobile radionuclides of concern are C-14, I-129, technetium-99 (Tc-99), and uranium. The mobile chemical constituent of concern is the nitrate anion. The LANL model only indicates quantities for uranium and nitrate. Quantities are not shown for C-14, I-129, and Tc-99 for the LANL model, so no differences from currently projected impacts could be calculated. The LANL model indicates about 20 percent more uranium in the SSTs than the inventory data package shows. For the DSTs, the inventory data package does not indicate any uranium in the DSTs, while the LANL model shows 160 metric tons. For total uranium in both SSTs and DSTS, the LANL model indicates about 30 percent more uranium than the inventory data package shows. In the case of nitrate quantities, the inventory data package shows about twice as much in the SSTs than the LANL model shows. Both estimates are essentially equal for nitrate in the DSTs. The effect of using quantities estimated by the LANL model for the EIS would be to indicate marginally higher risks in post remediation caused by uranium and somewhat lower risks caused by nitrate.

A.3.3 TANK INVENTORY DATA ACCURACY AND ITS EFFECT ON THE EIS

The predicted inventories from different models will not necessarily be in agreement with regards to the kinds and quantities of substances that make up the tank wastes. There is an ongoing effort to compile a standard inventory estimate that would serve as a unified source of tank constituents (WHC 1995q). These best-basis estimates are to be incorporated into the existing Tank Characterization Database. However, this work is in its initial stages and completion is expected at a future date. Until this unified source has been completed and is universally used, other documents, such as the EIS, must use available inventory data and recognize the effects of inaccuracies in those data. This section presents the effects of inventory data accuracy on the various portions of the EIS.

An important point to keep in mind when considering inventory data accuracy is the ultimate significance of the data as they are used to calculate or predict environmental impacts. For a substance that is present in minute quantities and is not radioactive or toxic, high accuracy in reporting that substance in the tank inventory is not required. The effects of variation in the amount of such a benign substance would not be great. Conversely, if a substance is a major tank waste constituent, or is highly radioactive or very toxic, the accuracy in reporting that substance and the ultimate effect on environmental impacts must be recognized. For example, sodium is a major waste component and its quantities will affect the size of the low-activity waste facility for the ex situ alternatives. However, the pre-conceptual estimation of the size and cost of facilities for the EIS has a variation that is typically plus or minus 40 percent. This variation in size and cost estimation is based on factors that include the variability of the feed stock. A variation in sodium quantities by plus or minus 20 percent would not produce environmental effects that were unexpected.

Rather than discuss the effects of inventory accuracy on an element-by-element basis, this section presents the measures that were taken by each function or discipline to account for the variability of the tank waste inventory. These measures must strike a balance between understating environmental impacts and overstating these impacts by compounding conservatism upon conservatism. In addition to the discussion in this section, each appendix contains the major assumptions and uncertainties, which include other factors in addition to uncertainties in tank inventory data.

Engineering

To provide conservatism in generating inventory information for use by other disciplines, the engineering function used the inventory data package as the basis for conservative estimates of the releases during retrieval and subsequent processing; the dissolution of the residual materials remaining in the tanks and the low-activity waste vaults; and the effects of blending and composition on the volume of high-level waste glass or calcine. Releases from the tanks during ongoing current operations were obtained directly from analytical data, which do not involve concentration modeling. The data relating to these releases were used directly, with no additional conservative factors being applied.

Groundwater Modeling

The inventories generated by the engineering function were used without change by the groundwater modeling function. To ensure that groundwater effects were not understated, conservative values of distribution coefficients (K_d) were used. While this would not affect the inventory of contaminants, it would ensure that the travel times of contaminants were at the upper bound of the range that is generally accepted for these studies. While other assumptions were made to complete the groundwater modeling, they did not directly involve the contaminant inventory.

Air Modeling

The model inputs used by the air modeling function were the routine emissions from the tank farms and emissions from the remediation facilities. The air modeling function used the analytical results from ongoing current operations to predict the concentrations of contaminants that would be released from the tank farms. The emissions from the remediation facilities were provided by the engineering function (Jacobs 1996). The analytical results from current tank farm operations were obtained by direct measurement and were considered to be sufficiently accurate for use without modification. Emissions from remediation facilities are directly related to the tank inventories because it is the tank contents that are being processed. Because the models that predict air contaminant concentrations are considered sufficiently conservative, the calculated emissions from the remediation facilities were used without further modification.

Risk Assessment

Inventory data were used to calculate risks from routine exposures and accidents during remediation and post-remediation activities. The assessment of risk from routine exposures during remediation used the same inputs as the air modeling function. As explained in the previous paragraph, the analytical results from ongoing operations of the tank farms and the calculated emissions from the remediation facilities were used. Because the results of the groundwater modeling were used as input to the assessment of risk during post remediation, the conservatism employed by groundwater modeling was directly reflected in the risk assessment modeling. Consequently, further conservative assumptions concerning the contaminant concentrations were not postulated.

The accepted practice for assessing risks from accidents during remediation combines the overall inventory of contaminants, both modeled and analyzed, to form the contents of a so-called super tank. This is a unique use of the tank inventory and is intended to ensure that the consequences of accidents invariably involve exposures to the same quantities of contaminants. This concept is used solely for accident analysis and is consistent with current Hanford Site practice. The assessment of risks during post remediation uses the conservative estimate of the volume and inventory of the high-level waste glass or calcined product, which has been provided by the engineering function. The models that calculate the consequences of transportation accidents are considered sufficiently conservative, and the inventory provided by the engineering function is used without modification.

Figure A.2.1.1 Location of Tank Waste Source Areas

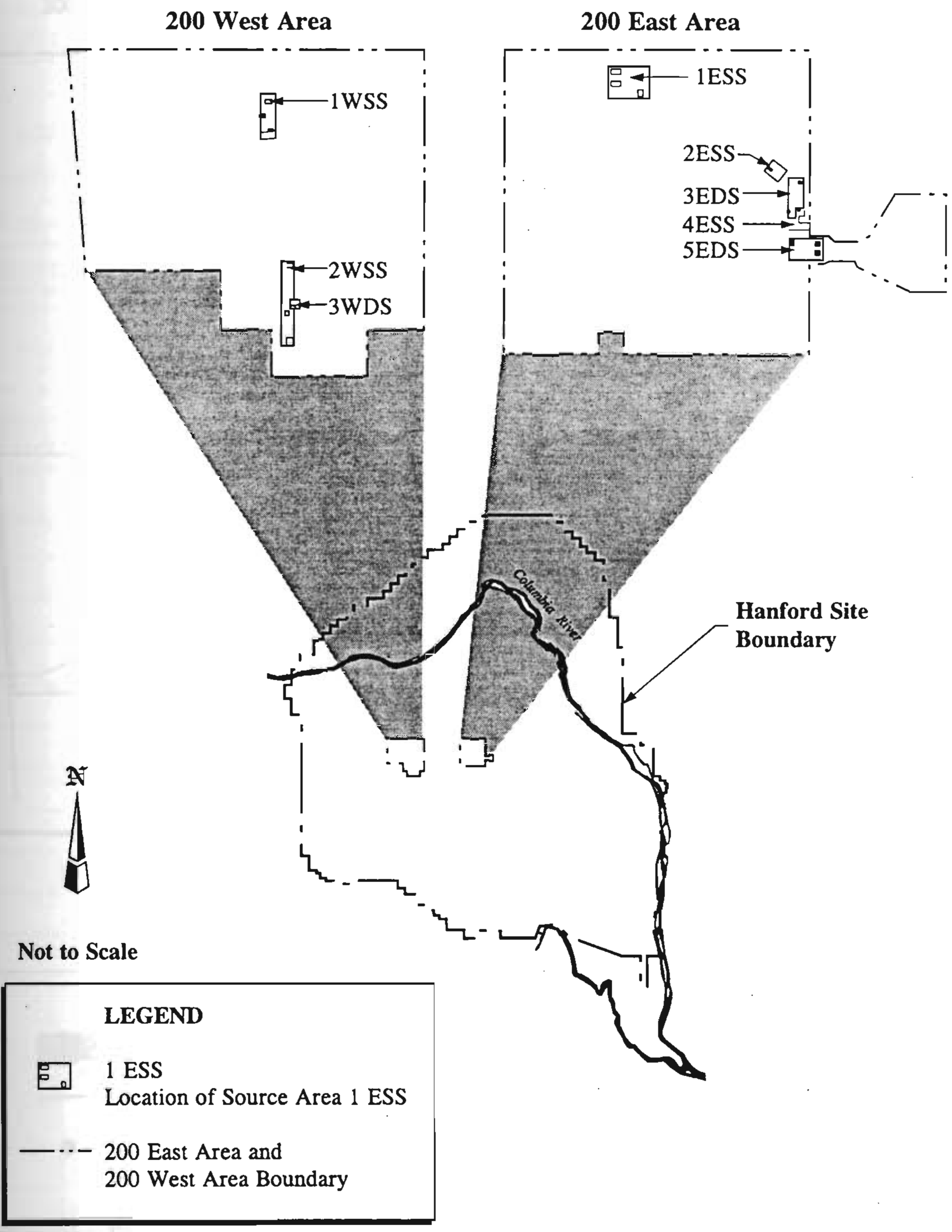
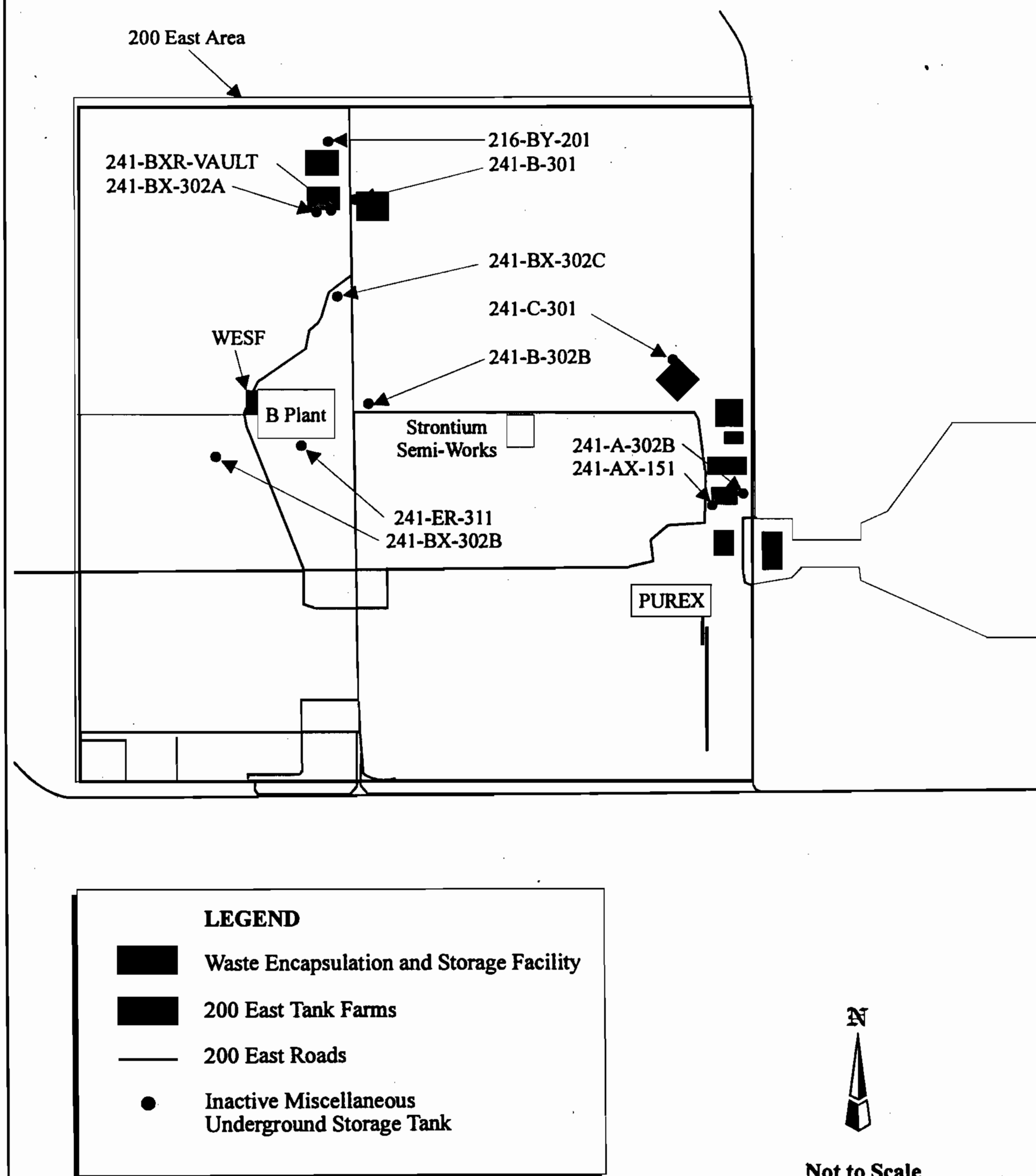
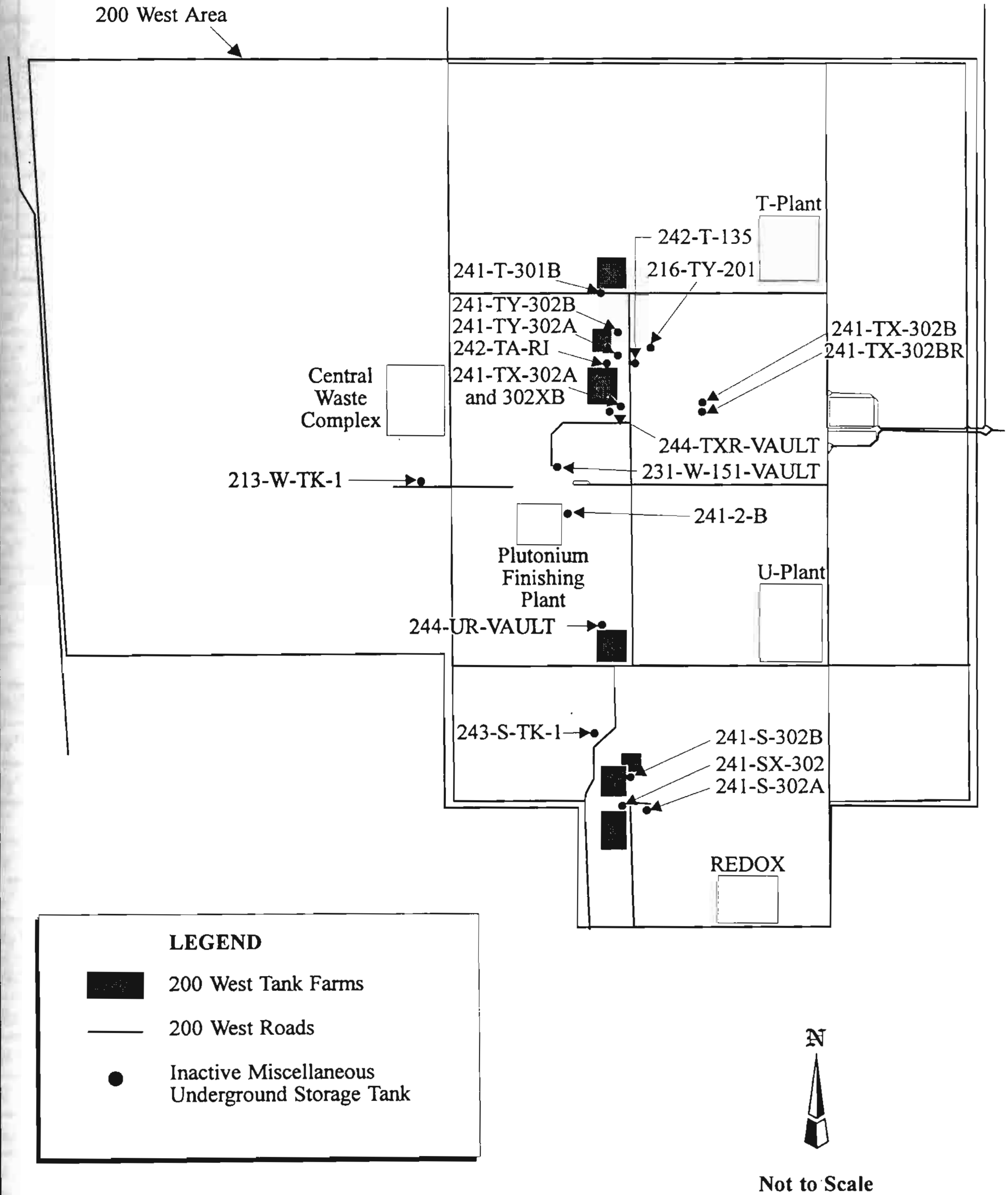


Figure A.2.3.1 Inactive Miscellaneous Underground Storage Tank Locations - 200 East Area



SOURCE: Adapted from Rasmussen 1995

Figure A.2.3.2 Inactive Miscellaneous Underground Storage Tank Locations - 200 West Area



SOURCE: Adapted from Rasmussen 1995

Table A.2.1.1 Tank Waste Volumes [1]

Waste Form	Inactive MUSTs [2] m^3 (gal)		SSTs [3] m^3 (gal)		DSTs [3] m^3 (gal)		Total m^3 (gal)	
Liquid								
Supernatant	45	(12,000)	2,170	(551,000)	56,200	(14,842,000)	58,400	(15,400,000)
Solids [4]								
DST Slurry	N/A		0		7,720	(2,040,000)	7,720	(2,040,000)
Sludge	360	(95,000)	45,400	(11,997,000)	7,400	(1,955,000)	53,200	(14,050,000)
Saltcake	N/R		88,000	(23,242,000)	2,880	(760,000)	90,900	(24,000,000)
Total Waste	405 [5]	(107,000)	135,600	(35,800,000)	74,200	(19,600,000)	210,200	(55,500,000)

Notes:
[1] Quantities with three or more significant digits do not imply a specific accuracy of the stated value.
[2] Source: Rasmussen 1995
[3] Source: Hanlon 1996
[4] Solids contain interstitial liquid that is contained within the interstitial spaces of the sludge and saltcake and is not added to the total waste volume. For SSTs the volume of interstitial liquid is 23,390 m^3 (6,051,000 gal), for DSTs the volume of interstitial liquid is 1,640 m^3 (439,000 gal), and for inactive MUSTs no interstitial liquid volume estimate was provided. The SSTs interstitial liquid remains in the tanks following interim stabilization.
[5] Total waste volume listed is greater than the sum of the liquid and solid waste forms listed and accounts for tanks where the total volume of waste is known but waste type is unknown.
N/A = Not applicable
N/R = Not Reported

Table A.2.1.2 Estimated Mass of Nonradioactive Chemical Components of SST and DST Waste in Metric Tons [1,2]

Chemical Species	SSTs				DSTs			Overall SST and DST Total
	Sludge	Saltcake	Interstitial Liquid	Total	Soluble	Insoluble	Total	
Ag^{+}					3.28E-01	1.38E+00	1.7E+00	1.7E+00
$Al(OH)_4^{-}$	6.25E+02	1.25E+03	4.57E+02	2.33E+03	5.09E+03		5.09E+03	7.43E+03
Al^{+3} (3)	1.99E+03			1.99E+03		6.78E+01	6.78E+01	2.06E+03
As^{+5}					7.70E-01	4.98E-01	1.27E+00	1.27E+00
B^{+3}					5.19E-01	9.94E-01	1.51E+00	1.51E+00
Ba^{+2}					7.91E-01	3.09E+00	3.88E+00	3.88E+00
Be^{+2}					8.19E-02	7.61E-03	8.95E-02	8.95E-02
Bi^{+3}	2.61E+02			2.61E+02	2.26E+00		2.26E+00	2.64E+02
Ca^{+2}	1.28E+02			1.28E+02	1.03E+01	1.15E+01	2.18E+01	1.50E+02
Cd^{+2}	3.84E+00			3.84E+00	1.67E-01	6.01E+00	6.18E+00	1.00E+01
Ce^{+3}	2.35E+02			2.35E+02	2.26E-02	3.04E+00	3.07E+00	2.38E+02
Cl^{-}	4.00E+01			4.00E+01	2.73E+02	1.49E+00	2.74E+02	3.14E+02
CO_3^{-2}	1.15E+03	4.13E+02	3.96E+01	1.61E+03	1.92E+03	5.83E+01	1.98E+03	3.59E+03
Cr^{+3}	8.63E+01			8.63E+01	1.20E+02	3.41E+01	3.41E+01	1.20E+02
CrO_4^{-2}			2.14E+01	2.14E+01	1.77E-01		1.20E+02	1.41E+02
Cu^{+2}					3.25E+02	7.46E-01	9.23E-01	9.23E-01
F^{-}	8.00E+02		5.00E+01	8.05E+02		1.91E+01	3.71E+02	1.18E+03
$Fe(CN)_6^{-4}$	3.22E+02			3.22E+02	8.09E+00			3.22E+02
Fe^{+3}	6.27E+02			6.27E+02	5.84E-02	1.42E+02	1.50E+02	7.77E+02
Hg^{+}	9.00E-01			9.00E-01	5.46E+02		5.84E-02	9.58E-01
K^{+}					2.19E-01	2.02E+01	5.66E+02	5.66E+02
La^{+}					5.77E-03	2.10E+01	2.12E+01	2.12E+01
Li^{+}					9.65E-01	2.46E-02	3.04E-02	3.04E-02
Mg^{+2}					7.69E+00	1.10E+01	1.20E+01	1.20E+01
Mn^{+4}	1.20E+02			1.20E+02	4.87E+00	1.80E+01	2.57E+01	1.46E+02
Mo^{+6}					1.40E+04	8.01E-01	5.67E+00	5.67E+00
Na^{+}	1.58E+04	3.39E+04	2.30E+03	5.48E+04	4.07E+00	2.30E+02	1.43E+04	6.91E+04
Ni^{+2}	1.78E+02			1.78E+02	4.80E+03	6.57E+00	1.06E+01	1.89E+02
NO_2^{-}	2.00E+03	1.53E+03	1.27E+03	4.80E+03	1.03E+04	8.42E+00	4.81E+03	9.61E+03
NO_3^{-}	1.48E+04	8.03E+04	1.71E+03	9.68E+04	2.33E+03	3.91E+01	1.03E+04	1.07E+05
OH-	4.22E+03	8.51E+02	3.15E+02	5.39E+03	1.96E+00	1.23E+02	2.45E+03	7.84E+03
Pb^{+4}					3.29E+02	3.28E+00	5.24E+00	5.24E+00

Table A.2.1.2 Estimated Mass of Nonradioactive Chemical Components of SST and DST Waste in Metric Tons [1,2] (cont'd)

Chemical Species	SSTs				DSTs			Overall SST and DST Total
	Sludge	Saltcake	Interstitial Liquid	Total	Soluble	Insoluble	Total	
PO_4^{-3}	3.89E+03	6.43E+02	8.58E+01	4.62E+03	1.53E+01	2.16E+01	3.51E+02	4.97E+03
SiO_3^{-2}	1.21E+03			1.21E+03	3.86E+02	2.14E+02	2.29E+02	1.44E+03
SO_4^{-2}	5.01E+02	1.15E+03		1.65E+03		6.68E+00	3.93E+02	2.04E+03
Sr^{+2}	3.60E+01			3.60E+01	1.26E+03			3.60E+01
TOC[4]			2.00E+02	2.00E+02	3.54E+00	6.84E+01	1.33E+03	1.53E+03
UO_2^{+2}					6.20E-02	2.68E+01	3.03E+01	3.03E+01
V^{+5}					7.47E-01	1.88E-01	2.50E-01	2.50E-01
W^{+4}	1.44E+01			1.44E+01	3.59E+00		7.47E-01	1.52E+01
Zn^{+2}					4.48E-01	9.45E-01	4.54E+00	4.54E+00
Zr^{+4}	2.46E+02			2.46E+02		2.77E+02	2.77E+02	5.24E+02
Total w/o H_2O	4.93E+04	1.23E+05	6.40E+03	1.79E+05	4.18E+04	1.45E+03	4.32+04	2.22E+05
H_2O	2.62E+04	1.40E+04	5.16E+03	4.54E+04	8.59E+04		8.95+04	1.35E+05
TOTAL	7.55E+04	1.37E+05	1.16E+04	2.24E+05	1.31E+05	1.45E+03	1.33E+05	3.57E+05

Notes:
[1] One metric ton is equal to 1,000 kilograms (2,205 pounds mass).
[2] Values with three or more significant digits do not imply a specific accuracy of the stated value; no data entry provided for insignificant inventories.
[3] Al^{+3} includes the Al present in cancrinite and $Al(OH)_3$.
[4] Total organic carbon includes HEDTA, EDTA, hydroxyacetic acid, citric acid, and degradation products.

Table A.2.1.3 Estimated Radionuclide Inventory for SSTs and DSTs in Curies [1, 2]

Radionuclides	SSTs Total	DSTs		
		Soluble	Insoluble	Total
Ac-225	1.98E-05			
Ac-227	2.21E-02			
Am-241	3.30E+04	5.31E+03	6.54E+04	7.07E+04
Am-242	6.82E+01			
Am-242m	6.86E+01			
Am-243	3.32E+01			
At-217	1.98E-05			
Ba-137m	7.68E+06	2.48E+07	6.49E+05	2.54E+07
Bi-210	7.17E-08			
Bi-211	2.21E-02			
Bi-212	3.72E-14			
Bi-213	1.98E-05			
Bi-214	2.70E-07			
C-14 [(3)]	3.00E+03	3.45E+02	1.99E+03	2.34E+03
Cm-242	5.66E+01			
Cm-244	1.18E+02			
Cm-245	1.04E-02			
Cs-135	1.45E+02			
Cs-137	8.12E+06	2.61E+07	6.83E+05	2.68E+07
Eu-154		5.37E+04	1.44E+03	5.51E+04
Fr-221	1.98E-05			
Fr-223	3.06E-04			
I-129 [(3)]	1.60E+01	1.90E+01	3.30E+00	2.23E+01
Nb-93m	3.20E+03			
Ni-59	5.03E+03			
Ni-63	2.69E+05			
Np-237	6.97E+01			
Np-238	3.26E-01			
Np-239	3.32E+01			
Pa-231	3.80E-02			
Pa-233	6.97E+01			
Pa-234	7.69E-01			
Pa-234m	4.81E+02			
Pb-209	1.98E-05			
Pb-210	7.17E-08			
Pb-211	2.21E-02			

Table A.2.1.3 Estimated Radionuclide Inventory for SSTs and DSTs in Curies [1,2] (cont'd)

Radionuclides	SSTs Total	DSTs		
		Soluble	Insoluble	Total
Pb-212	3.72E-14			
Pb-214	2.70E-07			
Pd-107	8.65E+01			
Po-210	7.17E-08			
Po-211	6.04E-05			
Po-212	2.38E-14			
Po-213	1.94E-05			
Po-214	2.70E-07			
Po-215	2.21E-02			
Po-216	3.72E-14			
Po-218	2.70E-07			
Pu-238	1.08E+03			
Pu-239 (3)	1.80E+04	1.31E+03	7.05E+03	8.36E+03
Pu-240 (3)	4.30E+03	3.28E+02	2.07E+03	2.40E+03
Pu-241	3.55E+04	7.76E+02	3.86E+04	3.94E+04
Pu-242	4.32E-04			
Ra-223	2.21E-02			
Ra-224	3.72E-14			
Ra-225	1.98E-05			
Ra-226	2.70E-07			
Ra-228	7.42E-14			
Rh-106	3.79E-02			
Rn-219	2.21E-02			
Rn-220	3.72E-14			
Rn-222	2.70E-07			
Ru-106	3.79E-02			
Sb-126	8.78E+01			
Sb-126m	6.27E+02			
Se-79	9.11E+02			
Sm-151 (3)	6.30E+05			
Sn-126	6.27E+02			
Sr-90 (3)	4.36E+07	6.15E+05	9.47E+06	1.01E+07
Tc-99 (3)	1.10E+04	2.07E+04	3.99E+02	2.11E+04
Th-227	2.18E-02			
Th-228	3.72E-14			
Th-229	1.98E-05			

Table A.2.1.3 Estimated Radionuclide Inventory for SSTs and DSTs in Curies [1,2] (cont'd)

Radionuclides	SSTs Total	DSTs		
		Soluble	Insoluble	Total
Th-230	3.90E-05			
Th-231	2.06E+01			
Th-232	6.42E-13			
Th-234	4.81E+02			
Tl-207	2.21E-02			
Tl-208	1.34E-14			
Tl-209	4.28E-07			
U-233	1.21E-02			
U-234	2.12E-01			
U-235	2.06E+01			
U-236	2.88E-03			
U-237	8.69E-01			
U-238	4.81E+02			
Y-90	4.36E+07	6.15E+05	9.47E+06	1.01E+07
Zr-93	3.94E+03			
TOTAL	1.04E+08	5.23E+07	2.04E+07	7.27E+07

Notes:
[1] Values with three or more significant digits do not imply a specific accuracy of the stated value; no data entry provided for insignificant inventories.
[2] Radionuclides reflect decay and ingrowth to December 31, 1999.
[3] SST amounts adjusted from original Track Radioactive Component (TRAC) output to account for inventory adjustments based on sample analysis and waste transfers to DSTs.

Table A.2.1.4 Tank Source Areas

Source Area	Location	Tank Type	Tank Farms
1WSS	200 W	SST	T, TX, TY
2WSS	200 W	SST	U, S, SX
3WDS	200W	DST	SY
1ESS	200 E	SST	B, BX, BY
2ESS	200 E	SST	C
3EDS	200 E	DST	AN, AZ, AY
4ESS	200 E	SST	A, AX
5EDS	200 E	DST	AW, AP

Table A.2.1.5 Estimated Mass of Nonradioactive Chemical Components of SSTs by Aggregated Tank Grouping in Metric Tons [1, 2]

Chemical Species	SST Groupings					Total
	1WSS	2WSS	1ESS	2ESS	4ESS	
	40 tanks	43 tanks	40 tanks	16 tanks	10 tanks	149 tanks
$Al(OH)_4^-$	3.32E+02	1.11E+03	8.04E+02	3.87E+02	2.64E+01	2.66E+03
Al^{+3}	7.12E+01	7.24E+02	5.92E+02	5.80E+02	2.53E+01	1.99E+03
Bi^{+3}	1.66E+02	2.80E-01	9.43E+01	5.95E-01		2.61E+02
CO_3^{-2}	7.07E+02	1.60E+02	6.40E+02	6.20E+01	3.80E+01	1.61E+03
Ca^{+2}	1.98E-01	5.82E+00	5.47E+01	6.59E+01	1.54E+00	1.28E+02
Cd^{+2}	8.63E-01	1.02E+00	1.16E+00	6.11E-01	1.78E+01	3.48E+00
Ce^{+3}	1.16E+02	3.16E+01	8.82E+01	2.64E-01	1.75E+00	2.38E+02
Cl^-	2.19E+01	5.41E+00	1.26E+01	4.01E-02	6.03E-02	4.00E+01
Cr^{+3}	1.26E+00	8.33E+01	7.25E-01	1.65E-01	8.24E-01	8.63E+01
CrO_4^{-2}	3.12E-01	2.07E+01	1.80E-01	4.10E-02	2.04E-01	2.14E+01
F^-	1.44E+02	3.00E+01	2.32E+02	4.00E+02	3.08E-01	8.06E+02
Fe^{+3}	1.70E+02	8.18E+01	1.42E+02	5.55E+01	1.78E+02	6.27E+02
$Fe(CN)_6^{-4}$	2.19E+00	1.37E+00	2.48E+02	7.00E+01	5.30E-02	3.22E+02
Hg^+	2.02E-01	2.40E-01	2.73E-01	1.43E-01	4.17E-02	9.00E-01
Mn^{+4}	2.10E+01	1.13E+01	1.31E+01	5.12E+01	2.35E+01	1.20E+02
Na^+	1.45E+04	2.11E+04	1.16E+04	2.10E+03	3.78E+03	5.31E+04
Ni^{+2}	5.02E+00	3.33E+00	1.25E+02	4.40E+01	9.93E-01	1.78E+02
NO_2^-	1.76E+03	8.01E+02	2.06E+03	4.74E-01	2.32E+02	4.85E+03
NO_3^-	2.63E+04	4.55E+04	1.89E+04	2.59E+02	4.89E+03	9.59E+04
OH^-	4.53E+02	2.30E+03	1.04E+03	1.42E+03	1.74E+02	5.39E+03
PO_4^{-3}	2.67E+03	1.10E+02	1.81E+03	2.98E+01	8.61E-01	4.62E+03
SiO_3^-	5.60E+02	2.40E+02	4.04E+02	7.07E-01	2.09E+00	1.21E+03
SO_4^{-2}	6.34E+02	2.48E+02	5.53E+02	1.34E+02	8.35E+01	1.65E+03
Sr^{+2}	9.38E-04	6.98E-02	3.59E+01	2.53E-02	5.78E-02	3.60E+01
W^{+4}	3.42E+00	3.84E+00	4.38E+00	2.30E+00	6.68E-01	1.44E+01
Zr^{+4}	1.40E+01	2.31E+01	6.50E+00	2.03E+02	1.28E-01	2.46E+02

Notes:
[1] Minor differences exist between the aggregated totals for some chemical species and the total quantities reported in Table A.2.1.2. These differences are a result of updates made to the overall inventory that are not currently reflected in the aggregated inventory.
[2] Values with three or more significant digits do not imply a specific accuracy of the stated value.

Table A.2.1.6 Estimated Radionuclide Inventory for Aggregated SST Groupings in Curies [1, 2, 3]

Radionuclide	SST Groupings					Total
	1WSS	2WSS	1ESS	2ESS	4ESS	
	40 tanks	43 tanks	40 tanks	16 tanks	10 tanks	149 tanks
Ac-225	1.72E-06	2.88E-06	6.03E-06	2.25E-06	2.84E-06	1.57E-05
Ac-227	5.18E-03	4.26E-03	8.84E-03	1.55E-03	2.77E-04	2.01E-02
Am-241	1.70E+03	9.48E+03	7.49E+03	9.72E+03	4.62E+03	3.30E+04
Am-242	2.68E+00	1.94E+01	1.88E+01	2.00E+01	8.67E+00	6.95E+01
Am-242m	2.69E+00	1.95E+01	1.89E+01	2.01E+01	8.71E+00	6.98E+01
Am-243	1.02E+00	7.82E+00	9.57E+00	1.16E+01	3.12E+00	3.32E+01
At-217	1.72E-06	2.88E-06	6.03E-06	2.25E-06	2.84E-06	1.57E-05
Ba-137m	8.44E+05	3.78E+06	3.54E+06	1.26E+05	1.37E+05	8.42E+06
Bi-210	1.50E-08	1.16E-08	1.34E-08	7.03E-09	2.81E-09	4.99E-08
Bi-211	5.18E-03	4.26E-03	8.84E-03	1.55E-03	2.77E-04	2.01E-02
Bi-213	1.72E-06	2.88E-06	6.03E-06	2.25E-06	2.84E-06	1.57E-05
Bi-214	6.08E-08	5.03E-08	5.20E-08	2.98E-08	1.58E-08	2.09E-07
C-14	2.84E+02	4.90E+02	1.83E+03	2.15E+02	1.82E+02	3.00E+03
Cm-242	2.22E+00	1.61E+01	1.56E+01	1.66E+01	7.19E+00	5.76E+01
Cm-244	3.22E+00	2.39E+01	5.01E+01	5.34E+01	7.20E+00	1.38E+02
Cm-245	2.08E-04	1.74E-03	3.83E-03	4.09E-03	5.51E-04	1.04E-02
Cs-135	2.07E+01	6.79E+01	5.27E+01	1.61E+00	2.13E+00	1.45E+02
Cs-137	8.93E+05	3.99E+06	3.74E+06	1.33E+05	1.44E+05	8.90E+06
Fr-221	1.72E-06	2.88E-06	6.03E-06	2.25E-06	2.84E-06	1.57E-05
Fr-223	7.15E-05	5.88E-05	1.22E-04	2.14E-05	3.82E-06	2.78E-04
I-129	1.70E+00	4.39E+00	9.14E+00	5.97E-01	1.71E-01	1.60E+01
Nb-93m	8.54E+01	6.76E+02	3.71E+02	4.05E+02	1.50E+03	3.04E+03
Ni-59		1.71E+03	3.33E+03			5.03E+03
Ni-63	6.83E+03	4.86E+04	5.30E+04	5.87E+04	1.09E+05	2.76E+05
Np-237	8.26E+00	1.10E+01	4.96E+01	3.37E-01	4.48E-01	6.96E+01
Np-238	1.28E-02	9.26E-02	9.00E-02	9.55E-02	4.15E-02	3.32E-01
Np-239	1.02E+00	7.82E+00	9.57E+00	1.16E+01	3.12E+00	3.32E+01
Pa-231	9.61E-03	7.33E-03	1.53E-02	3.38E-03	6.37E-04	3.62E-02
Pa-233	8.26E+00	1.10E+01	4.96E+01	3.37E-01	4.48E-01	6.96E+01
Pa-234	2.75E-01	1.03E-01	2.61E-01	1.03E-01	2.64E-02	7.69E-01
Pa-234m	1.72E+02	6.47E+01	1.63E+02	6.45E+01	1.65E+01	4.81E+02
Pb-209	1.72E-06	2.88E-06	6.03E-06	2.25E-06	2.84E-06	1.57E-05

Table A.2.1.6 Estimated Radionuclide Inventory for Aggregated SST Groupings in Curies [1, 2, 3] (cont'd)

Radionuclide	SST Groupings					Total
	1WSS	2WSS	1ESS	2ESS	4ESS	
	40 tanks	43 tanks	40 tanks	16 tanks	10 tanks	149 tanks
Pb-210	1.50E-08	1.16E-08	1.34E-08	7.03E-09	2.81E-09	4.99E-08
Pb-211	5.18E-03	4.26E-03	8.84E-03	1.55E-03	2.77E-04	2.01E-02
Pb-214	6.08E-08	5.03E-08	5.20E-08	2.98E-08	1.58E-08	2.09E-07
Pd-107	9.03E+00	2.33E+01	4.95E+01	3.66E+00	9.74E-01	8.65E+01
Po-210	1.50E-08	1.16E-08	1.34E-08	7.03E-09	2.81E-09	4.99E-08
Po-211	1.41E-05	1.16E-05	2.41E-05	4.24E-06	7.56E-07	5.49E-05
Po-213	1.69E-06	2.81E-06	5.90E-06	2.20E-06	2.78E-06	1.54E-05
Po-214	6.08E-08	5.03E-08	5.20E-08	2.98E-08	1.58E-08	2.09E-07
Po-215	5.18E-03	4.26E-03	8.84E-03	1.55E-03	2.77E-04	2.01E-02
Po-218	6.08E-08	5.03E-08	5.20E-08	2.98E-08	1.58E-08	2.09E-07
Pu-238	2.10E+02	2.96E+02	1.85E+02	1.99E+02	2.24E+02	1.11E+03
Pu-239	2.08E+03	3.59E+03	2.90E+03	4.84E+03	4.59E+03	1.80E+04
Pu-240	4.09E+02	7.91E+02	6.94E+02	1.24E+03	1.17E+03	4.30E+03
Pu-241	3.92E+03	6.36E+03	8.46E+03	1.32E+04	1.11E+04	4.30E+04
Pu-242	1.33E-05	9.59E-05	9.32E-05	9.89E-05	4.29E-05	3.44E-04
Ra-223	5.18E-03	4.26E-03	8.84E-03	1.55E-03	2.77E-04	2.01E-02
Ra-225	1.72E-06	2.88E-06	6.03E-06	2.25E-06	2.84E-06	1.57E-05
Ra-226	6.08E-08	5.03E-08	5.20E-08	2.98E-08	1.58E-08	2.09E-07
Rh-106	6.11E-05	1.70E-02	8.25E-02	9.73E-02	3.97E-01	5.94E-01
Rn-219	5.18E-03	4.26E-03	8.84E-03	1.55E-03	2.77E-04	2.01E-02
Rn-222	6.08E-08	5.03E-08	5.20E-08	2.98E-08	1.58E-08	2.09E-07
Ru-106	6.11E-05	1.70E-02	8.25E-02	9.73E-02	3.97E-01	5.94E-01
Sb-126	7.94E+00	2.33E+01	6.71E+00	1.39E+01	3.59E+01	8.78E+01
Sb-126m	5.67E+01	1.66E+02	4.79E+01	9.96E+01	2.57E+02	6.27E+02
Se-79	9.71E+01	2.51E+02	5.21E+02	3.23E+01	9.51E+00	9.11E+02
Sm-151	6.24E+04	1.84E+05	5.47E+04	1.01E+05	2.48E+05	6.50E+05
Sn-126	5.67E+01	1.66E+02	4.79E+01	9.96E+01	2.57E+02	6.27E+02
Sr-90	1.50E+06	1.43E+07	8.32E+06	4.90E+06	1.90E+07	4.80E+07
Tc-99	1.17E+03	3.03E+03	6.29E+03	3.93E+02	1.15E+02	1.10E+04
Th-227	5.11E-03	4.20E-03	8.72E-03	1.53E-03	2.73E-04	1.98E-02
Th-229	1.72E-06	2.88E-06	6.03E-06	2.25E-06	2.84E-06	1.57E-05
Th-230	9.00E-06	7.86E-06	7.51E-06	4.51E-06	3.11E-06	3.20E-05

Table A.2.1.6 Estimated Radionuclide Inventory for Aggregated SST Groupings in Curies [1,2,3] (cont'd)

Radionuclide	SST Groupings					Total
	1WSS	2WSS	1ESS	2ESS	4ESS	
	40 tanks	43 tanks	40 tanks	16 tanks	10 tanks	149 tanks
Th-231	7.22E+00	2.93E+00	6.92E+00	2.81E+00	6.98E-01	2.06E+01
Th-232	1.85E-14	3.57E-14	3.13E-14	5.59E-14	5.27E-14	1.94E-13
Th-234	1.72E+02	6.47E+01	1.63E+02	6.45E+01	1.65E+01	4.81E+02
Tl-207	5.16E-03	4.25E-03	8.82E-03	1.55E-03	2.76E-04	2.01E-02
Tl-209	3.73E-08	6.21E-08	1.30E-07	4.85E-08	6.13E-08	3.39E-07
U-233	1.20E-03	1.75E-03	5.91E-03	8.07E-04	1.18E-03	1.08E-02
U-234	4.91E-02	4.59E-02	4.31E-02	3.04E-02	2.52E-02	1.94E-01
U-235	7.22E+00	2.93E+00	6.92E+00	2.81E+00	6.98E-01	2.06E+01
U-236	2.16E-04	4.18E-04	3.67E-04	6.54E-04	6.17E-04	2.27E-03
U-237	9.60E-02	1.56E-01	2.07E-01	3.23E-01	2.71E-01	1.05E+00
U-238	1.72E+02	6.47E+01	1.63E+02	6.45E+01	1.65E+01	4.81E+02
Y-90	1.51E+06	1.45E+07	8.41E+06	4.95E+06	1.92E+07	4.85E+07
Zr-93	4.54E+01	8.00E+02	2.42E+02	5.63E+02	2.29E+03	3.94E+03

Notes:
[1] Minor differences exist between the aggregated totals for some radionuclides and the total quantities reported in Table A.2.1.3. These differences are a result of updates made to the overall inventory that are not currently reflected in the aggregated inventory.
[2] Radionuclides reflect decay to 12/31/95 and were back calculated from 12/31/99 data. No decay chains were used in back calculating inventories.
[3] Values with three or more significant digits do not imply a specific accuracy of the stated value; no data entry provided for insignificant inventories.

Table A.2.1.7 Estimated Mass of Nonradioactive Chemical Components by Aggregated DST Grouping in Metric Tons [1, 2]

Chemical Species	DST Groupings						Total	
	5EDS		3EDS		3WDS			
	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble
Ag^{+}	1.18E-01	1.32E+00	2.10E-01			5.80E-02	3.28E-01	1.38E+00
Al^{+3}		4.29E+01		1.05E+01		1.44E+01		6.78E+01
As^{+5}	7.44E-01	2.97E-01	2.60E-02			2.01E-01	7.70E-01	4.98E-01
B^{+3}	1.01E-01	9.17E-01	6.64E-02		3.52E-01	7.66E-02	5.19E-01	9.94E-01
Ba^{+2}	7.01E-01	2.41E+00	6.16E-02	6.80E-01	2.93E-02	3.26E-03	7.91E-01	3.09E+00
Be^{+2}	5.97E-02	7.47E-03	2.22E-02	1.39E-04			8.19E-02	7.61E-03
Bi^{+3}	1.74E+00		5.21E-01				2.26E+00	
Ca^{+2}	5.19E+00	7.96E+00	6.02E-01	1.79E+00	4.48E+00	1.74E+00	1.03E+01	1.15E+01
Cd^{+2}	9.68E-02	5.77E+00	7.05E-02			2.42E-01	1.67E-01	6.01E+00
Ce^{+3}	2.26E-02	2.78E+00				2.64E-01	2.26E-02	3.04E+00
Cr^{+3}		9.31E+00		7.84E-01		2.40E+01		3.41E+01
Cu^{+2}	7.32E-02	4.05E-01	1.04E-01			3.42E-01	1.77E-01	7.46E-01
Fe^{+3}	3.10E+00	1.32E+02	8.18E-01	1.92E+00	4.17E+00	8.27E+00	8.09E+00	1.42E+02
Hg^{+}	5.75E-02		9.43E-04				5.84E-02	
K^{+}	1.48E+02	1.79E+00	3.60E+02	1.80E+01	3.72E+01	3.76E-01	5.46E+02	2.02E+01
La^{+3}	2.19E-01	1.96E+01		1.35E+00		9.89E-02	2.19E-01	2.10E+01
Li^{+}	2.13E-03	2.26E-02			3.64E-03	1.96E-03	5.77E-03	2.46E-02
Mg^{+2}	5.26E-01	9.53E+00	3.92E-01	1.00E+00	4.67E-02	4.62E-01	9.65E-01	1.10E+01
Mn^{+4}	6.11E+00	1.48E+01	1.53E-01	9.50E-01	1.42E+00	2.29E+00	7.69E+00	1.80E+01
Mo^{+6}	3.82E+00	2.09E-01	2.72E-01	5.25E-01	7.85E-01	6.71E-02	4.87E+00	8.01E-01
Na^{+}	6.00E+03	6.51E+01	2.80E+03	1.36E+02	2.13E+03	2.85E+01	1.09E+04	2.30E+02
Ni^{+2}	3.34E+00	5.03E+00	1.81E-01	4.30E-01	5.54E-01	1.11E+00	4.07E+00	6.57E+00
Pb^{+4}	5.63E-01	2.95E+00	1.39E+00			3.34E-01	1.96E+00	3.28E+00
SiO_3^{-2}	1.03E+01	1.99E+02	5.13E+00	9.32E+00	7.15E-02	6.01E+00	1.55E+01	2.14E+02
UO_2^{+2}	2.19E+00	7.91E-01	1.36E+00	2.60E+01			3.54E+00	2.68E+01
V^{+5}	6.20E-02	8.09E-03		1.66E-01		1.37E-02	6.20E-02	1.88E-01
W^{+6}	7.47E-01						7.47E-01	
Zn^{+2}	3.50E-01	4.20E-01	2.14E+00	2.80E-01	1.10E+00	2.45E-01	3.59E+00	9.45E-01
Zr^{+4}	2.30E-01	1.85E+01	2.18E-01	2.58E+02		1.85E-01	4.48E-01	2.77E+02
$Al(OH)_4^{-}$	2.44E+03		8.34E+02		1.19E+03		4.47E+03	
CO_3^{-2}	9.41E+02	5.17E+01	8.43E+02	3.00E+00	8.39E+01	3.61E+00	1.87E+03	5.83E+01
Cl^{-}	1.47E+02	5.75E-01	5.24E+01	3.60E-02	7.41E+01	8.77E-01	2.73E+02	1.49E+00

Table A.2.1.7 Estimated Mass of Nonradioactive Chemical Components by Aggregated DST Grouping in Metric Tons [1,2] (cont'd)

Chemical Species	DST Groupings						Total	
	5EDS		3EDS		3WDS			
	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble
$CrOH_4^{-2}$	4.06E+01		1.14E+01		6.01E+01		1.12E+02	
F^-	3.56E+01	6.39E-01	3.02E+02	1.81E+01	8.63E+00	3.63E-01	3.46E+02	1.91E+01
SO_4^{-2}	2.77E+02	1.96E+00	7.10E+01	1.25E+00	3.83E+01	3.46E+00	3.86E+02	6.68E+00
NO_3^-	4.43E+03	2.04E+01	2.19E+03	8.28E+00	1.03E+03	1.04E+01	7.65E+03	3.91E+01
NO_2^-	1.94E+03	5.06E+00	8.88E+02	8.94E-01	2.44E+02	2.46E+00	3.07E+03	8.42E+00
PO_4^{-3}	7.13E+01	1.40E+01	7.44E+01	4.57E-01	6.63E+01	7.16E+00	2.12E+02	2.16E+01
OH^-	9.99E+02	2.45E+01	6.97E+02	5.96E+01	2.03E+02	3.87E+01	1.90E+03	1.23E+02
TOC	8.08E+02	6.25E+01	5.48E+01	4.60E+00	1.28E+02	1.29E+00	9.90E+02	6.84E+01

Notes:
[1] Minor differences exist between the aggregated totals for some chemical species and the total quantities reported in Table A.2.1.2. These differences are a result of updates made to the overall inventory that are not currently reflected in the aggregated inventory.
[2] Values with three or more significant digits do not imply a specific accuracy of the stated value; no data entry provided for insignificant inventories.

Table A.2.1.8 Estimated Radionuclide Inventory for Aggregated DST Groupings in Curies [1,2,3]

Radionuclide	DST Groupings							
	3WDS		3EDS		5EDS		Total	
	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble
C-14		8.06E-01	3.40E+02	1.98E+03	5.23E+00		3.45E+02	1.98E+03
Sr-90	2.16E+04	3.95E+04	6.41E+05	1.03E+07	1.34E+04	5.62E+04	6.76E+05	1.04E+07
Y-90	2.16E+04	3.95E+04	6.41E+05	1.03E+07	1.34E+04	5.62E+04	6.76E+05	1.04E+07
Tc-99	3.66E+03		1.54E+04	3.99E+02	1.60E+03		2.07E+04	3.99E+02
I-129	5.62E-01	1.71E+00	1.49E+01	1.43E+00	3.55E+00	1.59E-01	1.90E+01	3.30E+00
Cs-137	3.63E+06	3.91E+04	2.13E+07	5.44E+05	3.73E+06	1.66E+05	2.87E+07	7.49E+05
Ba-137m	3.63E+06	3.91E+04	2.13E+07	5.44E+05	3.73E+06	1.66E+05	2.87E+07	7.49E+05
Eu-154	4.34E+02	4.38E+00	7.14E+04	1.93E+03	5.33E+02		7.24E+04	1.93E+03
Np-237		3.79E-01	6.76E+00	3.83E+01	1.02E-01	3.98E-02	6.86E+00	3.87E+01
Pu-238		1.05E+03	1.65E+02	5.12E+00	1.40E+02	5.46E+01	3.05E+02	1.11E+03
Pu-239	2.02E+01	2.12E+03	1.22E+03	3.72E+03	6.27E+01	1.22E+03	1.30E+03	7.06E+03
Pu-240	5.06E+00	7.59E+02	3.07E+02	9.64E+02	1.57E+01	3.44E+02	3.28E+02	2.07E+03
Pu-241	9.47E+00	1.85E+04	7.43E+02	1.00E+04	2.86E+01	1.03E+04	7.81E+02	3.88E+04
Am-241	1.63E+02	1.17E+04	5.03E+03	5.37E+04	1.47E+02	3.51E+02	5.34E+03	6.58E+04
Total	8.60E+06	2.11E+05	4.99E+07	2.18E+07	1.01E+07	5.93E+05	5.88E+07	2.24E+07

Notes:

[1] Minor differences exist between the aggregated totals for some radionuclides and the total quantities reported in Table A.2.1.3. These differences are a result of updates made to the overall inventory that are not currently reflected in the aggregated inventory.

[2] Radionuclides reflect decay to 12/31/95 and were back calculated from 12/31/99 data. No decay chains were used in back calculating inventories.

[3] Values with three or more significant digits do not imply a specific accuracy of the stated value; no data entry provided for insignificant inventories.

Table A.2.2.1 Characteristics of Existing Capsules

Characteristics	Strontium (601 capsules) [1]				Cesium (1,328 capsules) [1]			
	As filled	Dec. 31, 1994	Dec. 31, 1999	Dec. 31, 2019	As filled	Dec. 31, 1994	Dec. 31, 1999	Dec. 31, 2019
Cumulative (MCi)	32.66	23.01	20.40	12.70	73.90	53.40	47.40	29.90
Cumulative (kW)	220.80	154.20	136.90	85.10	355.30	256.40	228.40	143.90
Average (kCi)	54.36	38.47	34.14	21.16	55.70	40.10	35.75	22.58
Average (W)	367.43	260.07	230.78	143.08	267.60	192.59	171.69	108.44
Highest curies loading (kCi)	146.60	93.27	82.76	51.31	74.50	54.38	48.48	30.62

Notes:

[1] The values for megacuries and highest curies loading reflect only parent radionuclide activity for the Sr-90/Y-90 decay chain and the Cs-137/Ba-137 decay chain.

Table A.2.3.1 Inactive MUSTs Estimated Current Waste Volumes in Liters [1]

Tank Designation	Nominal Tank Capacity	Solids Volume	Liquid Volume	Total Waste Volume	Comments
231-W-151-001	15,000	0	5,400	5,400	Settling tank, O/S since 1974
231-W-151-002	3,600	40	3,600	3,600	Settling tank, O/S since 1974
241-Z-8	58,000	1,900	0	1,900	Settling tank, O/S since 1962
241-A-302B	51,000	no data	no data	13,600	Interim Isolated. Monitored
241-B-301	136,000	82,000	2,200	84,000	Catch tank, O/S since 1984
241-B-302B	67,000	2,600	16,000	18,600	Catch tank, O/S since 1985
241-BX-302A	67,000	3,200	0	3,200	Catch tank, O/S since 1985
241-BX-302B	43,000	3,600	300	3,900	Catch tank, O/S since 1985
241-BX-302C	43,000	2,400	900	3,300	Catch tank, O/S since 1985
241-C-301	136,000	34,000	5,600	39,600	Catch tank, O/S since 1983
241-S-302A	67,000	no data	no data	19,000	Catch tank, O/S since 1991
241-S-302B	54,000	0	0	0	Emptied
241-SX-302	67,000	4,000	1,100	5,100	Catch tank, O/S since 1983
241-T-301B	136,000	82,000	2,200	84,200	Catch tank, O/S since 1985
241-TX-302A	67,000	9,300	100	9,400	Catch tank, O/S since 1982
241-TX-302B	67,000	no data	no data	5,000	Catch tank, stabilized and isolated in 1954
241-TX-302BR	45,000	no data	no data	no data	Catch tank, contents unknown
241-TX-302XB	50,000	400	900	1,300	Catch tank, O/S since 1985
241-TY-302A	67,000	1,700	0	1,700	Catch tank, O/S since 1981
241-TY-302B	54,000	0	0	0	Emptied
244-BXR-001	190,000	27,000	0	27,000	Uranium recovery tank, O/S since 1957
244-BXR-002	57,000	6,800	1,400	8,200	Uranium recovery tank, O/S since 1957
244-BXR-003	57,000	5,500	1,400	6,900	Uranium recovery tank, O/S since 1957
244-BXR-011	190,000	26,000	400	26,400	Uranium recovery tank, O/S since 1956
244-TXR-001	190,000	8,700	200	8,900	Uranium recovery tank, O/S since 1956
244-TXR-002	57,000	11,000	0	11,000	Uranium recovery tank, O/S since 1956

Table A.2.3.1 Inactive MUSTs Estimated Current Waste Volumes in Liters [1] (cont'd)

Tank Designation	Nominal Tank Capacity	Solids Volume	Liquid Volume	Total Waste Volume	Comments
244-TXR-003	57,000	24,600	0	24,600	Uranium recovery tank, O/S since 1956
244-UR-001	190,000	7,000	1,500	8,500	Uranium recovery tank, O/S since 1957
244-UR-002	57,000	8,700	2,200	10,900	Uranium recovery tank, O/S since 1957
244-UR-003	57,000	5,900	0	5,900	Uranium recovery tank, O/S since either 1957 or 1976
244-UR-004	31,000	Minimal	Minimal	Minimal	Volumes unknown. Used for temporary storage of 60 percent nitric acid solutions.
244-ER-311A	N/R	N/R	N/R	N/R	Southwest of B Plant
241-AX-151	N/R	N/R	N/R	N/R	Diverter station with several tanks inside
216-TY-201	N/R	N/R	N/R	N/R	Flush tank, located east of TY Tank Farm
216-BY-201	N/R	N/R	N/R	N/R	Flush tank, located north of BY Tank Farm
242-TA-R1	N/R	N/R	N/R	N/R	Receiver tank for Z Plant
242-T-135	N/R	N/R	N/R	N/R	Outside the 242-T Evaporator, decontamination tank
243S-TK-1	N/R	N/R	N/R	N/R	Decontamination tank
213-W-TK-1	7,100	N/R	N/R	7,100	Decontamination tank, tank may not have received waste in the past.

Notes:
[1] Values with three or more significant digits do not imply a specific accuracy of the stated value.
N/R = Not Reported
O/S = Out of Service

Table A.2.4.1 Future Post Evaporator DST Waste Projections

Source Facility	Waste type	Volume (m^3)	Duration of Accumulation
PUREX: Deactivation waste	DN [1]	5,700	FY 1994 - FY 1997
B Plant: Terminal cleanout waste (concentrated)	DN	2,100	FY 1997 - FY 2001
100 Area: Terminal cleanout waste (concentrated)	DSSF [2]	2,200	FY 1995 - FY 1999
100 Area: Sulfate waste	DN	140	Not reported
300 Area: Fuel supply cleanout	DN	45	Not reported
105-F, 105-H: Basin cleanout	DN	850	Not reported
Tank 107-AN: Caustic addition	DN	190	Not reported
100-KE, 100-KW: Basin cleanout	DN	1,200	Not reported
TOTAL		12,400	

Notes:
[1] Dilute noncomplexed waste.
[2] Double-shell slurry feed.
FY = Fiscal Year

Table A.3.3.1 Comparison of Reported Quantities of Chemicals in Metric Tons

Chemical	SST - Sludge and Saltcake		DST - Soluble and Insoluble	
	LANL	Data Package	LANL	Data Package
Na^{+}	2.97E+04	4.97E+04	1.07E+04	1.43E+04
Al^{+3}	5.56E+03	1.99E+03	1.53E+03	6.78E+01
Fe^{+3}	2.59E+03	6.27E+02	2.23E+02	1.50E+02
Cr^{+3}	7.47E+02	8.63E+01	7.75E+01	3.43E+01
Bi^{+3}	6.63E+02	2.61E+02	1.05E+01	2.26E+00
La^{+3}	4.01E+01	0	4.75E-02	2.12E+01
Ce^{+3}	1.70E-04	2.35E+02	9.41E-01	3.07E+00
$ZrO(OH)_2$	0	3.81E+02 [1]	1.94E+02	4.29E+02 [1]
Pb^{+2}	1.32E+01	0 [2]	8.39E-01	5.24E+00 [2]
Ni^{+2}	2.10E+02	1.78E+02	2.22E+01	1.06E+01
Sr^{+2}	1.57E+02	3.60E+01	3.20E-02	0
Mn^{+4}	1.75E+01	1.20E+02	2.75E+01	2.57E+01
Ca^{+2}	5.36E+02	1.28E+02	1.08E+02	2.18E+01
K^{+1}	1.30E+02	0	2.05E+02	5.66E+02
OH^{-}	1.70E+04	5.07E+03	4.71E+03	2.45E+03
NO_3^{-}	4.30E+04	9.51E+04	1.04E+04	1.03E+04
NO_2^{-}	5.57E+03	3.53E+03	4.00E+03	4.18E+03
CO_3^{-2}	2.72E+03	1.56E+03	1.44E+03	1.98E+03
PO_4^{-3}	3.91E+03	4.53E+03	7.25E+02	3.51E+02
SO_4^{-2}	4.32E+03	1.65E+03	1.17E+03	3.93E+02
SiO_3^{-2}	3.73E+02	1.21E+03	7.73E+01	2.29E+02
F^{-}	5.38E+02	8.00E+02	3.59E+02	3.71E+02
Cl^{-}	3.48E+02	4.00E+01	2.74E+02	2.74E+02
$Fe(CN)_6^{-4}$	1.39E+02	3.22E+02	0	0

Notes:
[1] Converted from Zr^{+4}.
[2] Shows as Pb^{+4}.
LANL = Los Alamos National Laboratory

Table A.3.3.2 Comparison of Reported Quantities of Radionuclides

Element	SST - Sludge and Saltcake		DST - Soluble and Insoluble	
	LANL	Data Package [1]	LANL	Data Package
Pu (MT)	5.37E-01	3.10E-01 [2]	1.59E-01	1.46E-01 [2]
U (MT)	1.70E+03	1.43E+03 [2]	1.60E+02	0
Cs (Ci)	3.79E+07	8.12E+06	2.82E+07	2.68E+07
Sr (Ci)	3.85E+07	4.36E+07	2.13E+07	1.01E+07

Notes:
[1] Total = sludge + saltcake + liquid (assumed saltwell pumping is completed).
[2] Converted from curies.
LANL = Los Alamos National Laboratory

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APPENDIX B
DESCRIPTION OF ALTERNATIVES

ACRONYMS AND ABBREVIATIONS

APM	ammonium phosphomolybdate
CFR	Code of Federal Regulations
CMPO	N-diisobutylcarbamoylmethylphosphine oxide
DOE	U.S. Department of Energy
DST	double-shell tank
DTPA	diethylenetriaminepentaacetic acid
Ecology	Washington State Department of Ecology
EDTA	ethylenedianimetetraacetic acid
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FR	Federal Register
HEDTA	hydroxyethylanediamivetriacetic acid
HEPA	high-efficiency particulate air
HI	hazard index
HLW	high-level waste
HMPC	Hanford Multi-Purpose Canister
HVAC	heating, ventilating, and air conditioning
LAW	low-activity waste
MUST	miscellaneous underground storage tank
NCRW	neutralized cladding removal waste
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission

PFP	Plutonium Finishing Plant
PUREX	Plutonium-Uranium Extraction
RCRA	Resource Conservation and Recovery Act
REDOX	Reduction-Oxidation
SIS	Safe Interim Storage
SST	single-shell tank
TBP	tributyl phosphate
TFCF	tank farm confinement facility
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TRUEX	transuranic extraction
TSLCC	Total System Life Cycle Cost
TWRS	Tank Waste Remediation System
WAC	Washington Administrative Code
WESF	Waste Encapsulation and Storage Facility
WHC	Westinghouse Hanford Company
WNP-2	Washington Public Power Supply System Nuclear Plant 2

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length		**Area**		**Volume**	
cm	centimeter	ac	acre	cm^3	cubic centimeter
ft	foot	ft^2	square foot	ft^3	cubic foot
in	inch	ha	hectare	gal	gallon
km	kilometer	km^2	square kilometer	L	liter
m	meter	mi^2	square mile	m^3	cubic meter
mi	mile			ppb	parts per billion
				ppm	parts per million
				yd^3	cubic yard

Mass		**Radioactivity**		**Electricity/Energy**	
g	gram	Ci	curie	A	ampere
kg	kilogram	MCi	megacurie (1.0E+06 Ci)	J	joule
lb	pound	mCi	millicurie (1.0E-03 Ci)	kV	kilovolt
mg	milligram	Ci	microcurie (1.0E-06 Ci)	kW	kilowatt
mt	metric ton	nCi	nanocurie (1.0E-09 Ci)	MeV	million electron volts
		pCi	picocurie (1.0E-12 Ci)	MW	megawatt

V	volt
W	watt

Temperature

C degrees Centigrade

F degrees Fahrenheit

This appendix describes the Hanford Site tank waste and cesium (Cs) and strontium (Sr) capsules and the alternatives that are addressed in this Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS). The detailed description of each alternative includes 1) an overview of the alternative; 2) the facilities to be constructed; and 3) the processes involved. Because certain post-remediation activities are common to each alternative, they are discussed in a separate section followed by a discussion of specific applicable technologies that are not now but could be included in the alternatives. The appendix concludes with a compilation of comparison data such as resource requirements, staffing requirements, and emissions data for each alternative.

This appendix provides specific details about the alternatives to supplement the more general discussion in Volume One, Section 3.0 of the EIS. The data used in generating this appendix came from a series of engineering data packages that were compiled separately by Westinghouse Hanford Company (WHC) and Jacobs Engineering Group Inc. (WHC 1995a, c, d, e, f, g, h, i, j, n and Jacobs 1996).

B.1.0 EXISTING FACILITIES AND OPERATIONS

B.1.1 TANK WASTE

From 1943 to 1988, the primary purpose of the Hanford Site was to produce weapons-grade plutonium (Pu) and other defense-related material to support the national defense mission. Plutonium production occurred in a nuclear reactor when a uranium-238 (U-238) atom in a fuel rod absorbed a neutron released from the splitting of another atom. After the fuel rods spent the required length of time in the reactor, the fuel was removed and processed to recover the Pu. The first processes to recover Pu were developed to exclusively separate Pu from the other elements in the fuel rods. Later, processes were developed to also recover U, which was then recycled back into the reactor fuel process. Processing fuel elements involved performing chemical separations to isolate and recover the Pu and U from the spent fuel elements. Chemical waste, the by-product of these separations, created the need for large-capacity, onsite storage. The tank farms, which are a group of interconnected underground storage tanks, were designed and built to accommodate the chemical waste. The first 149 storage tanks built were single-shell tanks (SSTs), which are reinforced-concrete tanks with a single steel tank. The last 28 tanks built were double-shell tanks (DSTs), which are reinforced-concrete tanks with two steel tanks. The locations of the tanks are shown in Figures B.1.1.1 and B.1.1.2.

Figure B.1.1.1 Hanford Site

Figure B.1.1.2 Tank Farm Locations in 200 East and West Areas

Chemical separations processing generated approximately 1.5E+09 liters (L) (4.0E+08 gallons [gal]) of waste. More than 1.1E+09 L (3.0E+08 gal) of waste was sent to the SSTs and DSTs throughout the production period. Volume reduction practices were used to maintain waste volumes within the available tank space. Through liquid evaporation, waste concentration, and decanting (liquid removal following solids settling) dilute waste to the ground, this waste volume has been reduced to approximately 2.1E+08 L (5.6E+07 gal) (Hanlon 1996). The decanting, or discharging, of settled SST waste to the ground was stopped in 1966; no tank waste from SSTs or DSTs has been intentionally discharged to the ground since that time. Liquid discharged to the ground was sent to cribs (drain fields) to drain into the soil. This practice resulted in soil and groundwater contamination. These cribs are past practice units that are not within the scope of the TWRS EIS.

Underground transfer lines (pipelines) transferred liquid waste from the processing plants to the tank farms. Routing the liquid waste from a plant to a specific tank farm was controlled by valve pits and diversion boxes. Diversion boxes, which are concrete-walled pits located in the ground with a removable top at ground level, allowed a jumper or spool piece to be installed to control the routing of the waste and minimize the number of pipelines. After the waste transfer was completed, the volume change in the tank was logged for future reference.

B.1.1.1 Description of Single-Shell Tanks

The SSTs were the first large volume tanks constructed. The 149 SSTs at the Hanford Site vary in size from 2.1E+05 to 3.8E+06 L (5.5E+04 to 1.0E+06 gal). Figure B.1.1.3 shows a typical SST. The SSTs consist of a reinforced-concrete shell surrounding a carbon steel tank. Each of the larger tanks has multiple access points called risers that provide access to the tank from the surface. The risers are either sections of pipe or square concrete pits that connect to the top of the tanks, which are 1.8 to 2.5 meters (m) (6 to 8 feet [ft]) below grade. The risers, between 10 and 110 centimeters (cm) (4 and 42 inches [in.]) wide, are used for monitoring instruments, camera observation, tank ventilation systems, and sampling. Wells drilled into the ground around the tanks are used for monitoring and detecting leaks in the SST farms.

Figure B.1.1.3 Single-Shell Tank General Configuration

The sizes and quantities of SSTs that were built in the 200 Areas are shown in Table B.1.1.1.

Table B.1.1.1 Single-Shell Tank Summary

The tank farms are located close to the center of the 1,450-square-kilometer (km^2) (560-square-mile [mi^2]) Hanford Site (shown in Figure B.1.1.1) in the 200 Areas. The 200 Areas are specific areas of operation and are divided into the 200 East Area and the 200 West Area, which are approximately equal in size. The tank farms are approximately 8 kilometers (km) (5 miles [mi]) from the Columbia River at their closest point. There are 66 SSTs in the 200 East Area and 83 SSTs in the 200 West Area. These tanks are arranged in groups called farms, which range from 4 to 18 tanks. Building the tanks in farms allowed the tanks to be interconnected within the farm, thereby reducing the number of pipelines between the processing plants and the tank farms. The tank farm concept also allowed the use of cascades, in which the first tank overflowed into the second tank, the second into the third, and so on within the tank farms to allow solids settling. The solids contain a majority of the radionuclides, except for Cs-137, iodine-129 (I-129), and technetium-99 (Tc-99), which are more prevalent in the liquid phase.

The 200 West Area has 83 SSTs in six tank farms. These tanks supported operations of T Plant, U Plant, the Plutonium Finishing Plant (PFP), and the Reduction-Oxidation (REDOX) Plant as described in Section B.1.1.6.

There are 66 SSTs in the 200 East Area associated with operations of the Plutonium-Uranium Extraction (PUREX) Plant and B Plant. North of the PUREX Plant are three tank farms with a total of 26 tanks. North of B Plant on the northern edge of the 200 East Area are three tank farms with a total of 40 SSTs.

B.1.1.2 Description of Double-Shell Tanks

The DSTs were developed as a design improvement over the SSTs. The DSTs have double-carbon steel tanks inside a reinforced-concrete shell, as shown in Figure B.1.1.4. There is an annulus or space between the two steel tanks with equipment to detect and recover waste in the event that the inner tank develops a leak. Each tank has multiple risers connecting the tank with the surface above. These risers are different diameters or sizes depending on their intended use. The risers for the DSTs are used for the same purpose as the SST risers (i.e., monitoring instruments, camera observation tank ventilation systems, and sampling). Each DST tank has its own leak detection pit that is connected to the bottom of the tank and monitored for tank leaks.

Figure B.1.1.4 Double-Shell Tank General Configuration

The DSTs are approximately 23 m (75 ft) in diameter, 15 m (48 ft) tall, and cylindrical in shape with a concrete-domed top. All of the tanks are buried in the ground with the tops of the domes located approximately 2 m (7 ft) below the surface. Twenty-four of the tanks have a capacity of 4.4E+06 L (1.2E+06 gal), while four of the tanks have a capacity of 3.8E+06 L (1.0E+06 gal). Tank farm operations restrict the total volume allowed in the tanks to approximately 76,000 L (20,000 gal) below maximum capacity.

The 25 DSTs in the 200 East Area are located just north of the PUREX Plant. Twenty-one of the DSTs have a capacity of 4.4E+06 L (1.2E+06 gal) and four of the DSTs have a capacity of 3.8E+06 L (1.0E+06 gal). The 21 DSTs in service are operating between 75 and 97 percent of allowable volume capacity. The waste in the DSTs is primarily liquid with small volumes of sludges and saltcakes. There have been no leaks from the DSTs.

B.1.1.3 Miscellaneous Underground Storage Tanks

In addition to the 177 underground storage tanks previously discussed, there are approximately 20 active and 40 inactive miscellaneous underground storage tanks (MUSTs). The EIS alternatives also address the disposition of the waste in the MUSTs. The inactive MUSTs were used during processing and waste transfer operations and were not intended for use as long-term storage tanks. The MUSTs that were used primarily for solids settling, adding caustic, and catch tanks are also currently inactive. The characteristics of the waste contained in the inactive MUSTs is expected to be similar to the SST waste. The active MUSTs still are used as receiver tanks during waste transfer activities or as catch tanks to collect potential spills and leaks.

Most of the inactive MUSTs were interim stabilized and isolated before September 1985. The MUSTs range in size from 3,400 to 190,000 L (900 to 50,000 gal). There is a wide range in the amount of waste currently in the MUSTs. While most of the MUSTs are empty or nearly empty, several inactive MUSTs contain residual sludges and liquid. The volume of waste in all the MUSTs combined is less than one-half of 1 percent of the total tank inventory (WHC 1995n).

B.1.1.4 Existing Transfer Lines

When the tank farms were constructed, they were connected to the process facilities by underground transfer lines. Associated with these transfer lines are subgrade valve pits and diversion boxes. Valve pits and diversion boxes provide a means to route waste to specific tank farms with a minimum number of transfer lines. In addition, there is an existing cross-site transfer system to transfer waste between the 200 East and 200 West Areas. Some of the older transfer lines are blocked or plugged up and cannot be used for waste transfers. All of the existing transfer lines are buried below grade to use the natural radiation shielding of the ground. Most of the transfer lines installed during early operations are single-wall carbon-steel pipe lines, while later lines are double-wall pipe lines with a stainless-steel inner pipe encased in an outer carbon-steel pipe. The valve pits and diversion boxes are below grade concrete structures that are covered with removable concrete panels. A new replacement cross-site transfer system is under construction and scheduled to begin operations in 1998.

B.1.1.5 Support Facilities

Support facilities provide utilities and other operations to help manage the tanks and tank waste. The following is a list of the primary existing support facilities required to continue managing the tank waste.

- Steam is provided by the 284-East Steam Plant. The Steam Plant was built in 1943 with a design life of approximately 20 years. The boilers operate below capacity and require a high level of maintenance.
- Water, both sanitary and process, is delivered to the 200 Areas by the Hanford Site Water System.
- Electrical power is delivered to the Hanford Site by the Bonneville Power Administration. The 200 Areas have one substation with two independent transformers.
- Road and rail access is established to the 200 Areas.
- Tank waste and new waste undergo evaporation at the 242-A Evaporator to reduce waste volume requiring storage. The 242-A Evaporator has recently been upgraded.
- Evaporator condensate is treated at the Effluent Treatment Facility to remove contaminants before being discharged.

B.1.1.6 Tank Waste

Sources of the Waste

Several different chemical separations processes were used in the past for separating and recovering Pu and U from irradiated reactor fuels at the Hanford Site. Common steps to the different recovery processes included chemically removing the fuel element cladding, dissolving the fuel in nitric acid, chemically processing the fuel to separate the Pu, and in some instances separating the U from the dissolved fuel mixture.

The first processing for Pu recovery started in 1944 at T Plant and 1945 at B Plant using the bismuth phosphate process. Both plants used bismuth phosphate to precipitate Pu from dissolved spent fuel solutions. The extraction waste was classified as a metal waste and contained 90 percent of the fission products and 99 percent of the U. This waste was sent to specific SST tank farms in the 200 East and 200 West Areas.

In January 1952, the REDOX Plant began operating as the worlds first nuclear solvent extraction plant using the REDOX process. The REDOX process extracted Pu and U into a hexone solvent in a continuous solvent extraction process.

In January 1956 , the PUREX Plant began operating. PUREX used tributyl phosphate (TBP) in a kerosene base as a solvent to extract U and Pu from the fuel elements that had been previously dissolved in a nitric acid solution. Both the REDOX and PUREX process recovered Pu, U, and neptunium (Np) from spent reactor fuel.

All of the acidic aqueous waste was made alkaline by adding sodium hydroxide or calcium carbonate before storing in the underground storage tanks.

The PFP took the plutonium nitrate product from PUREX Plant and REDOX Plant and further refined it into Pu metal. The PFP used a process similar to PUREX Plant to further purify the Pu and produce a finished Pu product from the PUREX Plant output. The PFP sent waste to the tank farms that was low in radioactivity and high in metallic nitrates. Before PFP was operating, the plutonium nitrate paste was transported to Los Alamos National Laboratories for processing.

Because U was not recovered in the bismuth phosphate process it was sent to the tank farms during B Plant and T Plant operations. The U Plant was built and operated to recover the U from B and T Plant tank waste. This U recovery operation required the recovery of B and T Plant waste from the tank farms.

Midway through U Plant operations the process of scavenging or precipitating Cs with ferrocyanide was started to remove the Cs from the liquid waste. This scavenging operation precipitated the Cs in the tanks as solids, allowing the liquid to be decanted and sent to the cribs. This practice allowed for the discharge of clarified liquid and provided additional tank space. This process was completed in 1957 (WHC 1995b).

B Plant was also operated as a waste fractionization plant in the 1960's to early 1980's. Cesium and Sr were recovered as waste by-product and the secondary waste containing complexants (ethylenediaminetetraacetic acid [EDTA] and hydroxyethylenediaminetriacetic acid) were sent to the tank farms.

As a result of using the tanks to hold waste from such a variety of operations, the tank contents have changed as time passed. While records were kept as transfers were made, the inter-tank piping allowed the tank contents to cascade from one tank to another. Consequently, the tanks now contain a variable mixture of sludge, precipitated salts (saltcake), and liquid. Characterization on a tank-by-tank basis would be required to determine the actual contents of any given tank.

Waste Types

The waste stored in DSTs is reported by waste type stored in individual tanks. There are seven waste types associated with DSTs.

- Concentrated complexant waste is concentrated product from evaporating dilute complexed waste.
- Concentrated phosphate waste is waste originating from the decontamination of the N Reactor in the 100-N Area.
- Dilute complexed waste is characterized by a high content of organic carbon including organic complexants. The main source of dilute complexed waste in the DSTs is the liquid-removal operations from the SSTs.
- Dilute noncomplexed waste is low-activity liquid waste.
- Double-shell slurry is waste that exceeds the sodium aluminate saturation boundary in the evaporator without exceeding receiver tank composition limits.
- PUREX Plant neutralized cladding removal waste (NCRW) is the solids portion of the PUREX Plant NCRW. This NCRW waste was sent to the tank farms as a slurry and is classified as transuranic (TRU) waste.
- PFP TRU solid is solid TRU waste from PFP operations.

B.1.1.7 Current TWRS Activities

The TWRS program was established in 1991 to safely manage and dispose of radioactive and chemical or mixed waste that has been generated at the Hanford Site. The current TWRS program mission is to dispose of the radioactive tank waste (includes current and future tank waste) and the Sr/Cs capsules in an environmentally sound, safe, and cost-effective manner.

Continued Operations of Tank Farm System

Numerous tank waste activities are ongoing to provide for the continued safe storage of the tank waste until remediation measures are implemented. These activities consist of a number of routine activities as well as a number of additional activities required for safe storage.

Routine operations include management oversight, regulatory compliance and reporting activities, and operations and maintenance of facilities and equipment. Tank monitoring activities support waste management by gathering information on waste temperature, liquid levels, solid levels, and tank status. Leak detection activities involve in-tank liquid level monitoring, leak detection monitoring of the annulus for the DSTs, drywell monitoring around tanks for increases in radioactivity levels, and groundwater monitoring.

TWRS safety management activities include the following:

- Calculating operational waste volume projections that involve comparing projected waste volumes against tank capacity. The projections also provide for identification and management of risk that could negatively impact available tank storage space;
- Combining compatible waste types. Transferring tank waste between tanks and tank farms through the existing cross-site transfer system to provide the required tank space and to address safety issues;
- Implementing a waste minimization program to reduce the generation of new waste requiring storage in the tanks. This program includes job preplanning and identification of new technologies such as low volume hazardous waste decontamination practices to limit the generation of new waste. A waste minimization support program for non-TWRS waste generators is used to encourage waste minimization practices;
- Screening and characterizing the waste on a tank-by-tank basis to gather data in support of safety and remedial action design activities;
- Isolating and removing pumpable liquid from SSTs to reduce the potential of future leakage (interim stabilization by saltwell pumping); and
- Operating the 242-A Evaporator to concentrate waste and treating evaporator condensate at the Effluent Treatment Facility

These activities are not within the scope of this EIS because they were addressed in previous National Environmental Policy Act (NEPA) documents: the Safe Interim Storage of Hanford Tank Waste EIS (SIS EIS) (DOE 1995i), Waste Tank Safety Program Environmental Assessment (DOE 1993h), Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes EIS (DOE 1987).

Tank Monitoring and Maintenance

As part of its routine operations, the Hanford Site has an extensive tank farm surveillance program in which tanks are monitored for temperature, surface level, and interstitial liquid level (in tanks having low-activity waste [LAW]) as required to safely manage and operate the tank farms. There are pressure and gas monitors on some tanks. The surface level inside the tanks is monitored either manually with an installed tape or with automated instrumentation.

Watchlist tank temperatures are monitored with automated equipment where installed, and manually where required. The automated systems allow temperature monitoring on a continuous basis. Watchlist tanks that require manual readings are done on a weekly or monthly basis. All Watchlist tanks are reviewed for increasing temperature trends. Non-Watchlist tank temperatures are monitored at 6-month intervals.

Fifty-eight of the SSTs and two of the DSTs have liquid observation wells installed for monitoring the level of interstitial liquid within the waste. Liquid observation wells are installed in SSTs that are known to have, or may have, greater than 1.95E+05 L (50,000 gal) of drainable liquid. The liquid observation wells are fiberglass or plastic pipe, sealed at the bottom, extending from the ground level down into the tank and through the waste to within 2.5 cm (1 in.) of the tank bottom. Gamma and neutron probes are used to monitor changes in the interstitial liquid level. Changes in liquid level would indicate fluid leakage either into or out of the tank, or could be an indication of the presence of gas within the waste if the observed liquid level changes are consistent with atmospheric pressure changes. The two steel liquid observation wells that are installed in the DSTs are used only for special monitoring purposes.

Radiation measurements are taken in the drywells surrounding the SSTs, in the leak detection pits, and the space between the liners of the DSTs. An increase in the radiation levels in any of the monitoring wells or pits would indicate a possible tank leak.

Safety Issues

All U.S. Department of Energy (DOE) facilities that store hazardous or radioactive materials have documented authorization bases that establish a range of operating parameters (e.g., temperature, pressure, concentration) within which routine operations are conducted. These authorization bases also evaluate the effects of potential accidents, abnormal events, and natural disasters.

The possibility of driving heavy equipment over an unstabilized tank during construction or operations, which potentially could result in a tank closure collapse was considered. To reduce the potential for this accident, engineered features would be installed and administrative controls used to prevent large vehicles from driving on top of the tank domes. These engineered barriers would be mechanical barriers such as closely spaced posts installed around the tanks or tank farms.

Watchlist Tanks

Concern over waste tanks having the potential for releasing high-level radioactive waste to the environment resulted in the passing of Public Law 101-510, Section 3137, Safety Measures for Waste Tanks at Hanford Nuclear Reservation, also known as the Wyden Amendment. In response to this law, DOE developed a set of criteria to identify tanks with potential safety concerns as Watchlist tanks. Current published information indicates that there are 50 Watchlist tanks, with 10 tanks listed in more than one of four different Watchlist categories based on specific safety concerns. The four different Watchlist categories include flammable gas, ferrocyanide, high organic content, and high-heat generation. The tanks in each category are shown in Table B.1.1.2 (Hanlon 1995 and Cowan 1996). As safety issues are resolved or mitigated, the number of tanks on the Watchlist is expected to change.

Table B.1.1.2 Watchlist Tanks

The flammable gas Watchlist identifies those tanks whose contents have the potential to generate/retain and release hydrogen gas at levels above the flammability limit, which is approximately 4 percent hydrogen by volume. Hydrogen and ammonia are generated within the tanks through radiolysis or radiation-induced decomposition and chemical reactions. If flammable concentrations are reached and an ignition source is present, the potential reaction could cause a radioactive release or provide an energy source to facilitate other reactions within the tank. Currently there are 25 hydrogen-generating tanks in this category. Tank 101-SY is currently being mitigated by using mixer pumps to stir the waste and allow hydrogen gas to be released gradually to prevent episodic releases of hydrogen that are above the lower explosive limit. Other tanks are being screened and evaluated to assess their magnitude of the risk from flammable gas generation, storage, and intermittent release.

The ferrocyanide Watchlist tanks are a concern because of the potential for self-propagating reactions if ferrocyanide in sufficient concentration comes in contact with an oxidizer (nitrates and nitrites) at a high temperature. The measured temperatures in all the ferrocyanide tanks are at or below 60 C (140 F), well below the 180 to 200 C (360 to 390 F) temperature required for self-propagating reactions to occur. The list of tanks with ferrocyanide was developed based on assessments of tank contents using process information. As tank characterization progresses, tanks with insufficient quantities of ferrocyanide for self-propagating reactions will be removed from the Watchlist. Currently, there are 14 tanks listed in this category.

There are 20 tanks in the high-organic Watchlist category. These are tanks that are estimated or have the potential to contain 3 percent total organic carbon on a dry weight basis. The concern with these tanks is that at elevated temperatures above 180 C (360 F), the organics in the tanks could result in self-propagating reactions with the nitrate and nitrite. These tanks are checked for the presence of an entrained or floating organic solvent layer that might pose a risk from a slow pooled or wicked fuel burn. Studies are underway to gain a better understanding of the high-organic safety issues. The differences between the measured tank temperatures and the temperatures required to sustain a reaction are large; therefore, the probability of a reaction is considered very low.

Currently one tank, tank C-106, is in the high-heat Watchlist category because of its content of heat-generating sludge. The heat generation is caused by decaying Cs and Sr in the sludge. The concern with the high-heat tank is that the heat-generating sludge could boil off or evaporate the liquid from the tank, which would raise the sludge temperature. If the temperature within the tank rises above the allowable limit for the tank materials, structural failure of the tank and collapse of the tank dome may result. While the tank currently is considered sound, water must be added periodically to keep the sludge wet and provide evaporative cooling.

Unreviewed Safety Questions

DOE has a formal administrative program to identify, communicate, and establish corrective actions for known or suspected operating conditions that have not been analyzed or that fall outside of the established authorization bases as an Unreviewed Safety Question. Following the identification of an Unreviewed Safety Question, a review is conducted, and corrective action is taken if applicable. Following the review process, the Unreviewed Safety Questions may be closed from an administrative standpoint, which means that conditions surrounding the safety issue have been analyzed. However, the conditions upon which the safety issue is based may still exist and may require mitigation, controls, or corrective action. In this way, safety issues and Unreviewed Safety Questions are related. The safety issues that were identified under the Watchlist program were also analyzed as Unreviewed Safety Questions. Those issues that had not been addressed in the documentation authorization basis were established as Unreviewed Safety Questions. Following the review processes, the Unreviewed Safety Question can be closed while the tank remains on the Watchlist for resolution of the safety issue. The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1994) requires the resolution of all Unreviewed Safety Questions by September 1998.

Technical evaluation and mitigative actions have resulted in closing the following Unreviewed Safety Questions: ferrocyanide (closed in March 1994); floating organic layer in tank C-103 (closed in May 1994); and criticality (closed in March 1994). Criticality was addressed on a tank farm basis and did not result in identifying any individual tanks to be added to the Watchlist tanks. Criticality would be an issue during tank waste retrieval and transfer, and would be evaluated on a tank-by-tank basis during final design. Closure of the Unreviewed Safety Questions was accomplished by defining the parameters (e.g., concentrations and temperature) of potential reactions that could lead to an uncontrolled release, collecting physical and chemical data on the waste, and establishing safety operating specifications.

The remaining Unreviewed Safety Questions are undergoing resolution. Mitigative action has been implemented for tank SY-101, the most widely known flammable-gas generating tank. This mitigative action involved installing a mixer pump to control the periodic release of flammable hydrogen gas and provide for more frequent and gradual releases of hydrogen. This mitigative action reduces the maximum concentration of flammable gas that can exist in the tank and greatly reduces the potential for an uncontrolled gas burn.

There is a safety screening and characterization program ongoing to determine if any additional tanks should be placed under special controls. Recently all 177 tanks, Watchlist and non-Watchlist, were placed under flammable gas controls, which means that flammable gas generation/retention may exist in all 177 tanks and special safety measures will be taken during maintenance, monitoring, and waste transfer activities. Until the necessary characterization data are obtained, the tank farm system will continue to operate under a conservative management program to maintain a safe operating envelope. Additional data may allow for relaxed operating procedures, where appropriate. Volume Four, Appendix E contains a more detailed description of the tank safety issue.

Interim Stabilization to Prevent Further Leakage

DOE removed all SSTs from service in November 1980 and initiated a program to remove all pumpable liquid and stabilize the tank waste until final disposition. This effort, known as interim stabilization, is currently ongoing. Approximately 30 tanks remain to be interim stabilized and these will be complete by the year 2000.

There are 67 confirmed or assumed leaking SSTs in the 200 Area tank farms. Over the years, these tanks have leaked an estimated 2.3E+06 to 3.4E+06 L (600,000 to 900,000 gal) of liquid to the soil column. All but five of the SSTs that are assumed leakers have been interim stabilized to minimize potential releases to the environment (Hanlon 1996).

An ongoing vadose zone characterization program that was initiated in April 1995 (DOE 1995t) is providing new baseline characterization data on the potential contaminant distribution in the vadose zone sediments beneath and in the vicinity of the SSTs. This has resulted in some recent information for the SX Tank Farm. The characterization effort relies on geophysical logging of existing drywells using a spectral gamma logging system with a high-purity intrinsic germanium detection device to provide assays of gamma-emitting radionuclides near the drywells (Brodeur 1996).

Ten of the 15 tanks in the SX Tank Farm are assumed or verified as leaking, as discussed in Volume Five, Appendix K. Ninety-five drywells ranging in depth from 23 m (75 ft) to 38 m (125 ft) from ground surface were logged with the Spectral gama logging system in the SX Tank Farm. The most abundant and highest concentration radionuclide detected was cesium-137, which was detected in "virtually every borehole" (Brodeur 1996). Cesium-137 was detected at the following depths in several drywells: 23 m (75 ft) in drywells 41-09-03 and 41-08-07, 32 m (105 ft) in 41-09-04, 27 m (90 ft) in 41-11-10, and 38 m (125 ft) in 41-12-02.

Other gamma-emitting radionuclides detected include cobalt-60, europium-152, and europium-154, which generally were found near the surface and are believed to be the result of spills (Brodeur 1996). Cobalt-60 was found in drywell 41-14-06 only. It was detected at a depth of 17 to 23 m (55 to 76 ft) below ground surface. The data are unclear as to whether relatively immobile contaminants such as cesium-137 would be found dispersed laterally within the vadose zone (i.e., at observed concentrations laterally several meters from the drywells) at the depths of over 30 m (100 ft) based on ambient conditions and vadose zone contaminant transport via advective flow in interstitial pore spaces. This suggests that there may be other transport mechanism(s) occurring such as those discussed in Volume Five, Section K.4.1.3. The viability of any other potential transport mechanism has not yet been demonstrated but is one of the objectives of the ongoing investigations.

Interim stabilization consists of saltwell pumping and is intended to reduce the volume of free waste liquid in the SSTs and minimize potential liquid losses to the environment. Interim stabilization is accomplished by reducing the supernatant liquid content of a tank to less than 190 m^3 (50,000 gal). The jet-pump system used to remove pumpable liquid continues operating until the pumping rate falls below 0.19 L/min (0.05 gal/min). The pumping effort may use the LR-56(H) cask truck for emergency pumping of leaking SSTs. Liquid removed from the SSTs is transferred to a DST. Interstitial liquid (within the solid pores) remains in the SSTs following interim stabilization. The 30 tanks that require saltwell pumping are scheduled to be completed by the year 2000.

Waste Characterization

The tank waste characterization process involves determining the physical, radiological, and chemical properties of the waste. Considerable historical data are available that have been used to estimate the contents of the storage tanks. Historical data, which are based on invoices for the purchase of chemicals and waste transfer and processing records, provide a basis for an overall inventory of the waste in the tanks. Historical tank content estimates have been completed for the DSTs and the solid waste in the SSTs (WHC 1995b). These estimates provide an inventory of the radioactive and mixed waste stored in the SSTs and DSTs.

Waste characterization is performed to help resolve safety issues, allow for the safe storage of the waste until waste treatment operations begin, and support planning and design decisions for implementing the remedial alternative selected. A considerable amount of inventory information is available from process records and past sampling activities. However, this information is not considered adequate to characterize the waste in individual tanks to support safety, treatment, and design activities.

There is an ongoing waste characterization program that is using waste sampling and analysis, in situ measurements, monitoring, surveillance, and waste behavior modeling to provide more detailed and accurate characterization data for the contents of each tank. Current agreements between DOE, the Washington State Department of Ecology (Ecology), and the U.S. Environmental Protection Agency (EPA) require that all characterization reports be issued by September

1999. Prior to disposal system final design, additional data requirements may be generated.

The tank waste is classified as liquid, sludges, or saltcake. Liquid is made up of water and organic compounds (e.g., solvents that are both heavier and lighter than water) with dissolved salts. Sludges are mixtures of insoluble (will not dissolve in tank liquid) metal salt compounds that settle out of solution after the waste is made alkaline for storage. A majority of the radioactive elements are contained in the sludges. However, radionuclides such as I-129, Tc-99, and Cs-137 are more prevalent in the liquid phase. Salts or saltcake are primarily sodium and aluminum salts that crystallize out of solution following evaporation. These three types of waste exist in the tanks in numerous combinations and proportions resulting in complex combinations of waste with varied physical and chemical properties. Sludges have been found with consistencies from mud to hardened clay. Layers of organic compounds have been found in some tanks floating on the top of solid waste, and crusts have formed in some tanks where a layer of solids has formed on top of the tank liquid.

Present data indicate that the SSTs as a group have on a volume basis 65 percent saltcake, 33 percent sludges, and 2 percent liquid, although the percentages of these differ greatly between tanks.

The DSTs have more than 77 percent liquid with 9 percent sludges, 10 percent double-shell slurry, and 4 percent saltcake (Hanlon 1995). These percentages may change as additional data become available and as waste transfers take place. SST and DST chemical inventory estimates, based on historical data, are provided in Volume Two, Appendix A of the EIS.

Evaporating Liquid in the 242A-Evaporator

The 242-A Evaporator is used to manage waste volume by evaporating the water from the tank waste. Recent evaporation campaigns have removed several million gallons of water from the tank waste. This water would be transferred to the Effluent Treatment Facility for treatment and release to the State-approved land disposal site. Following evaporation, concentrated waste would be returned to the DSTs.

B.1.1.8 Proposed TWRS Activities

Several tank waste activities are planned for implementation in the near future. These activities will address urgent safety or regulatory compliance issues.

Newly Generated Waste

At present, the DSTs are used to store waste generated from ongoing site activities. Future DST additions are expected to come from routine operations. These waste additions would involve loading the waste as liquid or slurry into a tank truck or railcar at the generating facility, transporting the waste to the tank farms, and unloading and transferring the waste into existing DSTs for storage. This waste would be transferred using existing rail or tanker truck systems. Section B.9.2 contains a description of the LR-56(H) truck. Facilities generating waste requiring transport to the tank farms include:

- 300 Area laboratory and facility cleanout;
- Cleanout waste from PUREX Plant, PFP, and B Plant;
- Decontamination waste from T Plant;
- Routine laboratory waste; and
- Cleanout of K Basins.

Additional information on newly generated waste is contained in Volume Two, Appendix A.

Safe Interim Storage

One issue that requires action is the safe storage of tank waste in the interim period before implementing actions for the permanent remediation of tank waste. To address this issue, the SIS EIS was prepared to consider alternatives for maintaining safe storage of Hanford Site tank waste (DOE 1995i). The actions considered in the SIS EIS include interim actions to 1) mitigate the generation of high concentrations of flammable gases in tank 101-SY; and 2) contribute to the interim stabilization of older SSTs, many of which have leaked.

The most pressing interim need identified by DOE and Ecology was for a safe, reliable, and regulatory compliant replacement cross-site transfer capability to move waste between the 200 West and 200 East Area tank farms. This transfer capability is needed because the 200 West Area has far less useable DST capacity than there is waste in SSTs. The replacement waste transfer capability would provide a safe, reliable, and regulatory compliant means to move waste from the 200 West Area to the available DST capacity located in the 200 East Area.

Based on tank waste management and operation activities when the SIS EIS was prepared, the following needs were addressed:

- Removing saltwell liquid from older SSTs to reduce the likelihood of liquid waste escaping from corroded tanks into the environment. Many of these tanks have leaked, and historically, new leaks , either known or assumed, have developed in these tanks at a rate of more than one per year;
- Providing the ability to transfer the tank waste via a regulatory compliant system to mitigate any future safety concerns and use current or future tank space allocations;
- Providing adequate tank waste storage capacity for future waste volumes associated with tank farm operations and other Hanford Site facility operations; and
- Mitigating the flammable gas safety issue in tank 101-SY.

The alternatives evaluated in the SIS EIS provide DOE with the ability to continue safe storage of high-level tank waste and upgrade the regulatory compliance status with regard to Resource Conservation and Recovery Act (RCRA) (40 Code of Federal Regulations [CFR] 260) and the Washington Administrative Code (WAC) Dangerous Waste Regulations (WAC 173-303).

On December 1, 1995, DOE and Ecology published their Record of Decision for the SIS EIS in the Federal Register (FR) (60 FR 61687). The decision was to implement most of the actions of the preferred alternative, including:

- Construct and operate a replacement cross-site transfer pipeline system;
- Continue operating the existing cross-site transfer pipeline system until the replacement system is operational;
- Continue operating the mixer pump in tank 101-SY to mitigate the unacceptable accumulation of hydrogen and other flammable gases; and
- Perform activities to mitigate the loss of shrub-steppe habitat.

The existing cross-site transfer system has been used to transfer waste from the 200 West Area for 40 years. This underground pipeline system is at the end of its original design life. Currently, four of the six lines are out of service and unavailable to perform transfers because of plugging. The two useable lines do not meet current engineering standards such as double-containment and leak detection, which are required for waste management facilities. The design and operation of the replacement cross-site transfer system will meet the requirements of RCRA and WAC for secondary containment and Tri-Party Agreement Milestone M-43-07, which required construction of the replacement cross-site transfer system to commence by November 1995. Construction of the cross-site transfer system has begun and the system is scheduled to be operational in 1998.

DOE will continue to use the existing cross-site transfer system until the replacement cross-site transfer system is operational to provide access to 200 East Area DSTs for storage of 200 West Area facility waste and retrieved liquid waste from SSTs. Saltwell liquid retrieval will continue to reduce the risk to the environment from leaking SSTs. Operational procedures will ensure the integrity of the existing cross-site transfer system before any waste transfers. The current planning base estimates that the existing cross-site transfer system will operate for approximately 625 hours during 5 transfers before the replacement cross-site transfer system is operational in 1998.

The mixer pump in tank 101-SY was proven to be effective in mitigating the flammable gas as a safety issue in that tank during more than 1 year of operation. DOE and Ecology revised their preferred alternative between release of the Draft and Final EIS, based on the demonstrated success of the mixer pump, and determined that the construction of new tanks to resolve safety concerns was not necessary.

Based on new information available to DOE regarding nuclear criticality safety concerns during retrieval, transfer, and storage actions since the issuance of the Final SIS EIS, DOE has decided to defer a decision on the construction and operation of a retrieval system in tank 102-SY. Through an ongoing safety evaluation process, DOE recently revisited its operational assumptions regarding the potential for the occurrence of a nuclear criticality event during waste storage and transfers. Changes to the Tank Farm Authorization Basis for Criticality approved in September 1995 were rescinded by DOE in October 1995, pending the outcome of a criticality safety evaluation process outlined for the Defense Nuclear Facility Safety Board on November 8, 1995. Until these criticality safety evaluations are completed, the Hanford Site will operate under the historic limits, which maintain reasonable assurance of subcritical conditions during tank farm storage and transfer operations. Of the actions evaluated in the Final SIS EIS, only the retrieval of solids from tank 102-SY was affected by the technical uncertainties regarding a criticality. Based on the quantities of Pu in tank 102-SY sludge, retrieval of the solids falls within the scope of the criticality safety issues that will be evaluated over the next few months. As a result, a decision on retrieval of solids from tank 102-SY was deferred in the SIS EIS Record of Decision. Also, pending the outcome of the technical initiative to resolve the tank waste criticality safety issue, transfers of waste (primarily saltwell liquid) through tank 102-SY will be limited to noncomplexed waste. Tank 101-SY mixer pump operations, interim operations of the existing cross-site transfer system, operation of the replacement cross-site transfer system, saltwell liquid retrievals, and 200 West Area facility waste generation all would occur within the applicable criticality limits and would be subcritical.

Privatization of Tank Farm Activities

Currently, DOE is considering contracting with private companies for waste remediation services for the tank waste. DOE is interested in encouraging industry to use innovative approaches, and in using competition within the private marketplace to bring new ideas and concepts to tank waste remediation. The goal of the privatization effort is to streamline the TWRS mission, transfer a share of the responsibility, accountability, and liability to industry, improve performance, and reduce cost without sacrificing worker and public safety or environmental protection. DOE has issued a TWRS Privatization Request for Proposal and has received two bids to treat tank wastes (Briggs 1996) . DOE plans on issuing contracts to perform the first phase of the work in late summer 1996 . As currently envisioned, DOE would select contractors to construct and operate commercial demonstration facilities for two tank waste separations and LAW immobilization facilities, one of which may include a high-level waste (HLW) vitrification facility. If these commercial demonstrations are successful, DOE may use the lessons learned from those demonstration facilities and proceed with contracting for full-scale facilities to remediate the remainder of the tank waste. The planning process for these privatization activities is not complete. This planning process is subject to the final decision concerning remediation of the tank waste, which is the subject of this EIS.

Tank Farm Upgrades

Upgrades to the tank farms are planned to improve the reliability of safety-related systems, minimize onsite health and safety hazards, upgrade the regulatory compliance status of the tank farms, and place the tank farms in a controlled, stable condition until disposal is complete. Upgrades planned include 1) instrumentation including the automatic tank data gathering and management control system and the closed-circuit television monitoring to minimize personnel exposure; 2) tank ventilation to replace outdated ventilation systems; and 3) an electrical system to provide electrical power service with sufficient capacity and in compliance with current electrical codes (WHC 1996c). These three components of the tank farm upgrades are not addressed in the TWRS EIS but will be the subject of other analyses.

Upgrades to the existing waste transfer system that would be used in conjunction with the replacement cross-site transfer system also are planned. Waste transfer system upgrades are included in the TWRS EIS and discussed in Section B.3.0.2.

Initial Tank Retrieval System

This project would provide systems for retrieval of waste from up to 10 DSTs. Initial tank retrieval capabilities also would allow consolidation of compatible tank waste to create additional DST storage capacity and support passive mitigation such as diluting hydrogen-gas-generating Watchlist tanks should that become necessary. Retrieval of waste and transfer from all tanks is addressed in this EIS so the Initial Tank Retrieval System project is a subset of the actions included in this EIS and is not addressed separately.

Waste transfer system upgrades are an element of the Tank Farm Upgrades Project included in the TWRS EIS. Waste transfer system upgrades are discussed in Section B.3.0.2.

Hanford Tanks Initiative

Under this program, several waste retrieval activities discussed in the TWRS EIS would be demonstrated in support of the ex situ alternatives. This program would reduce the uncertainties associated with waste retrieval by developing and demonstrating the technologies required to meet retrieval requirements. The Hanford Tanks Initiative includes activities associated with waste retrieval and tank closure. Those activities associated with waste retrieval are covered under this EIS while activities associated with the closure would be the subject of future NEPA analysis.

This program would demonstrate equipment and systems for removal of tank residuals from tank 241-C-106 that are expected to remain following initial retrieval by sluicing. The objective would be to retrieve sufficient waste to meet waste retrieval requirements. This program also would attempt to develop technologies and criteria to retrieve waste from known or assumed leaking SSTs.

B.1.2 CESIUM AND STRONTIUM CAPSULES

B.1.2.1 Background

The cesium chloride (CsCl) and strontium fluoride (SrF_2) capsule program separated the heat-generating Cs and Sr from the tank waste. To reduce the heat being generated in the tanks, a portion of the tank waste was recovered and processed to isolate the Cs and Sr. Removing the heat-generating isotopes from the waste allowed safe storage of the waste. Cs and Sr were removed from existing tank waste through the waste retrieval and treatment program or by treating the waste as it came out of the processing facility before it was put into the waste storage tanks. The Cs and Sr capsule inventory now stored at the Waste Encapsulation and Storage Facility (WESF) is the result of separating Cs and Sr from other waste. The Cs and Sr were converted to chloride and fluoride salts, respectively, and encapsulated for storage. The retrieval and processing activities started in 1967 and lasted until 1985. The storage of the capsule inventory at WESF is an ongoing activity. The capsules are currently designated as waste by-product, which means they are available for productive uses if uses can be found. If and when they are determined to have no potential productive uses, they would be managed and disposed of as HLW consistent with the TWRS EIS alternative selected for implementation.

The majority of the Sr was removed from tank waste sludges obtained from eight tanks in the A and AX Tank Farms. Additional Sr was recovered directly from PUREX Plant waste. Cs is relatively soluble in the tank liquid, which allowed Cs recovery from tank liquid from numerous tanks. The majority of the Cs was recovered from liquid waste produced at the PUREX or REDOX Plants using an ion exchange recovery process.

A capsule configuration was selected for containing the stabilized CsCl and SrF_2 salts because it provides a physical form suitable for long-term storage. Details of capsule construction are shown in Figure B.1.2.1. Of the 1,577 Cs capsules initially fabricated, 249 have been subjected to destructive testing or repackaged into smaller sources and will not be returned. Similarly, of the 640 Sr capsules that were initially fabricated, 39 have been subjected to destructive testing or repackaging and will not be returned. At present, approximately 1,328 Cs and 601 Sr capsules are either stored onsite or will be returned to be stored at WESF by the end of 1997 . The number of capsules could increase if any existing capsule or cut-up capsule contents are repackaged.

Once recovered, the Cs was converted to CsCl, which was melted and poured into a type 316-L stainless-steel capsule, which was then capped and sealed by welding. This capsule was placed inside another capsule and sealed by welding on an outer cap. Figure B.1.2.1 illustrates the general configuration and original design dimensions of the capsules. Later design revisions incrementally increased the inner and outer wall thicknesses. The majority of the capsules produced have the thicker walls. The Cs content of the capsules is primarily Cs-137, with a half-life of 30.17 years, releasing 8.7E-2 watts per gram (W/g) of initial Cs. This decay emits a beta ray 5.4 percent of the time with a maximum energy of 1.2 million electron-volts (MeV), and a beta ray 94.6 percent of the time with a maximum energy of 0.5 MeV. The less-frequent decay mode creates stable barium-137 (Ba-137). The more-frequent decay mode creates Ba-137m, a metastable isotope that decays to the stable Ba-137 through a gamma ray of energy 0.66 MeV.

Figure B.1.2.1 Capsule Details

The Ba-137m has such a short half-life (2.5 minutes) that it can be thought of as occurring simultaneously with the decay of Cs-137. The second decay adds 3.4E-1 W/g of initial Cs. The curie and thermal loading of the Cs capsules at various time periods is provided in Volume Two, Appendix A.

The Sr was converted to SrF_2 salt and was physically packed into a metal capsule. The metal alloy used for the SrF_2 inner capsules was Hastelloy C276, which is a high-temperature corrosion-resistant alloy. After welding a cap on the inner capsule, the entire capsule was placed into a type 316-L stainless-steel outer capsule and an outer cap was welded in place. The Sr content of the capsules is primarily Sr-90, which has half-life of 28.6 years. The Sr-90 decay emits a beta ray with a maximum energy of 0.5 MeV releasing 1.6E-1 W/g of initial Sr. This creates yttrium-90 (Y-90), which decays to stable zirconium-90. The Y-90 has such a short half-life (3 hours), that it can be thought of as occurring simultaneously with Sr-90. The second decay in this chain manifests itself in the emissions of a beta ray with maximum energy of 2.3 MeV, releasing an additional 7.7E-1 W/g of initial Sr. The curie and thermal loading of the Sr capsules at various time periods is provided in Volume Two, Appendix A. The high-temperature corrosion-resistant alloy is required for the SrF_2 capsules, because the Sr-90 decay chain results in higher capsule temperatures than experienced with the CsCl capsules.

The Cs capsules, which are strong emitters of penetrating gamma radiation, were shipped offsite in limited numbers and used for commercial irradiation purposes. The Sr capsules were used as heat sources because the primary radiation emitted by Sr is contained within the metallic capsule, which in turn heats the capsule. The capsules have also been used by DOE programs for fabricating radioactive sources and various research activities at Pacific Northwest National Laboratory, Sandia National Laboratory, and Oak Ridge National Laboratory. Several studies have been performed that document the integrity of the Cs and Sr capsules and their ability to continue safe storage. Corrosion data indicate that attack on the capsule walls from the CsCl would be very low.

The Cs capsule program was terminated, and the approximately 778 CsCl capsules that were at commercial facilities are in the process of being returned to the Hanford Site. Current plans call for all Cs capsules to be returned to the Site by the end of 1997 . The commercial uses of the Cs capsules varied, with the majority of them used for sterilizing medical equipment and supplies. The offsite commercial uses of the CsCl capsules are shown in Table B.1.2.1

Table B.1.2.1 Offsite Commercial Uses of Cesium Chloride Capsules

B.1.2.2 Description of Cesium and Strontium Capsules

The Cs and Sr capsule program was performed between 1974 and 1985 at WESF to remove the heat-generating Cs and Sr isotopes from the tank waste because they generated sufficient decay heat to evaporate the water from the tank waste. Hypothetically, after all the tank wastewater had evaporated, the waste would continue to heat and had the potential to initiate a self-propagating reaction or destroy the structural integrity of the tank. Between 300 and 400 C (570 and 750 F), the oxidizing chemicals present (such as sodium nitrate) could have reacted with the organic chemicals remaining in the tank. This possibility was initially avoided by replacing the water that had evaporated; a more permanent solution was to substantially decrease the concentration of the heat source. The program to decrease the tank concentration and package the Cs and Sr was carried out between 1974 and 1985 at WESF, which is annexed to B Plant in the 200 East Area. The program timeline is shown in Figure B.1.2.2.

Figure B.1.2.2 Capsule Program Timeline

A capsule consists of a sealed inner metallic tube containing the radioactive material inside an outer metallic capsule providing secondary containment. The double-walled capsule is used to provide added safety for confinement (see

Figure B.1.2.1).

Current and Planned Activities

The only ongoing and planned activities for the capsules are the continued storage of the capsules in WESF, return of the remaining capsules to WESF, and attempts to find productive uses for the Cs and Sr capsules. The Cs and Sr capsules are currently stored in water-filled basins at WESF in the 200 East Area. WESF is directly adjacent to B Plant in the 200 East Area, and is approximately 5,600 square meters (m^2) (60,000 square feet [ft^2]), approximately one-fifth the size of B Plant.

The capsules are stored, in a retrievable manner, in racks at the bottom of the pool cells, which are filled with water to a depth of 4 m (13 ft). The storage racks provide for controlled capsule storage locations within the pools. WESF has a total of eight pools, five that are active and used for capsule storage, one that is used for temporary storage, and two that are not used but are maintained. Storing the capsules under water cools the capsules and provides radiation protection for WESF workers. All of the storage basins are monitored for radiation, which would indicate a capsule leak.

Currently, B Plant is scheduled for deactivation by the year 2001. DOE currently is upgrading WESF to operate independently of B Plant because in the past, o peration of WESF was dependent on the operation of B Plant.

DOE is in the early planning stages of considering whether the capsules should remain in WESF or be placed in alternative locations for storage. Among the possible alternatives that may be considered are placing the capsules in the proposed Canister Storage Building originally planned to store HLW.

No decisions have been made to proceed with any alternative storage options. For purposes of analyzing impacts in the TWRS EIS, it is assumed that the capsules will remain in WESF until disposal. If DOE decides to change the method or location for the interim storage of the capsules, an appropriate NEPA review would be performed. A Cs and Sr capsule management program will provide for management of the capsules until final disposition has been implemented.

Capsule safety concerns have not been broken down into specific categories. However, the dominant safety issue for the capsules is the integrity of the storage facility. As it currently exists, the storage facility at WESF has no provision for handling a situation in which the cooling water is lost. If a catastrophic event such as an earthquake were to occur and cause a failure in the basin or its water supply, there is no engineered system to provide secondary containment or an alternate water supply, although efforts are underway to resolve this issue. The impacts of such an event are discussed in Volume Four, Appendix E of the EIS.

DOE is pursuing alternative uses for the Cs and Sr capsules. If no future uses for these capsules are found, the capsules eventually would be designated as HLW and managed and disposed of consistent with the Tri-Party Agreement and the TWRS EIS alternative selected for implementation.

B.1.2.3 Volume and Activity Comparison Between Capsules and Tank Waste

The volume of the material in all of the Cs and Sr capsules combined is approximately 2 cubic meters (m^3) (70 ft^3), which is very small in comparison to the 2.1 E+5 m^3 (7.5 E+06 ft^3) in the waste storage tanks. Although the amount of material in the capsules is small, the amount of radioactivity contained in the capsules is approximately 35 percent of the total activity of the waste storage tanks and the capsules combined. Thus, separating and encapsulating the Cs and Sr from the other tank waste resulted in containing a large portion of the radioactivity in a small volume.

B.1.2.4 Current Monitoring and Maintenance

Monitoring and maintenance activities for the capsules involve calculating the annual inventory, physically verifying that the inner capsule can still move independently of the outer capsule, and using online radiation monitors to detect pool cell water contamination. The annual inventory provides the exact storage location and accountability for all of the Cs and Sr capsules stored at WESF.

The Cs capsules are "clunk-tested" on a quarterly basis. This involves physically grasping one end of a capsule with a pool tong and rapidly moving the capsule vertically approximately 15 cm (6 in.). This allows the inner capsule to slide within the outer capsule, making a "clunk" sound that is easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged.

B.10.0 HIGH-LEVEL WASTE DISPOSAL AT THE POTENTIAL GEOLOGIC REPOSITORY

B.10.1 WASTE ACCEPTANCE

The Nuclear Waste Policy Act of 1982 established a national policy for disposal of HLW and commercial spent nuclear fuel in a geologic repository and required the President to evaluate the use of commercial repository capacity for the disposal of defense high-level nuclear waste. In February 1985, the Secretary of Energy submitted a memorandum to the President recommending that DOE proceed with plans and actions to dispose of defense waste in a commercial repository. In an April 1985 Presidential Memorandum, the President approved proceeding on the basis of the recommendation. Subsequently, in September 1988, DOE issued DOE Order 5820.2A, which stated requirements to process and dispose of DOE's new and readily retrievable HLW in a potential geologic repository and to consider options such as in-place stabilization or retrieval, processing and disposal in a potential geologic repository for permanent disposal of a singly contained tank waste.

The Nuclear Waste Policy Act Amendments of 1987 ordered termination of activities for all potential geologic repository candidate sites other than Yucca Mountain site and required that the Secretary of Energy report to the President and Congress between January 1, 2007 and January 1, 2010 on the need for a second repository. The Nuclear Waste Policy Act prohibits emplacement in the first repository of a quantity of spent fuel containing in excess of 70,000 mt (77,000 tons) of heavy metal of a quantity of solidified high-level radioactive waste resulting from the reprocessing of spent nuclear fuel until such a time as a second repository is in operation. It is recognized that current projections for spent nuclear fuel and HLW exceed the 70,000-mt (77,000-ton) limit for the first repository; however, this issue will not be resolved prior to addressing the need for a second repository. The EIS is based on the assumption that the potential geologic repository or a second repository could accommodate all of the HLW produced by any of the alternatives. Therefore, the current planning basis for disposal of DOE's new or readily retrievable HLW is for disposal at a geologic repository, which may be Yucca Mountain should that site be shown to be acceptable and approved as a potential geologic repository.

In support of the potential first geologic repository, DOE has issued a Waste Acceptance Systems Requirements Document (DOE 1994g) describing functions and technical requirements for a system that would accept HLW and spent nuclear fuel into the Civilian Radioactive Waste Management System. The Waste Acceptance Systems Requirements Document sets forth the criteria established for waste forms reviewed and judged acceptable for disposal. All radioactive waste (both spent nuclear fuel and HLW) that would be accepted into the Civilian Radioactive Waste Management System would be required to meet either existing waste acceptance criteria or waste acceptance criteria developed for a specific waste form. The current waste form acceptance criteria include the following requirements:

- Radioactive waste shall be in solid form;
- Particulate waste forms shall be consolidated (e.g., by incorporating the waste into an encapsulating matrix) to limit the availability and generation of particulates;
- Combustible radioactive waste shall be reduced to noncombustible form unless it can be demonstrated that a fire involving the waste packages containing combustibles will not adversely affect other waste packages, any structures, systems, and components important to safety, or the repository's ability for waste isolation.

The three criteria previously listed are in response to requirements of 10 CFR 60.135(c).

- The waste form shall not contribute to free liquid in the waste packages to an amount that could compromise the ability of the waste package to achieve the performance objectives related to containment of the waste form or result in spillage and spread of contamination in the event of waste package perforation during the period through permanent closure. This criterion is in response to the requirements of 10 CFR 60.135(b) (2).

- The waste form shall not contain explosive, pyrophoric, or chemically reactive materials in an amount that could compromise the repository's ability for waste isolation or the repository's ability to satisfy the performance objective. This criterion is in response to the requirements of 10 CFR 60.135(b)(1).
- The waste shall not exceed the repository limit for defense waste in terms of metric tons of equivalent heavy metal (DOE 1995q).

Establishing acceptance criteria for other HLW products (waste form plus the packaging system) would involve identification of the candidate waste product. The candidate waste form product would then be judged for acceptability. If the candidate waste form product is judged to be an acceptable candidate for repository disposal, waste acceptance criteria would be established. All HLW waste sent to the repository would meet a set of waste acceptance requirements defined for that product.

At present, the Waste Acceptance Systems Requirement Document (DOE 1995q) assumes that the standard HLW form to be accepted will be vitrified borosilicate glass. The borosilicate glass is to be sealed inside an austenitic stainless-steel canister. The assumption of the standard form is intended to provide guidance to proceed with waste acceptance activities. It is based on informed technical opinion, preliminary study results, and accumulated institutional experience. The standard form assumption is subject to further resolution in subsequent revisions of the Waste Acceptance Systems Requirements Document.

Throughout the TWRS EIS, Yucca Mountain is referred to as the potential geologic repository. Currently, Yucca Mountain is the only site being characterized as a geologic repository for HLW. If selected as the site for development, it would be ready to accept HLW no sooner than 2015. The potential environmental impacts that would occur at the geologic repository from the disposal of HLW from TWRS are not addressed in this EIS. Potential impacts at the repository are being addressed in an EIS that DOE will prepare to analyze the Site-specific environmental impacts from construction, operation, and eventual closure of a potential geologic repository for spent nuclear fuel and HLW at Yucca Mountain. Detailed evaluations to support decisions on the disposal of HLW from the Hanford Site would be made following the completion of the repository EIS. The repository EIS will also assess the impacts of transporting spent nuclear fuel and HLW from various storage locations to the potential geologic repository.

Each of the ex situ alternatives addressed in this EIS include sufficient interim onsite storage facilities to store all of the immobilized HLW produced while awaiting offsite transport and disposal at the potential geologic repository. This would allow each of the alternatives to operate independent of the acceptance schedule for the potential geologic repository. Schedules for shipping HLW to the potential geologic repository were developed for each alternative. The assumed shipment schedule would begin at approximately 2020. This is five years after the scheduled opening of the repository and would allow DOE to ship a backlog of HLW from other sites. To address concerns regarding the scheduled acceptance of the Hanford Site's HLW at the repository, the impacts of interim onsite storage have been assessed for a 50-year period.

The range in number of canisters that would be produced under the different alternatives varies widely based on the amount of separations and does not agree with the current technical planning basis for the geologic repository. The current geologic repository design is based on acceptance of approximately 7,100 standard sized canisters (1,800 HMPCs) of HLW from the Hanford Site. The number of canisters and waste packages that would be produced under the different alternatives is subject to change during waste package design and optimization. Using the larger canisters would reduce the number of waste packages requiring storage, transportation, and disposal at the potential geologic repository.

Subsequent to issuing the current Waste Acceptance Systems Requirements Document (DOE 1995q), DOE determined that the potential first geologic repository will accept only spent nuclear fuel and HLW that does not include components regulated as hazardous waste under RCRA. As most of the Hanford HLW contains hazardous or characteristic components, the HLW would have to be treated and/or delisted to be disposed of in the potential first geologic repository.

B.10.2 HIGH-LEVEL WASTE DISPOSAL COST

Repository fees for alternatives that include shipping HLW to the potential geologic repository are based on analysis performed by the Office of Civilian Radioactive Waste Management in support of the TWRS EIS (Milner 1996a). This analysis was performed using a consistent methodology as used by the Civilian Radioactive Waste Management Program in developing the Analysis of the Total System Life Cycle Cost (TSLCC) of the Civilian Radioactive Waste Management Program of September 1995 (DOE 1995u). Lifecycle cost estimates for four alternative scenarios were provided for disposal of vitrified HLW from the Hanford Site. The four alternatives varied the volume and HLW canister sizes from the 1995 TSLCC estimate basis. The analysis included estimates for two new HLW waste package designs, two new transportation cask designs, and estimates of changes to repository surface facilities, subsurface impacts, transportation, and other program cost elements. The analysis provided scoping level detail scaled from the detailed point estimate reported in the 1995 TSLCC analysis.

Estimates of the total defense share, based on application of the 1987 Federal Register methodology, were provided in the cost estimate report. Allocating the defense share between the Hanford Site and other defense sites was estimated by multiplying the defense share by the ratio of the number of Hanford Site waste packages to the total number of defense waste packages. A waste package consists of up to four canisters of HLW and is equivalent to an HMPC for Hanford Site waste from a numerical standpoint. Repository fees for alternatives that were not addressed in the Office of Civilian and Radioactive Waste Management report were estimated by extrapolating data from the estimate (Jacobs 1996). The estimated disposal fees for placement of HLW in the potential geologic repository are shown in Table B.10.2.1.

Table B.10.2.1 HLW Disposal Fees

The 1995 TSLCC forms the baseline for comparing disposal cost between alternatives and for allocating the defense share for each alternative. The 1995 TSLCC assumed 2,465 waste packages of HLW from the Hanford Site would be disposed of with approximately 2,050 waste packages of HLW from other DOE sites and the West Valley Demonstration Project. These waste packages were assumed to be commingled with waste packages of commercial spent nuclear fuel containing approximately 84,000 mt of U. The 1995 TSLCC assumed disposal in a single repository, with the Yucca Mountain site in Nevada serving as a surrogate to allow estimation of TSLCC. The design concepts assume emplacement of waste packages containing HLW canisters in the spaces between commercial spent nuclear fuel packages in a special arrangement with a high thermal load.

The methodology collects direct cost, allocates certain indirect cost elements based on piece count and areal dispersion factors, and then assigns remaining cost based on factors derived from relative direct and allocated cost. Unassigned cost comprises a significant portion of the total system cost due to high development and evaluation cost compared to construction and operation.

A methodology to specifically evaluate extreme variations from the 1995 TSLCC basis of 2,465 waste packages from the Hanford Site was not developed. For these reasons, there is a higher level of uncertainty in the estimates for the Ex Situ Extensive Separations and Ex Situ No Separations alternatives.

All of the ex situ alternatives except Ex Situ No Separations (vitrification and calcination) were able to maintain 1995 TSLCC design assumptions for the repository thermal loading approach and emplacement of HLW waste packages in the space between hot spent nuclear fuel packages. The Ex Situ No Separations alternative would require an additional area that would have a low thermal loading, dedicated to excess Hanford Site HLW. The number of HLW packages produced by the Ex Situ No Separations alternative exceeds the number of available openings in the high thermal load repository.

Development, evaluation, and other program costs were evaluated and were assumed to be essentially constant for all ex situ alternatives except for Ex Situ No Separations. Significant increases in development, evaluation, and other program costs would occur for Ex Situ No Separations due to additional repository area and licensing and significant extension of waste acceptance and transportation operations.

The estimated repository fees are at a scoping level of detail, scaled from TSLCC data and estimated through use of TSLCC models. The estimates are consistent with the 1995 TSLCC. Results are not based on engineering studies of the specific alternatives and do not represent detailed point estimates. Changes in the repository system baseline will have system impact and will affect cost estimates.

B.11.0 ALTERNATIVES DATA

The following statistical section provides a direct comparison of the various alternatives. The data are grouped in the following categories and arranged so the alternatives can be compared:

- Schedule for each alternative (Table B.11.0.1) ;
- Cost summary for tank waste and capsule alternatives (Tables B.11.0.2 and B.11.0.3);
- Resource summary for tank waste and capsule alternatives (Tables B.11.0.4 and B.11.0.5);
- Radiological emissions summary (Table B.11.0.6);
- Nonradiological emissions summary (Table B.11.0.7) ; and
- Transportation summary for tank waste and capsule alternatives (Tables B.11.0.8 and B.11.0.9).

In addition to the tables, effort-power requirements in effort years are presented in graphs to provide a direct comparison of the alternatives (Figures B.11.0.1, B.11.0.2, and B.11.0.3). The graphs do not extend beyond the years 2040, after which staffing requirements are minimal.

Appendix B References are unavailable electronically.

B.2.0 DEVELOPMENT OF ALTERNATIVES

This section explains the process that was followed to develop alternatives for remediating the tank waste, implementing the alternatives for remediating the tank waste, and remediating the cesium and strontium capsules. This section also discusses the TWRS activities that are not included in the EIS.

B.2.1 TANK WASTE

B.2.1.1 TWRS Elements

Final remediation of TWRS involves three distinct activities: remediating the tank waste; dispositioning the tanks and all associated equipment (a process called closure); and decontaminating and decommissioning any new facilities constructed to remediate the tank waste. These activities are described in the following text.

Remediating Tank Waste

Remediating the tank waste involves those activities associated with remediating the waste in 177 underground tanks and approximately 60 MUSTs. The activities required to remediate this waste is the subject of this EIS. Volume One, Section 3.3. describes the process followed to select alternatives for inclusion in this EIS. The remainder of the EIS provides information relative to the environmental impacts of the alternatives addressed.

Dispositioning the Tanks (Closure)

The final disposition of the tanks and associated equipment and the remediation of contaminated soil and groundwater associated with leaks from the tanks is a process called closure. Closure is not within the scope of this EIS because there is insufficient information concerning the amount of contamination that would need to be remediated. For purposes of comparing the alternatives, a single and consistent method of closure was assumed for all of the alternatives. Closure as a landfill was chosen as the representative closure method for purposes of analysis and is included in all of the alternatives (except the No Action and Long-Term Management alternatives). This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. It is included to allow a meaningful comparison of the in situ and ex situ alternatives and to provide information to the public and the decision makers of the total cost and impacts of final restoration of the Site.

Decontamination and Decommissioning

Decontamination and decommissioning of any new facilities constructed to implement any of the alternatives is not evaluated in detail in this EIS because the decisions on the appropriate method to accomplish decontaminating and decommissioning the facilities would not be required until the treatment and disposal of waste was completed, which is up to 30 years in the future. Insufficient information is available at present to provide meaningful evaluation; however, decontamination and decommissioning of these facilities is foreseeable. Therefore, the costs, personnel requirements, and volume of contaminated and noncontaminated materials resulting from decontamination and decommissioning are included in each alternative to show how tank waste remediation and decontamination and decommissioning are interrelated.

B.2.1.1.1 Development of Alternatives

A wide range of potentially applicable technologies exists for treating tank waste. One of the challenges for DOE and Ecology is to eliminate technologies that are not viable and develop a range of reasonable alternatives for presentation in the TWRS EIS. This section describes how the alternatives were developed.

There is a distinction between technologies and alternatives. Technologies are specific processes (e.g., cesium ion exchange) that relate to a component (e.g., retrieval or treatment) of an alternative. Alternatives include a set of technologies, or building blocks, that have been engineered to work together, forming complete systems for accomplishing the purpose and need for action. Alternatives are made up of a number of technologies linked together.

The first step in developing alternatives was to screen out technologies that were not viable. The full range of available technologies for each component of the proposed action was evaluated, and technologies that were not viable were eliminated from further consideration. The technologies eliminated by this screening process are described in Volume One, Section 3.8 and Volume Two, Appendix C.

After rejecting technologies that were not viable, a large number of potential technologies remained for inclusion in the EIS. It would not be possible to develop alternatives that include all of the potential combinations of technologies. In accordance with NEPA, representative alternatives were developed to bound the full range of reasonable alternatives (10 CFR 1500). Upper, lower, and intermediate bounding alternatives were developed in terms of cost, risk, and technologies for the two primary decisions that affect environmental impacts: the amount of waste to be retrieved from the tanks and the degree of separation of retrieved waste into HLW and LAW. The full range of applicable technologies and alternatives is included in the EIS.

Because representative alternatives were developed to support detailed analysis in the EIS, there are many other viable technologies for individual components of the alternatives that could not be included in the detailed analysis. These technologies are included in Section B.9 and could be substituted for one of the technologies that is included in an alternative without a substantial change in the impacts of that alternative. An evaluation was performed of each of the technologies identified in this appendix. Most of these technologies would have little change on impacts. Where there were changes in impacts, the changes were discussed. The level of analysis was dependent on the magnitude of the change on impacts.

The alternatives developed for presentation in the EIS were chosen to be representative of many of the possible variations of the alternative. The design information for all alternatives is at an early planning stage, and the details of the alternative that ultimately is selected and implemented may change as the design process matures. Therefore, the alternatives are intended to represent an overall plan for remediation at a level of detail sufficient for impact analysis and alternative comparisons.

NEPA requires that an EIS include a No Action alternative, which addresses the alternative of not taking the proposed action (i.e., not initiating the project). For the TWRS project, there is a management program in place to continue the safe management of the tank waste and the capsules; therefore, the No Action alternative addressed in this EIS (continue the current waste management program) consists of the activities currently being conducted to safely manage the waste. Further, under the No Action alternative, no new facilities would be constructed other than those for which decisions already have been made based on other NEPA reviews (e.g., the SIS EIS).

Since the late 1950's, there have been numerous studies analyzing alternatives for tank waste treatment and disposal. The technologies that have contributed to the development of the alternatives presented in the EIS come from different sources. One of the main sources of information is the Tank Waste Technical Options Report (Boomer et al. 1993). The initial set of technologies used in the report was obtained by reviewing literature for processing radioactive, hazardous, and mixed waste. The literature review was supplemented by several DOE-sponsored workshops on treatment technologies for Hanford Site tank waste. Objectives and technologies were also proposed for consideration in the EIS during the public scoping process.

Four general categories of response actions have emerged through the alternative identification process. These categories are 1) continued safe management of the tank waste; 2) waste treatment and disposal in the tanks, referred to as in situ treatment; 3) waste treatment outside of the tanks in a processing facility, referred to as ex situ treatment; and 4) a combination of in situ and ex situ treatments. In situ waste treatment would not involve removing the waste from the tanks. In situ alternatives eliminate the need for any waste retrieval and would result in leaving all of the waste onsite following treatment. Ex situ treatment would require that the waste be removed from the tanks for treatment and disposal. Ex situ alternatives provide the opportunity for separating the waste into HLW and LAW components. The purpose of separating the waste is to minimize the volume of HLW requiring offsite disposal. Combination alternatives provide the opportunity to selectively retrieve waste for ex situ treatment based on waste type to achieve acceptable post-remediation risk levels.

Ex situ alternatives allow for geologic disposal of HLW at a potential geologic repository. Solely for the purpose of analysis, the potential geologic repository at Yucca Mountain, Nevada was assumed to be the final destination because it is currently being characterized to determine its suitability as a repository. It was assumed that the potential geologic repository would be operational and accept HLW generated by the ex situ alternative (see Section B.10.0 for additional details) .

In January 1994, DOE, Ecology, and EPA renegotiated the Tri-Party Agreement, which led to a new proposed technical strategy for remediating the tank waste. This technical strategy provides the basis for the TWRS EIS Ex Situ Intermediate Separations alternative and includes the following activities:

- Retrieve present and future waste from all DSTs and SSTs;
- Separate the waste into high-level and low-activity streams to the extent required to meet onsite disposal requirements for LAW and maintain an acceptable volume of HLW for offsite disposal;
- Vitrify the LAW and dispose of it onsite in a near-surface disposal facility in a retrievable form; and
- Vitrify the HLW and store it onsite at a designated interim storage facility for future disposal at the potential geologic repository.

B.2.1.1.2 Implementation of Alternatives

There are many technical uncertainties associated with all of the alternatives for remediating the tank waste. These uncertainties include the types of waste contained in the tanks and the effectiveness of the retrieval techniques, waste separations, waste immobilization, and cost of implementing the alternatives. These uncertainties exist because some of the technologies that may be implemented are first-of-a-kind technologies, and have not previously been applied to the TWRS tank waste, or have not been applied on a scale as large as would be required for the TWRS tank waste.

Because of these uncertainties, DOE considered different approaches to implementing the alternatives to reduce the financial risk involved if one or more of the technical uncertainties could not be readily resolved. DOE identified two approaches to implementing the alternatives: full-scale implementation and phased implementation. Under full implementation, either DOE or a private contractor would design, construct, and operate full-scale facilities to remediate the tank waste. Under phased implementation, DOE or a private contractor would design, build, and operate demonstration-scale facilities to prove that the remediation concept would function adequately before constructing and operating a full-scale facility. All calculations performed for this EIS are based on DOE implementing the alternatives through the existing Management and Operations Contractor system. This phased implementation approach has the potential to prove that the technologies work before committing large capital expenditures that could not be recovered.

A phased approach could be developed for any of the alternatives but not all phased approaches would involve changes to environmental impacts from the full-scale approach. Therefore, not all phased approaches need to be addressed in the EIS. To decide which of the full-scale alternatives would need to have an associated phased implementation alternative addressed in this EIS, the following two criteria were used.

- Would the full-scale alternative involve large front-end expenditures of funds that could be lost if an unproven technology did not function adequately?
- Would the environmental impacts of the phased implementation approach be different than those of the full-scale alternative?

If either criterion was met, a phased approach would be included in the EIS.

Applying these criteria showed that most alternatives did not warrant a separate analysis of a phased implementation approach. A phased implementation approach to the No Action and Long-Term Management alternatives would not involve changes in environmental impacts, large front-end expenditures, or unproven technologies, so no phased approach was included in the EIS for these alternatives. A phased implementation approach to the In Situ Fill and Cap alternative would involve the simple process of filling several tanks as a demonstration, and therefore would not involve different environmental impacts or large front-end expenditures of funds that could be lost, so no phased approach was included in the EIS. Similarly, a phased approach to the In Situ Vitrification alternative would involve testing the in situ vitrification process first on MUSTS, then small tanks, and then large tanks. Although this technology previously has not been performed on the tank waste, it could be tested gradually without any differences in environmental impacts or large expenditures of funds that could be lost if the process did not function adequately. Therefore, the In Situ Vitrification alternative did not warrant a separate phased implementation alternative, and no phased approach was included in the EIS.

All of the ex situ alternatives involve the application of technologies that have not been applied to the tank waste, and all would involve large front-end expenditures of funds to construct large, complex separations and immobilization facilities. The phased implementation approach for these alternatives would involve constructing and operating demonstration-scale facilities prior to constructing the full-scale facilities, and therefore would result in environmental impacts substantially different than the full-scale implementation alternative. Therefore, a Phased Implementation alternative has been included in the EIS to bound the impacts for the ex situ alternatives.

The Phased Implementation alternative consists of two phases: a proof of concept or demonstration phase (Phase 1) and a full-scale treatment phase (Phase 2). Phase 1 would include the construction and operation of one combined separations and LAW vitrification facility and one combined separations, LAW vitrification, and HLW vitrification facility. Enough waste would be remediated to prove that the many waste types in the tanks could be remediated effectively. Phase 2 would include completing tank waste remediation by constructing and operating new full-scale separations, LAW immobilization, and HLW vitrification facilities. The degree of separations into LAW and HLW was assumed to be similar to the Ex Situ Intermediate Separations alternative and includes additional processes to separate out the Sr, Tc, and TRU elements.

The following tank waste alternatives are addressed in this EIS:

- No Action;
- Long-Term Management;
- In Situ Fill and Cap;
- In Situ Vitrification;
- Ex Situ Intermediate Separations;
- Ex Situ No Separations;
- Ex Situ Extensive Separations;
- Ex Situ/In Situ Combination 1 ;
- Ex Situ/In Situ Combination 2; and
- Phased Implementation (preferred alternative).

The alternatives developed for detailed analysis cover the full range of actions as well as the No Action alternative. The tank waste alternatives range from waste containment with the Long-Term Management alternative to extensive processing (separating HLW from LAW fractions) and immobilization using new technologies with the Ex Situ Extensive Separations alternative. The relationship among the alternatives is shown in Figure B.2.1.1.

Figure B.2.1.1 Relationship Among TWRS EIS Alternatives

B.2.1.2 Cesium and Strontium Capsules

The Cs and Sr capsules are currently classified as waste by-product and this EIS is addressing only measures to remediate the capsules when an if they are determined to have no potential productive uses. The development of alternatives to remediate the Cs and Sr capsules is much less technically complicated than the tank waste. There are two distinct activities related to remediation of the capsules: the disposition of the capsules, which is the subject of this EIS; and decontamination and decommissioning of the current storage location of the capsules in WESF, which is part of B Plant. Decontamination and decommissioning of WESF would be performed with the remainder of B Plant and is not within the scope of this EIS.

The alternatives for remediating the capsules include No Action, disposal on the Hanford Site, or disposal off the Hanford Site either with or separately from the tank waste. None of these involve unproven technologies or the construction of major facilities. The following capsules alternatives are addressed in this EIS:

- No Action;
- Onsite Disposal;
- Overpack and Ship; and
- Vitrify with Tank Waste.

B.3.0 TANK WASTE ALTERNATIVES

The following sections describe each of the tank waste alternatives. Elements common to all tank waste alternatives are described in Section B.3.0. The discussion includes a general description of the alternative followed by a description of the construction activities that would be involved if the alternative would be implemented. The discussion continues with a description of the process/operations and ends with a discussion of key issues associated with implementing the alternative. Engineering data for each alternative may be found in Section B.11.0. Each alternative includes the continuation of routine operations discussed in Section B.1.1.7.

Section B.3.1 - B3.4 are unavailable electronically.

B.3.5 EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE

B.3.5.1 General Description

Ex situ alternatives would require removing the waste from the tanks for treatment and separating the waste into high- and low-level components. The benefit of separating the waste would be to minimize the volume of HLW requiring offsite disposal and reduce the amount of radioactivity for disposal in near-surface vaults onsite. Ex situ alternatives would dispose of HLW at a potential geologic repository, which is assumed to be at Yucca Mountain, Nevada (see Section B.10 for further discussion) .

This alternative involves retrieving as much of the waste as practicable from the tanks and separating it into HLW and LAW streams. Each waste stream would be vitrified into glass. The HLW would be transported offsite to the potential geologic repository and the LAW would be placed in retrievable near-surface disposal vaults at the Hanford Site (WHC 1995j).

It should be noted that the design information for all of the alternatives is at an early planning stage. The details of implementing the selected alternative(s) are likely to change as the planning and design process matures. Therefore, these alternatives are intended to represent an overall plan for remediation rather than a definitive design. Any aspect of the alternative could change as the design process optimizes details of the plan; however, the overall plan for the alternative would not change. This alternative would involve the actions described in the following text.

Retrieval

Slurry pumping would be used to extract DST waste. Hydraulic sluicing would be used to remove SST waste. If hydraulic sluicing does not meet waste retrieval requirements, robotic arm-based retrieval methods would be used. Robotic-arm removal of solid waste saltcake within the tanks would require using a crusher to produce fine particulate material that could be slurried and pumped from the waste tank to the receiving or blending tank(s). Once the waste is removed and converted to a slurry form it would be pumped via pipe line(s) from the tank farms to a pretreatment facility.

In addition, the robotic arm would be used to remove solid waste such as piping and instrument trees from the tank. This type of solid waste would require remote mechanical handling for separate treatment prior to disposal as low-level waste.

Pretreatment

Pretreatment would consist of performing sludge washing, enhanced sludge washing, solid/liquid separation, and ion exchange to separate the waste into HLW and LAW streams. The solids in the waste would be washed to dissolve salts to the extent practical, and the salt solutions would be added to the supernatant for Cs removal. The sludge remaining in the tanks would be transferred to the HLW vitrification facility. The Ex Situ Extensive Separations alternative includes using multiple pretreatment modules designed to minimize the volume of HLW.

Immobilization

The LAW would be pumped into a LAW vitrification facility where it would be concentrated and mixed with glass formers (e.g., borosilicate and silica) and vitrified. Vitrification is a high-temperature process in which the waste is blended with additives and fused into a glass-like form suitable for disposal. The vitrification facility would have pollution abatement controls to ensure that effluents and emissions are within regulatory standards.

The washed sludges mixed with the separated Cs would be routed from a temporary storage facility to a HLW vitrification facility where they would be mixed with glass formers and fused into glass. The HLW glass would be sent to an onsite interim storage facility where it would be stored before shipment to a permanent potential geologic repository. The HLW vitrification facility would include pollution abatement controls to ensure that all effluents and emissions are within regulatory standards.

Disposal

The disposal of radioactive waste is regulated by DOE and the U.S. Nuclear Regulatory Commission (NRC). DOE's guidance for classifying waste is contained in DOE Order 5820.2A, Radioactive Waste Management (DOE 1988). The Order classifies waste into HLW, low-level waste, and TRU waste. Specific guidance includes near-surface disposal of low-level waste and deep geologic disposal of HLW and TRUs. The NRC regulates and licenses the disposal of radioactive materials from non-DOE facilities and the disposal of HLW for DOE facilities through regulations contained in 10 CFR 60. The Nuclear Waste Policy Act provides the statutory framework for NRC regulation of HLW disposal. The NRC guidance on waste classification is contained in 10 CFR Part 61. Currently, DOE disposal of low-level waste is not regulated by the NRC, although NRC rulings regarding waste treatment and waste feed limitations would affect classifying waste that is subject to HLW disposal requirements.

The vitrified LAW glass would be put into large disposal containers and placed into a near-surface retrievable disposal facility on the Hanford Site. Retrievable disposal means that the design of the disposal facility would be for permanent disposal but the waste could be retrieved from the disposal facility within a certain amount of time (assumed to be 50 years) if a different method of disposal was determined to be necessary. A Hanford Barrier would be constructed over the retrievable LAW disposal site to inhibit migration of contaminants and intrusion by humans, plant roots, or burrowing animals. Markers would be used to identify the location of the storage disposal facility. Security and administrative controls would be implemented and maintained indefinitely to protect workers and the public. For the purpose of calculating the potential impacts, it is assumed that the controls will be terminated after 100 years.

The vitrified HLW glass, following canister packaging into HMPCs, would be placed in an aboveground interim storage facility at the Hanford Site. The glass would then be shipped to the potential geologic repository for permanent disposal.

B.3.5.2 Facilities to be Constructed

The alternative includes constructing a tank waste retrieval and transfer facility, a sludge washing (separations) facility, the vitrification and process support facilities, onsite LAW disposal facilities, and temporary HLW storage facilities.

Tank Waste Retrieval and Transfer Facilities

The retrieval and transfer facilities would include bridging structures over the tanks to support the equipment, the off-gas treatment systems, four transfer annex buildings, one waste staging and sampling facility, and the transfer piping system (WHC 1995n). The bridge structures would span the tanks to transfer the equipment loads to foundations outside the perimeter of the tank. The structures, which would be movable or relocatable from tank to tank, would include a vertical, 24-m (80-ft) -high container to house equipment withdrawn from the tank while the entire assembly was relocated to another tank. Operating areas in the structures would be provided with HEPA ventilation equipment to maintain the pressure gradient required between the process, operating, and uncontrolled areas.

After being retrieved from the tanks, the waste would be transferred to the sludge washing tanks. The waste transfer system would include two transfer annexes in the 200 East Area and two transfer annexes and a waste staging and sampling facility in the 200 West Area. The transfer annexes and waste staging and sampling facility are shown in Figures B.3.5.1 and B.3.5.2. The inter farm and cross-site transfer piping would also be part of the system.

Figure B.3.5.1 200 East Area Tank Waste Transfer Facilities

Figure B.3.5.2 200 West Area Tank Waste Transfer Facilities

The transfer annexes would include multi-story facilities that contained tanks to store, blend, and dilute the slurry, equipment to crush oversize solids (saltcake and hardened sludge) , and pumps to transfer the slurry to the processing facility or, in the 200 West Area, to the waste staging and sampling facility.

The buildings would be built of concrete, approximately 25 m (80 ft) on each side, 11 m (35 ft) high, and extend 5 m (16 ft) below grade to allow the earth to serve as shielding. The facility would include the process equipment, a maintenance bridge crane, a decontamination area, an HVAC system with HEPA filters, a control room, and other features necessary for facility operations. The waste staging and sampling facility would pump the waste from the 200 West Area to the replacement cross-site transfer system for transfer to the processing facility in the 200 East Area. This facility would also be built of concrete, but would be larger than the transfer annexes. It would be approximately 73 m (240 ft) long, 23 m (75 ft) wide, 12 m (40 ft) high, and extend approximately 12 m (40 ft) belowgrade. Process equipment would include six agitated slurry tanks and two transfer pumps.

The processing facility would include a maintenance bridge crane with a repair bay, a decontamination bay, an HVAC system with HEPA filters, and an attached structure for emission/effluent monitoring. Except for the initial installation, tank farm piping would be rearranged during operation to accommodate the needs of the operation. Transfer piping between the tank farms and the transfer annexes and between the waste staging and sampling facility would be constructed as part of this alternative.

The replacement cross-site transfer line between the 200 West and 200 East Area lines would consist of two 8-cm (3-in.) -diameter stainless-steel pipes, each encased in a 15-cm (6-in.) -carbon-steel outer pipe to provide secondary containment as required by Federal and State regulations and DOE design criteria (see discussion in Section B.1.1.8). The lines would be sloped (at least 0.25 percent to preclude accumulation of solids) and buried, bermed, or appropriately shielded for radiation and freeze protection. The pipeline would be designed to prevent corrosion from the metal pipes contacting the soil. Both pipelines would be insulated with polyurethane foam and covered with a fiberglass jacket. A diversion box would connect the new transfer line to existing pipelines to facilitate liquid waste transfer between the 200 West and 200 East Areas. A booster pump located in the diversion box would provide the power to transfer waste slurries at the minimum required velocity to prevent the lines from clogging. A vent station would be located at the high point of the transfer system. The function of the vent station would be to introduce air into the lines after a transfer to allow draining the primary containment pipes. Both the diversion box and the vent station would be equipped with stainless-steel liners and would have provisions for washing down radioactive contamination, collecting accumulated liquid, and routing the liquid back to the tank farms. All process piping would have sufficient earth cover to reduce personnel exposure to as low as reasonably achievable, and would not exceed 0.05 millirem per hour (mrem/hr) at grade. The diversion box and cover would attenuate radiation levels to 0.05 mrem/hr at the surface.

Separations Facility

Separations would consist of two major process steps, sludge washing and Cs ion exchange. Other radionuclides would be removed, if required, to conform to the limits for LAW. The Cs ion exchange would be performed in the low-activity vitrification facility. The general arrangements for separations and low-activity vitrification are shown in Figures B.3.5.3 and B.3.5.4; however, the final design decision about washing the tank sludges has not yet been made. It is possible that an alternate method such as washing on crossflow filters may be used. Because in-tank washing represents a bounding condition for sludge washing, it will be described in detail in this appendix. Sludge washing would be done in DSTs that would be modified to accommodate the process. A mixer, decant pumps, and sludge transfer pumps would be added to the tanks through existing risers in the tank dome. New surface tanks would be installed for process chemicals, and surface piping would be rearranged to accomplish the objectives of the washing operation. Surface facilities would include three 20-m^3 (700-ft^3) process tanks, a tank ventilation system with HEPA filters to isolate the tank atmosphere, pump service and decontamination facilities, and an operations building. The ventilation system would allow the tanks to breathe as the waste level varied during transfer and mixing operations. The tank ventilation system, which would use HEPA filters, would be centrally located to serve the sludge washing system.

Figure B.3.5.3 Ex Situ Intermediate Separations Layout

Figure B.3.5.4 Pretreatment/Low-Activity Waste Facility Layout (Sheet 1 of 7)

Figure B.3.5.4 Pretreatment/Low-Activity Waste Facility Layout (Sheet 2 of 7)

Figure B.3.5.4 Pretreatment/Low-Activity Waste Facility Layout (Sheet 3 of 7)

Figure B.3.5.4 Pretreatment/Low-Activity Waste Facility Layout (Sheet 4 of 7)

Figure B.3.5.4 Pretreatment/Low-Activity Waste Facility Layout (Sheet 5 of 7)

Figure B.3.5.4 Pretreatment/Low-Activity Waste Facility Layout (Sheet 6 of 7)

Figure B.3.5.4 Pretreatment/Low-Activity Waste Facility Layout (Sheet 7 of 7)

The pump service and decontamination facilities would be arranged around a central chamber mated to tank nozzles and would contain equipment removed from the tank. The equipment would be flushed with fresh water as it was removed, and the central chamber would finally be filled with lead shot before the entire assembly was transferred to a LAW disposal facility. Each internal tank pump would have a dedicated confinement chamber.

The operations building would be a 590-m^2 (6,400-ft^2) single-story block structure that would house a motor control center and a control room for the washing operation. Change rooms, operations offices, and a lunch room would also be included.

Low-Activity Waste Vitrification Facility

The LAW waste vitrification facility would be sized to produce 200 mt (220 tons) of vitrified waste per day in two production trains. It would contain seven operational areas, including feed receipt and sampling, Cs ion exchange, melter operations, cullet processing, cullet matrix operations, cold chemical makeup, and off-gas treatment areas.

The facility would have an overall footprint of 90 m (290 ft) wide by 75 m (250 ft) long with an overall height of 40 m (130 ft), of which 20 m (65 ft) would be belowgrade. In addition to the process level, which would be belowgrade, the facility would have two other levels, one at grade and the other at +9 m (30 ft). Overall, the facility would have a total area of approximately 6,800 m^2 (73,000 ft^2).

The process level would include feed receipt and sampling, Cs ion exchange, process evaporation, and cullet processing areas. Feed receipt and sampling would occur in six 200-m^3 (7,100-ft^3) tanks that would receive feed from six 400-m^3 (14,300-ft^3) tanks external to the building. The Cs ion exchange area would include a single stage of 12.5-m^3 (440-ft^3) columns and supporting tanks. The cullet processing area would consist of quench tanks below the evaporator and 18 cullet storage tanks.

The facility's other two levels would provide space for support services and additional process equipment. The grade level of the facility would provide space to support canister filling operations, instrumentation for the process equipment, melter operations, process evaporator for LAW melter feed, maintenance areas, and sulfur operations. The

+9-m (30-ft) level would provide electrical services and cold chemical makeup systems.

Low-Activity Waste Cullet Disposal

Under the Ex Situ Intermediate Separations alternative, LAW cullet would be disposed onsite. The cullet would be mixed with a matrix material in the vitrification facility and placed into disposal containers (approximately 2.6 m^3 [92 ft^3]), which would then be transported to onsite disposal vaults. A total of 66 vaults would be constructed. Each vault would be an estimated 37 m (120 ft) long by 15 m (50 ft) deep. The vaults would be engineered concrete structures.

The requirements for using a matrix material and specific matrix material requirements have not been established. The use of a matrix material for the LAW waste form has been included as being representative of waste form matrices for bounding the transportation and resource impacts.

When all of the LAW glass has been placed in final storage, a Hanford Barrier would be constructed over the storage site. Hanford Barrier performance objectives are discussed in Section B.6.0.

High-Level Waste Vitrification Facility

The HLW vitrification facility would have six operational areas that would include feed receipt and sampling, process evaporation, melter operations, maintenance areas, canister loading, cold chemical makeup, and off-gas processing (Figure B.3.5.5). The facility would have an overall height of 45 m (150 ft), of which 13 m (45 ft) would extend belowgrade. In addition to the process level, the facility would have three other levels at -13 m (-45 ft), +13 m (+45 ft), and +20 m (+65 ft). The facility's dimensions would be 55 by 165 m (175 by 545 ft) with an area of 8,800 m^2 (94,700 ft^2).

Figure B.3.5.5 High-Level Waste Vitrification Facility Plant - 0.00 Meters (at Grade) (Sheet 1 of 5)

Figure B.3.5.5 High-Level Waste Vitrification Facility Plant - 20 Meters (Sheet 2 of 5)

Figure B.3.5.5 High-Level Waste Vitrification Facility Plant - Section A (Sheet 3 of 5)

Figure B.3.5.5 High-Level Waste Vitrification Facility Plant - Section B (Sheet 4 of 5)

Figure B.3.5.5 High-Level Waste Vitrification Facility Plant - Section C (Sheet 5 of 5)

The facility's process levels would contain feed receipt and sampling equipment, centrifuges, process evaporation equipment, melter operations equipment, and the maintenance area. The feed tanks would be located in an adjacent structure. Three other areas would provide the remainder of the support facilities. The 13-m (45-ft) level would house the canister loading and handling equipment. The +20-m (+65-ft) level would provide crane maintenance and cold chemical storage makeup.

The final HLW glass form would be a glass canister measuring 0.61 by 4.57 m (2.0 ft by 15 .0 ft). The HLW interim onsite storage facility would allow enough interim storage space for all of the HLW glass produced. After the HLW campaign concluded, the canisters would be transported in the HMPCs (four canisters per HMPC) to the potential geologic repository for final disposal.

Support Facilities

Each of the process facilities would provide its own process support equipment. Common utilities and cold chemical areas would provide headers for service to support the process systems in the plants. These common services would include:

- Medium pressure steam and condensate;
- Instrument and plant compressed air;
- Cooling water;

- Sanitary water;
- Process water;
- Demineralized water;
- Raw water and fire water;
- Sanitary sewer;
- Nonradioactive liquid waste processing;
- Cold chemical bulk storage and makeup;
- Oxygen; and
- Electrical power.

Support facilities that would provide for nonprocess and personnel activities would include the following.

- The Operations Support Building would serve as the administration building for the complex. It would have 19,000 m^2 (21,000 ft^2) of floor space with approximately 40 percent dedicated to offices and the remaining 60 percent dedicated to office support functions (e.g., conference rooms, lunch rooms, utility rooms, equipment areas, storage rooms, and supply rooms).
- The Regulated Entrance Building would be the single point of entry into the facility for maintenance and operation personnel. The building would provide 6,500 m^2 (70,000 ft^2) of space for security operations, health physics, change rooms, lunch rooms, and a first aid clinic.
- The 2,100-m^2 (22,500-ft^2) Operations Control Building would house the central control room for the entire TWRS Treatment Complex as well as space for control support functions.
- The Bulk Cold Chemical Building would be a one-story building approximately 90 by 90 m (300 by 300 ft) providing 8,360 m^2 (90,000 ft^2) of floor area. The building would store anhydrous ammonia, kerosene, nitric acid, LAW form matrix materials, sodium hydroxide, and sulfur. Chemical makeup would also be located in this building.
- The Switch Gear/Generator Building would be a 90- by 90-m (300- by 300-ft), single-story structure. It would house switch gear and be unoccupied.
- The Mechanical Utilities Building would be a single-story, 90- by 90-m (300- by 300-ft) building. It would house plant air compressors, an instrument air system, chillers, a demineralized water system, and a process steam and condensate system.
- Four small pumphouses external to the Mechanical Utilities Building would pressurize fire-water and cooling-water systems.

Other support facilities would include a cooling tower (60 by 90 m [200 by 300 ft]), a fabrication shop (45 by 90 m [150 by 300 ft]), mock-up shops (45 by 90 m [150 by 300 ft]), three warehouses (45 by 90 m [150 by 300 ft]), and a switchyard. The switchyard would include a 120 by 150 m (400 by 500 ft) substation consisting of incoming 230-kilovolt (kV) dead-end towers feeding a double-ended bus with a single tie breaker. The bus would feed redundant transformers rated 230 to 13.8 kV, with a capacity of approximately 100,000 kV-ampheres. The 13.8-kV transformer secondaries would feed a double-ended switchgear, located in a switchgear building that would include utility monitoring and control equipment.

B.3.5.3 Description of the Process

Overview

The overall tank waste treatment process would include 1) retrieving the waste; 2) separating the LAW from the HLW; 3) vitrifying each waste stream separately; 4) disposing of the LAW onsite; 5) temporarily storing the HLW; and 6) transporting the HLW to the potential geologic repository at a future date. Separating the HLW from the LAW would be accomplished with a liquid/solid separation process (many of the HLW constituents are insoluble) and a subsequent ion exchange step to recover Cs (which is partially soluble and has allowable concentration limits in the LAW) from the liquid phase. Other radionuclides would be removed, if required, to conform to the limits for LAW. The HLW and LAW would be vitrified in separate but similar processes. The vitrification process would include feed-preparation systems, the vitrification process itself, off-gas treatment systems, wastewater processing systems, glass-handling systems, and a number of utility and support systems. Figures B.3.5.6 and B.3.5.7 illustrate the process.

Figure B.3.5.6 Ex Situ Intermediate Separations Alternative - Separations and LAW Vitrification Process

Figure B.3.5.7 Ex Situ Intermediate Separations Alternative - HLW Vitrification Process

Sludge washing would be performed with approximately four modified DSTs. Sludge washing may also be done on filters or in centrifuges. The supernatant aqueous phase would be pumped to the LAW vitrification facility where the first operation would be Cs recovery. The sludge from sludge washing would be transferred to the freestanding HLW vitrification facility as would be the Cs recovered in the LAW facility. The vitrified LAW cullet would be placed in containers and transported to vaults for onsite disposal. The HLW would be temporarily stored in casks on a pad near the HLW facility before being shipped to the potential geologic repository for permanent disposal.

Tank Waste Retrieval and Transfer

The Tri-Party Agreement (Ecology et al. 1994) includes a milestone that directly impacts the TWRS program. Milestone M-45-00 requires tank waste residues not exceeding 10.2 m^3 (360 ft^3) in each 100 series tank, and tank residues not exceeding 0.85 m^3 (30 ft^3) in each 200 series tank. Thus, this milestone provides the basis for the 99 percent removal requirement.

Most of the SST waste would be removed by reslurrying the waste with a hydraulic jet. This process, referred to as sluicing, would remove the slurry with a pump to remove all but a 1 percent heel of waste from the tanks. The sluicers would dislodge and erode the sludges and dislodge, dissolve, and/or breakup the saltcake creating a slurry, which would be pumped to a DST where it would be allowed to settle. The supernate would be recycled to the sluicing jets to continue the recovery process. Reusing the saturated supernate would minimize saltcake dissolution and reduce the liquid volume in the process. Controlling the liquid volumes would be important because virtually all of the water added to recover and transfer the waste would need to be removed by evaporation before vitrification.

Currently, there are several technologies available for use in sluicing systems, one of which is presented in Figure B.3.5.8. Considerable experience on tank sluicing on which a design can be based exists, as the SSTs were previously sluiced to recover U sludges from 1952 to 1957 and again to recover Sr sludges from 1962 to 1978.

Figure B.3.5.8 Sluicing Arrangement for Single-Shell Tank Waste Retrieval

In some instances, the sluicing operation may not be able to remove sufficient waste to meet the removal requirement. A recovery system based on a robotic arm would be used as a backup for the SSTs. A robotic arm would provide additional flexibility to position sluicing jets and pumps and extended capability to recover additional waste by using tools and equipment. Arm-based systems would also provide for dismantling and recovering internal tank hardware that would otherwise interfere with sludge retrieval. Figure B.3.5.9 is a conceptual view of the robotic arm. It is estimated that 24 sluicing systems and 12 robotic arm systems would be required. This estimate is based on the proposed retrieval and transfer schedule, the life and reliability of the equipment, and the amount of sludges that will be difficult to retrieve.

Figure B.3.5.9 Robotic Arm-Based Arrangement for Single-Shell Tank Waste Retrieval

Because the solids in the DSTs may not be compacted into the dense material that occurs in the SSTs, the principal technology used for retrieving the DST waste would be mixer pumps. The pumps would be installed in existing DST risers. The pumps rotating hydraulic jets would breakup and mobilize the sludge, and vertical turbine pumps would transfer the slurry. Unlike the SST equipment that would be moved from tank to tank, each DST would be permanently equipped with two to four mixer pumps. A sluicing system would be provided as a backup to the mixer pumps. It is assumed that six of the 28 DSTs (20 percent) would use sluicing to retrieve waste that could not be retrieved with mixer pumps (WHC 1995n).

After retrieval, the waste from the SSTs would be either transferred directly to process facilities or the DSTs for interim storage. The waste transfer annexes would be the primary means for transferring waste, but container transport could be selectively used for small waste volumes and tank heels. Four waste transfer annexes would be constructed, two in the 200 West Area and two in the 200 East Area. In addition, a waste staging and sampling facility would be provided in the 200 West Area.

The waste transfer annexes would be located close to clusters of SST farms to receive waste slurry from the SSTs, condition the slurry, and pump it within the 200 East Area to DST storage or the processing facility. In the 200 West Area, the waste transfer annexes would pump to the staging and sampling facility that in turn would pump the waste to the 200 East Area processing facilities. Slurry conditioning would include dissolving, diluting, and reducing the size of entrained solids.

Waste would be recovered from approximately 60 MUSTs by sluicing and then transported by the LR-56(H) truck or a containerized transfer system to the transfer annexes for discharge to the process. Approximately 120 trips or more with the 3,800-L (1,000-gal) LR-56(H) truck would be required to nearly empty the tank waste volumes tabulated (see Appendix A, Table A.2.3.1) for 28 of the MUSTs.

For purposes of this EIS, it is assumed that an average, or nominal, feed would be the input to the processing plant. The concept of nominal feed is an averaging of the feed during the duration of waste treatment operations. For the ex situ alternatives, the retrieval function would be designed to deliver a nominal feed to the processing plant. The actual feed would vary depending on tank inventories and retrieval sequences. The Facility Configuration Study (Boomer et al. 1994) identified the following five design feed streams that would be addressed in the engineering design of the proposed treatment facility:

- Nominal feed, average feed over plant life;
- Shielding basis feed, highest radionuclide concentration feed used for shielding design;
- Safety/regulatory assessment feed, bounding radionuclide feed used for accident analysis;
- Criticality assessment feed, feed with bounding fissile material content used to define criticality controls; and
- Variability assessment feed and range of feed compositions that might be expected during plant operation.

Sludge Washing

One of the primary purposes of the sludge washing step would be to dissolve constituents that limit the waste loading of the HLW such as aluminum, chromium, and phosphorous. Sodium hydroxide solutions would be used during enhanced sludge washing to solubilize aluminum, chromium, and phosphorous, which have limited solubility in water alone. Approximately 85 percent of the aluminum, 75 percent of the chromium, and 70 percent of the phosphorous would be recovered from the HLW and sent to the LAW vitrification facility. The supernatant solutions from the sludge washing process would be forwarded to the separations facility for Cs recovery.

Feed to the sludge washing process would be a slurry of insoluble sludges suspended in an aqueous solution of soluble waste. The solids would contain most of the HLW and, except for Cs and some complexed waste, the solution would contain limited HLW. The HLW (solids slurry at approximately 50 percent by weight would be separated from the liquids in a counter-current decantation operation that would use existing DSTs. Sludge washing could also be done outside the tanks on filters or in centrifuges. The waste slurry would be allowed to settle (separation by mechanical means may be required) to 50 percent total solids by weight, the supernatant would be transferred to the separations facility, and supernatant from a previous wash would be added to the solids remaining in the tank. After two washes with successively cleaner water the aqueous phase of the slurry would contain fewer soluble salts and the slurry could be transferred to the HLW vitrification facility.

Low-Activity Waste Processing

Cesium Recovery

For purposes of the EIS, it has been assumed that the only soluble radionuclide that would be removed would be Cs. It may become necessary to provide further liquid processing to remove additional radionuclides from the LAW to the extent required to meet onsite disposal requirements. This additional liquid processing could include organic destruction and Sr and Tc removal. The impacts to be expected as a result of additional liquid processing would be a small decrease in the amount of LAW and a small increase in the amount of HLW.

The Cs is soluble in alkaline solutions and in sufficient concentrations is a HLW. A minimum of 85 percent of the Cs would be removed from the feed to the LAW melter by an ion exchange process. Four ion exchange columns preceded by a submicron prefilter would be arranged so that three of the columns would load in series while the fourth column was being regenerated. Nitric acid would be used to elute the Cs and sodium hydroxide, and wash water solutions would be used to regenerate the resin in the fourth column. The fourth column would be returned to service once the first column was loaded. The columns would be sized for continuous operation. The Cs solution would be characterized, concentrated by evaporation, and transferred to the HLW vitrification facility.

The LAW remaining following the separations processes would contain approximately 17 million curies (MCi) of radioactivity including 10 MCi Cs and Ba, 6.8 MCi of Sr and Y, 2.59E-02 MCi of Tc-99, and a total of 1.22E-02 MCi of TRU isotopes.

Feed Conditioning System

The primary functions of the feed conditioning system would be to 1) mix and concentrate the LAW feed; 2) provide for chemical adjustment and sampling; and 3) supply a controlled and monitored feed to the melter. The feed conditioning system would be made up of the following:

- Six 380,000-L (100,000-gal) sample/holding tanks located in an underground vault adjacent to the vitrification building;
- One 36,000-L (9,500-gal) evaporator feed tank, which would also be used to collect the various aqueous plant recycle streams;
- One steam-heated evaporator; and
- Four 36,000-L (9,500-gal) melter feed adjustment tanks.

The feed would be held in the six sample/holding tanks for sampling and analysis before being forwarded to the single evaporator feed tank and evaporator, which would be in continuous operation. The evaporator concentrate would be divided into four streams and continuously forwarded to two pairs (four) of melter feed adjustment tanks. At this point, the evaporator concentrate would be sampled and analyzed before being transferred to two pairs of melter feed tanks. Each pair of melter feed tanks would supply a melter in a staggered cycle so that the melters would receive a continuous feed.

The LAW evaporator feed tank would provide a place for blending various recycle waste streams from the LAW vitrification building, such as melter off-gas quench liquid, cullet fines slurry, and filter wash from the six off-gas HEPA filters. The tank would have an agitator to ensure complete mixing. From this tank the blended stream would be pumped to the evaporator.

The steam-heated LAW evaporator would continuously receive the blended stream containing about 2 weight percent suspended solids and about 18 weight percent dissolved solids. Evaporated water would rise to the overhead condenser through mist-eliminators to minimize the carry-over of contamination. The evaporator overhead would generate condensate that would be sent to the process condensate recycle tanks. The evaporator bottoms would contain about 5 weight percent suspended solids and about 47 weight percent dissolved solids. This bottoms stream would be split in half to serve the two melter trains, and would be continuously pumped to one of the available LAW melter feed adjustment tanks in each of the two trains. The LAW melter feed adjustment tanks and the downstream melter feed tanks would be located in the chemical process cell. The tanks, cooling coils, and piping in the chemical process cell would have a no-maintenance design. The tanks, pumps, and agitators would be located below ports in the cell roof so that they could be removed into shielded flasks for transport to maintenance.

Bulk Flux System

Bulk fluxes include silica, alumina, borate, and calcium oxide. The bulk flux system would include receiving and storage silos with a pneumatic loading system; a conveyor discharge system with batching capabilities; a batch mixer; and pneumatic transfer to a day bin, which would feed the melter. The fluxes would be selected, proportioned, and blended to complement the analysis of the waste feed tank so that the desired vitreous product is produced.

Oxygen Plant

The final design selection of the LAW melter has not yet been made. For purposes of analysis this alternative would include a vortex melter that would be fuel-fired, although ultimately other melter designs could be chosen. The melter would be fired with oxygen to reduce the volume of flue gas and minimize the formation of NO_x. The oxygen would be supplied by a pressure-swing adsorption unit with stored liquid oxygen available as backup.

Vitrification System

The vitrification system would combine the waste and flux in the desired proportions, heat them to the temperature required for vitrification, and evaporate the aqueous phase of the solution in the waste slurry. In the vortex melter this process would happen very rapidly. There would be two parallel vitrification systems, each with a 100-mt/day capacity for glass product. Each vitrification system would include a flux-feed system, waste injection system, burner system, vortex melter, glass separator, and a glass quench system. The flux-feed system would include a pneumatically supplied day bin and a weighfeeder with air locks.

The waste slurry would be fed to the combustion chamber of each melter at a 0.061-m^3/min (16-gal/min) rate. There the semi-volatiles and volatiles would be burned off and the remaining solids and waste oxides would be combined with glass forming oxides. The combustion fuel, kerosene, would be pumped to the combustion melter along with 100 percent gaseous oxygen. The incoming waste slurry from the LAW melter feed tank would be mixed uniformly with the glass forming oxides in a mixing and injection valve mounted on top of the combustion chamber. The glass oxides would be gravity fed from head bins and carefully metered by weigh feeders into the mixing and injection valve. The hot combustion gases and by-products would flow axially through the cyclone, creating a rotating gas flow. The heavier premelted glass solids would be deposited along the refractory wall by the action of the rotating gases (centrifugal force) and form a thin film as they flowed axially through the cyclone. The hot combustion gases and by-products would continue heating the glass while in the cyclone to finish dissolving the waste oxides into the glass matrix. The hot combustion gases would be approximately 50 C (120 F) hotter than the glass melt film, which would be 1,300 C (2,370 F).

The glass separators would function as reservoirs to refine the glass and remove entrained gases. Each glass separator would be close-coupled to a quench flume where the molten glass would be fractured into cullet. The final design decisions concerning the LAW glass form have not yet been made. While this alternative is based on the concept of glass cullet, ultimately, other forms such as canisters or monoliths could be chosen. Also close-coupled to each glass separator would be a quench tower that would cool the melter off-gas and collect the condensables.

Cullet Slurry Handling

The cullet slurry handling system would include a quench flume, wet roll crusher, cullet catch tank, slurry catch tank, washing trommel screen, and a transfer pump to recycle fines and quench water back to the evaporator feed tank. There would be two production trains in the cullet handling system for the LAW plant. Molten glass from the glass separator would be discharged to the quench flume where it would make contact with water and fracture into cullet. The cullet would pass through a wet roll crusher to break up any oversized pieces and drop into the cullet catch tank. Steam from the quenching operation would be condensed and recycled to the quench tank. The cullet slurry would be pumped from the cullet catch tank to a trommel screen where it would be dewatered and washed to remove adhering fines. The fines would be returned to the cullet catch tank with any excess water and recycled to the feed conditioning system.

Dry-Cullet Handling

The product handling system, which would fill the casks, would include a combination dryer/storage bin and a pneumatic transfer system. In the dry-cullet handling system, the cullet would be dried and transported via a pneumatic conveyor to the cullet storage bin, where it would be sampled and held until analyses are complete. Accepted cullet would be pneumatically transferred to the day bin, while rejected material would be recycled to the melter feed tank as off-specification material. The cullet in the day bin would be fed forward to the waste form matrix mixer.

Cullet Transfer to Vaults

This alternative is based on mixing the cullet with matrix material and placing the mixture into disposal containers. The disposal containers would provide a means for handling LAW and retrieving them at a future time if required. The LAW disposal containers would be transported using a specialized transporter and placed into the disposal vaults.

Off-Gas Systems Description

Overview

The main off-gas systems would be the melter off-gas system, vessel off-gas system, condenser vessel off-gas system, bin vent off-gas system, and the pneumatic vessel off-gas system. Each of the tank waste alternatives would make extensive use of recycle streams in the process to recycle back into the treatment process volatile radionuclide and chemical constituents captured in the off-gas systems. These recycle streams would be used to minimize the generation of secondary waste. It has been determined that a bleed stream would be required for each alternative to avoid a continuous buildup of certain volatile radionuclide and chemical constituents (e.g., Tc-99 and mercury [Hg]) in these recycle streams. For comparison purposes, it has been assumed for each alternative that the bleed stream percentage would be 1 percent of the recycle stream and that this secondary waste stream would be stabilized by some low-temperature process.

The melter off-gas system would receive the hot combustion gases from the glass separator. The gases leaving the melter would contain products of combustion, steam, volatilized radionuclides from the feed, and entrained particulates from the rapid water evaporation in the feed slurry. This gas would also contain nitrogen and sulfur dioxide (SO_2) from the decomposition of process feed constituents. The off-gas would be first quenched with scrub water, which would condense the water vapor and remove particulates, and water-soluble contaminants. Excess condensate from the melter off-gas system would be recycled to the HLW evaporator feed tank. The scrubbed melter off-gas would undergo further cooling and successive stages of HEPA filtration to remove radionuclide particulates, after which SO_2 would be adsorbed from the gas and subsequently converted into elemental sulfur by a Claus unit. Finally, the partially treated gas would pass through a catalytic de-NO_x reactor, where NO_x would be converted into nitrogen and water vapor before passing through another HEPA filter and discharging to the atmosphere.

Melter Off-Gas System

The primary functions of the melter off-gas system would be to 1) cool and quench the melter off-gas; 2) remove radionuclides and certain chemical constituents; 3) catalytically destroy SO_2; and 4) recover elemental sulfur to permit the release of these emissions to the atmosphere consistent with regulatory requirements. An additional function would be to provide a differential pressure confinement boundary for the melter.

The gas cooling and quenching portion of the melter off-gas system would consist of two identical parallel trains, each dedicated to a single melter. Each train would consist of a quench tower, a venturi scrubber and separator, and a mist eliminator. Each train would include a dedicated cooler, chiller, scrub solution tank, scrub solution recirculating pump, and scrub solution transfer pump. The radionuclide removal portion of the melter off-gas system would include two operating trains and one standby train of sub-micron particulate filtration and blowers. The emissions abatement portion of the melter off-gas system would consist of a single operating train of catalytic NO_x destruction, SO_2 removal, and sulfur recovery equipment.

Melter off-gas flow from each of the two melters would be quenched from 1,360 to 75 C (2,480 to 170 F) by direct, counter-current contact with 32 C (90 F) water in a refractory-lined quench tower. Entrained particulates would also be scrubbed from the off-gas in the quench tower. The scrub water and condensed moisture from the bottom of the tower would drain by gravity back to the scrub solution tank for re-use. The quenched off-gas would be contacted with scrub water in a venturi scrubber to further remove entrained particulates. The separator would receive the venturi scrubber discharge and separate the off-gas from the scrub water, which would gravity drain to the scrub solution tank.

A chiller would cool the off-gas leaving the separator to 30 C (86 F) before it would enter the mist eliminator. The mist eliminator would use glass fiber candle elements to remove mist and particulates from the off-gas stream. A continuous water spray would help clean condensate and particulates from the candle elements. The rinse from the mist eliminator would gravity drain to the scrub solution tank. The liquid mixture from the scrub solution tank would be cooled to 32 C (90 F) in the cooler and would be recycled back to the quench tower and venturi scrubber. A purge of excess process condensate plus associated solids would be continuously discharged from each scrub solution tank and collected in the scrub filter tank. The solution would then be recycled from the tank back to the evaporator feed tank for treatment. A small bleed stream would be taken from this recycle stream to prevent a buildup of certain volatile radionuclides and chemical constituents. This secondary waste stream would be stabilized by an appropriate low temperature process (such as grout).

The off-gas from each mist eliminator would flow to one of three identical parallel trains of filters. Two of the three trains would be in operation with the third train on standby. Each train would consist of a heater, two back-washable metal HEPA filters in series, and a blower. These metal HEPA filters would be high-efficiency metal fiber filters that would be back-washable for removal of radioactive particulates. The heater and washable metal HEPA filters would be remotely maintainable and located inside a hot cell. The blowers would be located in a contact-maintenance room. The heater would raise the off-gas temperature to prevent any condensation of moisture, which would increase filter pressure drop, reduce filter efficiency, and cause acid gas corrosion in the equipment and piping. The back-washable metal HEPA filter would remove submicron radioactive particulates from the off-gas stream. The blowers would draw the off-gas through the system and provide a pressure confinement boundary for all of the equipment, including the melter relative to the remote cells.

The filtered off-gases discharged from the blowers would be combined and then processed to remove SO_2 and catalytically destroy NO_x. The combined melter off-gas stream would first be blended with pure oxygen and the recycled tailgas from the downstream Claus unit before entering the tube side of the melter off-gas heat exchanger. Oxygen addition would help SO_2 absorption and catalytic NO_x destruction. In the exchange, the melter off-gas would be heated to 400 C (750 F) by exchange with the hot effluent gas from the NO_x catalytic reactor. The melter off-gas would then be sent to one of three copper oxide (CuO) bed absorbers containing CuO-impregnated alumina sorbent. Approximately 90 percent of the SO_2 would be absorbed and converted to copper sulfate in the presence of oxygen in the SO_2 absorber.

With one CuO bed serving as an SO_2 absorber, the remaining two CuO beds would be in the sulfate reduction mode and the SO_2 absorber regeneration mode, respectively. For sulfate reduction, a reducing gas stream containing hydrogen would reduce the copper sulfide and liberate gaseous hydrogen sulfide. The hydrogen would be produced by catalytically cracking ammonia to nitrogen gas and hydrogen. The hydrogen sulfide rich effluent would be sent to the Claus unit, which would recover the sulfur in its elemental form. The tailgas from the Claus unit would be recycled to join the melter off-gas downstream of the blowers. The SO_2 absorber regeneration would prepare the CuO bed for SO_2 absorption service by passing air across the absorber bed to oxidize the copper to CuO. Air leaving absorber regeneration would be sent to the vessel off-gas system for treatment.

From the SO_2 absorber, the melter off-gas would be preheated to 500 C (932 F) in an electric heater before entering the NO_x reactor. The NO_x reactor would contain a catalyst bed for the selective catalytic reduction of NO_x to produce nitrogen and water vapor in the presence of ammonia. The treated off-gas stream would be cooled to 66 C (150 F) or less as it passed first through the shellside of the melter off-gas heat exchanger, and then through the water-cooled melter off-gas discharge cooler prior to release to the process exhaust system.

Process Area Ventilation (Other Off-Gas Systems)

The primary function of the vessel off-gas, condenser vessel off-gas, bin vent off-gas, and pneumatic vessel off-gas systems would be to decontaminate vessel vent gases to meet regulatory requirements for stack release. An additional function of these systems would be to provide a pressure differential on process areas relative to the surrounding cells or vaults to prevent the out-migration of radioactive materials. Each of these systems would consist of a vent collection header, filter preheaters, metal HEPA filters, and blowers. The off-gases from the process vessels would be collected by the vent header and routed to one of two identical parallel trains of filtration. Each train would consist of a heater, two back-washable metal fiber HEPA filter and a blower. Both of these back-washable metal HEPA filters would be high-efficiency metal fiber filters that would be remotely maintainable and would be located inside a hot cell. The blower would be located in a contact maintenance room. The heater would raise the off-gas temperature to prevent the downstream condensation of moisture, which would increase filter pressure drop and reduce filter efficiency. The back-washable metal HEPA filters would remove submicron radioactive particulated from the gas stream. Following filtration, the vent gases would be pressurized by the two 100-percent capacity blowers before being discharged to the HVAC exhaust system.

In the process exhaust system, the melter off-gas would be combined with processed gas streams from other portions of the process and a stream of supply air. The combined flow of supply air and process gas streams would be exhausted through a high-efficiency metal fiber HEPA filter followed by a conventional paper HEPA filter and blower prior to being exhausted to the stack and discharged to the atmosphere. The metal HEPA filter would be remotely maintainable and located inside a hot cell. The conventional HEPA filter and blower would be located in a contact maintenance room.

Process Liquid Waste System

All of the process liquid waste from the LAW vitrification facility would be in the form of process condensate from contaminated process streams. The process condensate recycle tanks and the pH adjustment tank would be located inside an underground vault near the LAW vitrification building.

The process condensate recycle tanks would accumulate the continuously generating condensate, and sequester the contents while awaiting the analytical results of sampling. On-specification liquid would be transferred to the pH adjustment tank, but off-specification liquid would be returned at a controlled rate to the HLW evaporator feed tank for rework. To accommodate the occasional need to recycle off-specification liquid waste, the condensate recycle tanks would be sized so that two of the three tanks would be used to process the normal forward flow of on-specification liquid. The third tank would be used for short-term storage of off-specification waste.

Each process condensate recycle tank would have a 295,000-L (78,800-gal) capacity, and a working capacity of 274,000 L (73,000 gal). About 18 hours would be required to fill a single tank. With the two operating tanks alternately receiving the incoming feed, the time available for sampling, analysis, and pump-out of a tank would also be about 18 hours. Each tank would be agitated to ensure complete mixing. Each tank would have a sampling device and two motor-driven transfer pumps.

From a filled recycle tank, on-specification condensate would be transferred in batches to the pH adjustment tank every 18 hours. The adjustment tank would have the same capacity and type of associated equipment as the recycle tank. In the adjustment tank, a measured volume of sodium hydroxide would be added, based on previous sampling and analyses. The contents of the tank would then be sampled and analyzed prior to being transferred out of the facility. The normal destination for effluent that would meet acceptance criteria would be the Liquid Effluent Retention Facility from which the liquid waste would be transferred to the Effluent Treatment Facility for treatment and final disposal. On nonroutine occasions, off-specification liquid from the pH adjustment tank could be transferred to the tank farms.

Process Steam and Condensate System

The process steam and condensate system would provide 1,000 kilopascals (150 pounds per square inch-gauge) steam for the heating requirements of closed-loop process steam users. To minimize the amount of potentially radioactive material leaving the area, the process steam and condensate building would be located in the vitrification building. The process steam and condensate system would include the process steam generator, process steam condensate condenser and cooler, process condensate pumps, process condensate collection tank, particulate filter and ion exchange unit, and distribution piping for process steam and condensate. The HEPA filters would be provided on the process condensate collection tank vent discharge.

Process Cooling-Water System

The process cooling-water system would be capable of maintaining process tanks at 50 C (122 F) or less, during normal process operations and idle or shutdown periods. The process cooling water system would include heat exchangers, recirculation pumps, distribution piping, an expansion tank with HEPA filters on the tank vent, and a chemical addition tank. To minimize the amount of potentially radioactive material leaving the area, the process cooling water system would be located in the vitrification building.

Melter Cooling-Water System

The melter cooling-water system would remove heat from the melter during normal process operation. It would include heat exchangers, recirculation pumps, distribution piping, an expansion tank with HEPA filters on the tank vent, and a chemical addition tank. To minimize the potential for radioactive contamination outside of the facility, the process cooling water system would be located in the vitrification building.

Process Chilled-Water System

The process chilled-water system would remove heat from process streams, which would be cooled to below 27 C (80 F). This system would include a process water chiller, a process chilled-water expansion tank with HEPA filters on the tank vent, and a process chilled-water pump. To minimize the amount of potentially radioactive material leaving the area, the process chilled-water system would be located in the vitrification building.

Cold Chemical Vent System

The cold chemical vent system would provide vapor control on vents from cold chemical feed and decontamination tanks, drain catch tanks, and other potentially radioactive sources throughout the vitrification building. This system would include HEPA filters, blowers, and piping.

Breathing Air System

The breathing air system would provide breathing quality air for respirators. The source of this air would be breathing air bottles that would be located outside of the vitrification building. The breathing air stations, which would be the distribution system for breathing air, would be located inside the building. The building could also be served by portable breathing air carts.

Health Physics System Vacuum System

The health physics system vacuum system would provide a dedicated central vacuum system to support health physics monitoring and sampling systems. This system would provide constant flow rates for the monitors and samplers at various locations in the vitrification, regulated entrance, and operations control buildings, and the vitrification building annex. Each location would include HEPA filters, blowers, and piping. Buildings external to the process facilities would have their own dedicated health physics system. The health physics system vacuum system provided in buildings external to the process facilities would be located with the other shared facilities.

Potentially Radioactive Liquid Waste Processing System

The potentially radioactive liquid waste processing system would collect and store liquid waste from potentially contaminated areas. This waste would be analyzed for radioactivity. If the waste was determined to be radioactive, it would be transferred to radioactive waste processing for further treatment. If the waste was not radioactive, it would be transferred to nonradioactive waste processing. Facilities within the vitrification building would include drain catch tanks, pumps, transfer pumps, and HEPA filters. An externally located part of the potentially radioactive liquid waste collection system would convey potentially radioactive waste from the regulated entrance building and the repair shops to the main part of the system in the vitrification building.

Cold Chemicals System

The cold chemicals receipt, makeup, and distribution system would include all facilities required to receive, store, prepare, and feed cold chemicals to the process, neutralization, and decontamination facilities. The portion of the system that would be located within the vitrification building would include the cold chemical feed and decontamination tanks, their associated transfer pumps, and distribution piping.

High-Level Waste Processing

The HLW vitrification facility would be a freestanding, single train plant designed to produce 20 mt/day (22 tons/day) of of HLW glass. It would be essentially a small-scale version of the LAW vitrification facility performing similar processing and requiring similar support and utility systems.

Feed Conditioning System

The HLW vitrification facility would receive HLW slurry from the sludge washing operation and Cs solution from the LAW separation facility. After sampling, water would be removed first by centrifuging and then evaporating the centrate. The solids and the slurry from the evaporator would be recombined to feed the HLW melter feed system. As in the LAW vitrification facility, the feed would be sampled and analyzed. Based on the resulting analyses, fluxes would be added to provide the desired vitreous product, a borosilicate glass that would contain 20 percent waste oxides.

Vitrification System

A cold cap melter would be included in the alternative for HLW vitrification as the most thoroughly researched melter in the size required for this production level. The melter would use joule heating, in which current is passed through the molten charge that serves as the resistance element for the furnace. This type of furnace would have a crust over the surface of the melt that would receive the slurry feed, hence the term cold cap. The water in the slurry would be evaporated from the cold cap, and the dried waste would sink as the bottom of the cap entered the melt.

At this stage the HLW vitrification process would deviate from the LAW vitrification process. Instead of producing cullet as in the LAW process, the hot glass would be semi-continuously poured into cylindrical stainless-steel canisters, which would be 0.61 m (2 ft) in diameter and 4.57 m (15 ft) high. The quench flume, trommel, pneumatic transfer equipment, and a number of bins proposed for LAW vitrification would not be required to support HLW vitrification.

Canister Fill Operations

A canister would be moved from storage into position under a filling tube that would be lowered to mate tightly with the canister. The fill tube would contain a passage for molten glass to flow into the canister and a separate passage for air to vent out of the canister. The canister would be filled with molten glass. After canister filling was completed, the filled canister would then be transferred to the canister weld cell where it would be welded shut.

A transfer cart would move the canister into the decontamination cell from the weld cell. The crane would lift the canister from the cart and move it to a decontamination area. Decontamination solution would be sprayed onto the canister followed by a water rinse. After the canister dried, the crane would transport it to the smear test cell, where the canisters would be smear-tested for surface contamination. If the canisters failed the test they would be returned to the decontamination cell. If the canisters passed the test they would be forwarded to the load-out cell. Canisters would enter the load-out tunnel on a transfer cart. The tunnel would have a crane that would remove the canister from the cart and place it into an HMPC overpack container (four canisters per overpack).

Full HMPCs would be removed from the load-out well with the cask staging building crane. The cask lids would then be bolted on. The casks would be smear-tested, inspected, and then transferred to temporary storage pads pending shipment to the potential geologic repository for disposal.

Post Remediation

When processing of the tank waste has been completed, the processing facilities would be decontaminated and decommissioned in the following manner.

- Processing equipment would be decontaminated sufficiently to allow onsite disposal in a low-level waste burial ground.
- Processing facilities would be decontaminated to the extent possible and then entombed in place. The exact materials that would be used to cover processing facilities have not been decided.

B.3.5.4 Implementability

Issues related to implementing this alternative can be grouped into the following categories.

- Some of the technologies involved in this alternative are first-of-a-kind and thus do not have a performance history. In particular, the robotic-arm concept for retrieval and the fuel-fired melter for producing LAW glass have been used as applicable concepts. In neither case is there performance history, particularly with the radioactive waste.
- Processes for retrieving, separating, and immobilizing waste often have been based on engineering judgement and assumptions. Performance of key processes (e.g., sludge washing) has been assumed in the absence of extensive quantitative data. Quantitative performance requirements have not been established for many of the processes and functions. Further process testing to determine equipment sizes is necessary before plant engineering could proceed.
- Cost estimates for this alternative have a high degree of uncertainty because many processes are first-of-a-kind systems.
- Retrieval criteria specifying recovery of 99 percent of the waste volume in each tank may not be achievable. Recovery of less tank waste would have a direct bearing on classifying the waste remaining in the tank.
- While the robotic arm being considered for backup to the sluicing operation has been designed and built, it has not been tested and therefore may not perform as assumed.
- Facility requirements for shielding have not been generated and exposure during retrieval is based on engineering judgement.
- Recovery of DST waste by agitating with turbine pumps has not been demonstrated. If the turbine pumps do not perform as expected, then additional retrieval methods would be necessary.
- The vortec melter, which has been selected as a concept for this alternative, has been demonstrated on generic glass-making feedstock but not tested on the actual feeds that will be used in this process. The off-gases from a fuel fired melter may contain elevated levels of Cs, sodium, or radionuclides. The capture of large amounts of impurities in the scrubbers may result in a large quantity of liquid to be recycled or treated in a separate facility. The magnitude of the recycles stream has not been completely evaluated.
- The proposed LAW waste form is unique and has not been used before.
- The engineering data that served as a basis for this alternative were developed using cullet in a matrix material as a LAW form for onsite disposal.
- A performance assessment has not been completed defining the LAW waste form requirements for retrievable storage and disposal at the Hanford Site, and DOE and NRC have not yet completed negotiations on what constitutes "incidental waste" for disposal of LAW at Hanford. Additional separations steps may therefore be required to meet LAW disposal criteria. The laboratory data now available on enhanced sludge washing are limited. There may be a need to evaluate additional alternate pretreatment methods for certain classes of waste.

The following development or demonstration activities would be necessary if this alternative is selected for implementation:

- Design and test tank retrieval systems;
- Evaluate sludge washing;
- Evaluate the Cs ion exchange;
- Evaluate separable phase organic treatment;

- Test and evaluate the HLW melter;
- Test and evaluate the LAW melter;
- Evaluate melter off-gas treatment systems;
- Balance and determine the flowsheets size of recycle streams to accurately estimate equipment size and costs;
- Conduct performance assessment activities;
- Evaluate alternative approaches to durability testing; and
- Evaluate acceptance strategies for LAW and HLW waste forms.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components are adequately treated during waste processing or vitrification.

B.3.6 EX SITU NO SEPARATIONS ALTERNATIVE

B.3.6.1 General Description of the Alternative

The Ex Situ No Separations alternative is similar to the Ex Situ Intermediate Separations alternative except that there would be no separation of the waste into LAW and HLW; all waste would be handled as HLW. All of the waste would be vitrified or calcined without any pretreatment and placed in interim storage before being shipped to the potential geologic repository for final disposal. Consequently, there would be no LAW to be disposed of onsite.

Under the calcination option of this alternative, the waste would be calcined rather than vitrified. Calcination is the process of heating precipitates or residues to a temperature that is sufficiently elevated to decompose chemical compounds such as hydroxides or nitrates. Calcination differs from vitrification in that calcination temperatures would not necessarily cause the waste to melt and form a glass. Instead, the primary reaction product would be sodium carbonate. All of the waste would be retrieved from the tanks and calcined without any pretreatment. The calcined product (a dry powder) would be placed in large canisters for interim onsite storage before being shipped to the potential geologic repository for final disposal. For this alternative, no LAW would be disposed of onsite.

B.3.6.2 Facilities to be Constructed

Tank Waste Retrieval and Transfer Facilities

The facilities that would be constructed for recovering and transferring tank waste to the calcination or vitrification facility are exactly the same for both alternatives with one exception. There would be no requirement for sludge washing for the No Separations alternative. The waste would be pumped directly from the Transfer Annex or the Waste Staging Facility to the receipt and sampling system at the processing plant (vitrification or calcination facilities).

Vitrification Facility

If vitrification is chosen for this alternative, a vitrification facility would be constructed. The single vitrification facility for the Ex Situ No Separations alternative would be similar to the Ex Situ Intermediate Separations alternative LAW vitrification facility with a few exceptions. The No Separations (Vitrification) facility would not have Cs ion exchange columns or LAW vaults for onsite near surface disposal. In place of the matrix and cullet mixing and containerization system it would have a system for packaging the cullet in canisters and overpacking them into HMPCs, which would be placed on interim storage pads to await offsite transport (Figure B.3.6.1).

Figure B.3.6.1 Ex Situ No Separations Facility Layout

Because all of the waste would be considered high-level, separate HLW and LAW vitrification facilities would not be required. All of the waste would be vitrified in a single facility that would be virtually the same size as the LAW facility in the Ex Situ Intermediate Separations alternative (Section B.3.5). The off-gas treatment facilities would be identical in function to those described for the Ex Situ Intermediate Separations alternative.

Calcination Facility

If calcination is chosen for this alternative, a calcination facility would be constructed instead of a vitrification facility. The calcination facility would have a receiving and sampling system as in the Ex Situ Intermediate Separations facility. The calcination facility would not have a Cs ion exchange circuit, nor would the facility form cullet. Instead, it would have a system for processing the hot calcine and placing it in canisters. The canisters would be overpacked into HMPCs and placed on an interim storage pad and subsequently transported to the potential geologic repository for disposal. All of the waste would be calcined in a single facility. Because no engineering has been done for this alternative, the size of the facility has been estimated using engineering judgement. It is estimated that the calcination facility would be approximately the same size as the LAW facility in the Ex Situ Intermediate Separations alternative.

Support Facilities

All of the support facilities required for the Ex Situ Intermediate Separations alternative (Section B.3.5) would also be required in the same size and the same quantity for the Ex Situ No Separations alternative. As stated previously, there would be no LAW vaults for onsite waste disposal, but an increased area would be required for interim storage of the shipping casks for the HLW produced by the Ex Situ No Separations process.

The support systems for the calcination process would be essentially the same as those for the other ex situ alternatives. These would include:

- Fuel receipt and storage area;
- Process steam and condensate;
- Cooling water supply and return;
- Sugar receipt and storage area;
- Breathing air and other bottled gases;
- Electrical supply;
- HVAC and process ventilation; and
- Health protection facilities.

B.3.6.3 Process Description

The process for the Ex Situ No Separations alternative is similar to the Ex Situ Intermediate Separations alternative except that the waste would not be separated into LAW and HLW, because all waste would be HLW. This HLW would be vitrified or calcined and transported to the potential geologic repository for disposal. Figure B.3.6.2 illustrates the process.

Figure B.3.6.2 Ex Situ No Separations Alternative - Process Flow Diagram

Vitrification Process

In the Ex Situ No Separations alternative, there would be no sludge washing or Cs extraction process. The waste recovered from the tanks would be pumped via the Waste Transfer Annexes or the Waste Staging Facility directly to the receiving area of the vitrification facility. Other than deleting the Cs extraction process, there would be no change to the receiving process. The main process flow would be identical with the Ex Situ Intermediate Separations alternative from the evaporator through the day bin, which feeds the equipment that mixes the molten sulfur with the glass cullet in that process. In the Ex Situ No Separations alternative, the day bin would feed a cullet containerization system. The recycle systems, off-gas systems, liquid waste systems, and utility support systems would also be functionally identical to those of the Ex Situ Intermediate Separations alternative. Each of the tank waste alternatives would make extensive use of recycle streams in the process to recycle volatile radionuclide and chemical constituents captured in the off-gas systems back into the treatment process. These recycle streams would be used to minimize the generation of secondary waste. A bleed stream would be required for the off-gas system for vitrification and calcination to avoid a continuous buildup of certain volatile radionuclide and chemical constituents, namely Tc-99 and Hg, in these recycle streams. For comparison purposes, it has been assumed that the bleed stream percentage would be the same (at 1 percent of the recycle stream) and that this secondary waste stream would be stabilized by some low temperature process (such as grout).

The canister-filling process would be similar to the canister-filling operation in the HLW facility in the Ex Situ Intermediate Separations alternative although with larger equipment. The Ex Situ Intermediate Separations alternative would produce 20 mt/day of HLW glass. The Ex Situ No Separations alternative would produce 200 mt/day of HLW glass. Other differences are that the container would be filled with loose cullet. The container would be a 1.67-m (5.5-ft) diameter by 4.57-m (15 -ft) long canister that would be overpacked in an HMPC, which would be the same type of container used to overpack the HLW canisters described in the Ex Situ Intermediate Separations alternative.

Calcination Process

Calcination is the process of heating precipitates or residues to a temperature that is sufficiently elevated to decompose chemical compounds such as hydroxides or nitrates. It differs from vitrification in that calcination temperatures do not necessarily cause the reacting materials to melt and form a glass. Consequently, the final product of calcination is a solid or semi-solid, if certain products have been partially fused during the calcination process. Calcination techniques for solidifying radioactive waste similar to the TWRS waste have been studied previously, but no recent results are available. Sugar calcination refers to a process in which sugar is mixed with the tank waste prior to calcination. The calcination process would consist of evaporating the remaining feed liquid water content and the sodium nitrate, nitrite and hydroxide salts reacting with sugar and oxygen to form sodium carbonate salt, nitrogen oxide, carbon dioxide, and water vapor. Pure oxygen would be supplied to the calciner for these reactions. The oxygen would also combust the organic materials present in the feed to produce carbon dioxide gas and water vapor. Because sodium carbonate has a sufficiently high melting point, 850 C (1,560 F), it would remain as a solid in the calcining process rather than melting. Without reacting with sugar, sodium nitrate melts at 308 C (586 F) and sodium nitrite melts at 271 C (520 F).

Feed Preparation

Because all of the tank waste would be calcined, the waste feed to this process would be identical to the feed to the HLW vitrification melter in the Ex Situ Intermediate Separations alternative (Section B.3.5). Because the feed components would not be separated, all of the calcined product would be considered HLW. The primary function of the feed preparation system would be to mix measured amounts of sugar with the tank waste prior to calcination. Each batch of tank waste would be analyzed to determine the sugar requirements. A weighed amount of bulk dry sugar would then be added, and the mixture would be agitated until the sugar was dissolved.

Calcination

The prepared feed, after first being screened to separate small amounts of coarse solids and foreign objects, would be pumped to the feed nozzles of a spray calciner. The calciner would be an indirectly fired vessel consisting of a number of 20-cm (8-in.) diameter vertical tubes. The vessel is a box design approximately 9 by 9 m (30 by 30 ft) with an approximate height of 4.6 m (15 ft). This particular configuration would limit the reacting mass within the calciner as the reaction of the sugar could be very rapid and large quantities of sugar and nitrates could react violently. The calcination reactions would take place inside the tubes. The tubes would be heated by combustion of kerosene fuel with oxygen outside the tubes and the resulting hot off-gases exhausted directly to the atmosphere, probably after some indirect heat recovery operation. These gases would consist of only products from the combustion of kerosene with oxygen and should require no treatment as they would contain only very low levels of SO_x and NO_x due to the presence of small amounts of sulfur and nitrogen in the kerosene.

The feed for the calciner would consist of a slurry containing approximately 50 percent by weight solids (dissolved and suspended). Atomizing steam at the rate of approximately one-half of the feed rate (on a mass basis) would be added to ensure proper dispersion of the spray inside the calciner tubes. The atomized waste droplets would lose their water by evaporation and be heated to reaction temperature by the indirectly heated tubes as they fell through the length of the tube. The chemical reactions of the waste with the sugar would take place with the release of NO_x gases and the formation of solids, which would be collected at the bottom of the calciner. The calciner would operate at a temperature between 700 and 800 C (1,300 and 1,470 F).

The evaporated water and injected steam for atomization along with the gaseous products from calcination would be exhausted to a ceramic candle filter where particulates would be removed from the hot gases, and then processed similar to vitrification off-gas treatment. The solids removed from the ceramic filter would be collected with the solids from the calciner for further processing and compaction. The ceramic filter equipment envelope would be approximately 9 m (30 ft) in diameter by 18 m (60 ft) high.

Compaction

The calcined solids would consist of a hot, fine powder with a low bulk density, and would require compaction to increase its bulk density. This fine powder would be hot processed in a roll-type compactor machine to produce small pellets or briquettes of high bulk density. The bulk density of the briquettes would be approximately 90 percent of the theoretical density of the solids. After compaction, the product briquettes would be screened to remove fines, air cooled, and transferred to the HLW cyclone bin for feeding into the canisters. The fines collected from screening the briquettes would be returned to the feed bin for recycle to the compactor machine.

Canister Operations

After the calcined product briquettes were transferred to the HLW cyclone bin, the vitrification process canister filling operation flowsheet would be used. The calcined briquettes would be placed in 1.67-m (5.5 -ft) diameter by 4.57-m (15 -ft) long canisters identical to the canisters used for glass cullet for Ex Situ No Separations alternative. A major difference is the quantity of calcine briquettes to be disposed. The Ex Situ No Separations alternative would produce 92 mt/day (100 tons/day) of HLW calcine briquettes. The number of canisters required for calcine briquettes would be 10,300 , approximately 65 percent less than the 29,100 required for vitrification.

Off-Gas Treatment

Off-gas processing for calcination would be the same as that used for off-gas processing for vitrification. The HLW off-gas system would receive hot gases from the HLW calciner ceramic candle filter. The gases would be cooled and scrubbed with water to remove most of the remaining particulates and water soluble materials, which would be recycled to the process feed tanks. A small bleed stream from this recycle stream would be required to prevent a buildup of certain volatile radionuclides and chemical constituents. This secondary waste stream would be stabilized by some low temperature process (such as grout). The scrubbed off-gas would pass through a mist eliminator to remove fine water droplets and then through metal HEPA filters to remove the majority of the radionuclide particulates. The off-gas would then flow to an SO_2 adsorption process and a catalytic NO_x reactor before being discharged to the atmosphere. The amount of NO_x emissions estimated for the calcination process would be approximately five times larger than estimated for the vitrification process. The difference is caused by the assumption that reaction products of nitrites and nitrates for the calcination process would be NO_x, whereas for the vitrification process the assumption also includes a large quantity of nitrogen as a reaction product.

Post Remediation

When tank waste processing has been completed, the processing facilities would be decontaminated and decommissioned in the following manner.

- Processing equipment will be decontaminated sufficiently to allow onsite disposal in a low-level waste burial ground.
- Processing facilities will be decontaminated to the extent possible and then entombed in place. The exact materials that would be used to cover processing facilities have not been decided.

B.3.6.4 Implementability

Issues associated with implementing this alternative include the following.

- The Ex Situ No Separations (Vitrification) option has the same uncertainties as those listed for the Ex Situ

Intermediate Separations alternative (Section B.3.5.4). In addition, this option would result in a large volume of vitrified HLW (2.91 E+05 m^3 [1.0E+07 ft^3]). The calcination option would also produce a large volume of calcined HLW (1.0E+05 m^3 [3.7 E+06 ft^3]); however it is approximately 65 percent less than the volume of vitrified HLW.

- The calcination step using sugar as a reductant has had limited laboratory testing and the proposed facilities are conceptual. Calcination as a unit operation has been in use for many years on an industrial scale. No design or engineering has been completed for the process or support facilities. Consequently, the processing steps have been based on experience and engineering judgement. It is estimated that the consumption of fuel (kerosene) for calcination would be approximately 10 percent of that required for vitrification. Steam use for calcination would be higher than for vitrification due to the atomization steam required for feeding the calciner. Electrical power for calcination would be approximately 70 percent of that required for vitrification.
- The process design parameters for calcining, such as feed rate, temperature, reagent addition, and mass and energy balances remain conceptual in nature. A substantial part of the flowsheet for calcination and vitrification would be the same; implementation of the calcination and vitrification options is estimated to be of approximately the same size and complexity. As a result of this similarity, the nature of most support services is estimated to be similar for calcination and vitrification. Exceptions to this are that raw water use for the calcination option is estimated to be approximately 10 percent of that for vitrification, and sanitary water use for calcination is estimated to be approximately 70 percent of that for vitrification.
- It is estimated that the calcination and vitrification options would be approximately the same in size and complexity and therefore would have approximately the same costs for capital, monitoring and maintenance, decontamination and decommissioning, and research and development. Differences in cost occur in the operating category due to reduced cost of HLW casks/canisters and HLW disposal fees for calcination relative to vitrification (see Section B.10.0 for further discussion) . The operating costs for calcination are estimated to be approximately 60 percent of that for vitrification, resulting in an estimated overall cost for calcination that is approximately 60 percent of that for vitrification.
- Further laboratory and pilot-plant testing is required for calcining, particularly for analyzing reaction products including the nature of the gas streams and off-gas treatment methods. The calciner and off-gas processing may require different sizes and types of equipment from the ones conceptualized for the EIS.
- Processes for retrieving, pretreating, and immobilizing waste often have been based on engineering judgement and assumptions, performance of processes (e.g., sludge sluicing, robotic arm solids removal, and producing HLW glass with a high waste loading) has been assumed in the absence of extensive quantitative data. Further process testing (vitrification or calcination) to determine equipment size would be necessary before plant engineering could proceed.
- Retrieval criteria that specifies recovering 99 percent of the waste volume in each tank may not be achievable. Recovering less tank waste would have a direct bearing on classifying the waste remaining in the tank.
- Performance requirements for shielding have not been generated. Exposure during retrieval is based on engineering judgement.
- Recovery of DST waste by agitating with turbine pumps has not been demonstrated. If the turbine pumps do not perform as expected, then additional retrieval methods would be necessary.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components would be adequately treated during waste processing and vitrification or calcining. However, the HLW forms (soda-lime glass or calcine) may not meet the current standard waste form (borosilicate glass) specified in the waste acceptance requirements (see Volume One, Section 6.2). The vitrified cullet waste form, with its high surface-area-to-volume ratio may not be acceptable for disposal at the potential geologic repository. These wastes forms might not be acceptable and would require acceptance criteria resolution, which could result in delayed acceptance. The compacted powder calcine also might not meet the waste acceptance requirement for immobilization of particulates.

B.3.7 EX SITU EXTENSIVE SEPARATIONS ALTERNATIVE

B.3.7.1 General Description of the Alternative

The Ex Situ Extensive Separations alternative is similar to the Ex Situ Intermediate Separations alternative but involves performing additional complex chemical separations processes to separate the HLW components from the recovered tank waste. The purpose of the Ex Situ Extensive Separations alternative is to process tank waste to produce a minimum number of vitrified HLW canisters, and reduce the curie loading of LAW to NRC Class A or as low as reasonably achievable, which ever is lower (WHC 1995c). Under the Ex Situ Extensive Separations alternative, the waste would be recovered from the tanks and a complex series of processing steps would be performed during pretreatment to separate HLW from LAW. A series of chemical processing operations would be used to separate HLW elements such as U, Pu, Np, thorium, americium, lanthanide (rare earth metals) series elements, Cs, Sr, and Tc from the waste. Under this alternative, the activities to be performed following pretreatment would be very similar to those included in the Ex Situ Intermediate Separations alternative. The HLW would be vitrified, stored onsite, and disposed of at the potential geologic repository. The LAW would be vitrified and placed in retrievable containers in a near-surface, disposal facility at the Hanford Site. This alternative would create a smaller volume of HLW being sent to the potential geologic repository. The resulting LAW requiring onsite disposal would be approximately the same volume but would have a lower radionuclide concentration than the Ex Situ Intermediate Separations alternative (WHC 1995e).

B.3.7.2 Facilities to be Constructed

The main processing facilities would consist of an integrated pretreatment (chemical processing) and HLW vitrification facility and a detached LAW vitrification facility. The integrated pretreatment-HLW vitrification facility would be operated and maintained remotely, and the detached LAW vitrification facility would be contact operated and maintained (Figure B.3.7.1).

Figure B.3.7.1 Ex Situ Extensive Separations Facility Layout

Integrated Pretreatment - High-Level Waste Vitrification Facility

The integrated facility would have an overall size of 94 by 230 m (310 by 770 ft) and a height of 40 m (130 ft), of which 20 m (65 ft) would extend belowgrade. The facility would be divided into three levels: a processing level, a level at grade, and a level at 12 m (40 ft) abovegrade. It would contain:

- Sludge washing and dissolution;
- Alkaline liquid processing;
- Acidic liquid processing;
- Destruction, recovery, and recycle of bulk chemicals;
- Feed receipt and sampling;
- Chemical makeup; and
- HVAC.

The HLW vitrification portion of the integrated facility would have an overall size of 30 by 140 m (100 by 460 ft) and a height of 28 m (92 ft), of which 11 m (36 ft) would extend belowgrade. The facility would include:

- Melter operations;
- Maintenance areas;
- Canister loading;
- Cold chemical makeup; and
- HVAC.

Detached Low-Activity Waste Vitrification Facility

The LAW vitrification facility would have an overall size of 24 by 75 m (80 by 250 ft) with a height of 21 m (70 ft). The building would be aboveground and would include a process level, a grade level, and a level at +9 m (+30 ft). The facility would be divided into the following areas:

- Feed receipt and sampling;

- Melter operations;
- Cullet processing;
- Cold chemical makeup; and
- HVAC.

B.3.7.3 Process Description

The overall waste treatment process would include recovering and transferring the waste from the tanks, separating the HLW from the LAW, vitrifying the HLW, vitrifying the LAW, shipping the HLW offsite, and disposing of the LAW in onsite vaults in retrievable containers . The separation processes would include sludge washing, caustic and acid leaching, solvent extraction and ion exchange of acidic solutions, ion exchange of alkaline solutions, and recycling water, nitric acid, and sodium hydroxide to reduce HLW volumes. A process flow diagram is provided in Figure B.3.7.2.

Figure B.3.7.2 Ex Situ Extensive Separations Alternative - Process Flow Diagram (Sheet 1 of 2)

Figure B.3.7.2 Ex Situ Extensive Separations Alternative - Process Flow Diagram (Sheet 2 of 2)

Tank Waste Retrieval and Transfer

Recovering waste from SSTs and DSTs would not change from one ex situ process to another. Tank waste retrieval and transfer would be dependent on the content of the tanks, but would not be dependent on the processing of the waste. The recovery and transfer of the tank waste for the Ex Situ Extensive Separations alternative would be the same as that for the Ex Situ Intermediate Separations alternative. A full discussion of tank waste retrieval and transfer can be found in Section B.3.5.

Solids Separation and Dissolution

Liquid/Solid Separation

The Ex Situ Extensive Separations process would use centrifuges for separating liquid and solids in various stages of processing. These separations would occur after tank retrieval, complexing agent destruction, caustic dissolution, acid dissolution, and the chromium removal step. Several stages of liquid and solid separation would be used because supernate entrainment in the solids from the centrifuge would be assumed to make up about 12 percent of the centrifuge feed.

Destruction of Complexing Agents

The liquid resulting from liquid and solid separation would be treated by a wet air oxidation process to destroy organics, including complexing agents and ferrocyanides. The use of an organic destruction process is considered essential to break down the complexing agents that hold metal ions (such as Sr) in solution and prevent their extraction by subsequent processing. The wet air oxidation process has previous commercial application. In this process the liquid would be held at 325 C (620 F) and 14,000 kPa (2,000 psi) for 1 hour. The metals that would be released from their complexes would precipitate as hydroxides upon cooling. Hydroxides of Sr, nickel, calcium, and iron would occur along with coprecipitated TRU elements and lanthanides. Oxygen and hydroxide would react with organic constituents to form carbonates, oxalates, nitrogen, ammonia, and hydrogen.

Caustic Leach

Caustic leach is the first of three dissolution steps that would be used to reduce the amount of insoluble sludge that would ultimately be processed as HLW. Several hours of digestion at approximately 90 C (200 F) in appropriately designed reactors would be used to dissolve the desired elements. The caustic leach would be 4 molar in sodium hydroxide to solubilize aluminum, nickel ferrocyanide, and cancrinite. The liquid from caustic leaching would be added to the liquid from the initial liquid and solid separation, and the combined stream would be sent to the complexing agent destruction process. The solids from caustic leaching would then be sent to the first acid leach.

First Acid Leach

The first acid leach would be in a mixture that is 4.5 molar in nitric acid and approximately 0.3 molar in oxalic acid. This leaching operation would be expected to solubilize about 90 percent of the following substances: Cr^{+3}, Fe^{+3}, $Fe(CN)_6^{-3}$, Mn^{+2}, MnO_2, Ni^{+3}, PO_4^{-3}, Pu^{+4}, SO_4^{-2}, and Zr^{+4}. The solids from the first acid leach would then be sent to the second acid leach, while the liquid from both acid leaches would be combined and sent to solvent extraction of acidic liquid.

Second Acid Leach

The second acid leach would be in a mixture that is 4.5 molar in nitric acid and approximately 1 molar in hydrofluoric acid. This leaching operation would solubilize the remaining solids to the maximum extent possible. Most of the undissolved material from the second acid leach would be recycled to the caustic leaching operation, while a minor fraction of the undissolved solids would be sent to the HLW vitrification operation.

Purification of Acid Soluble Radionuclides

Tributyl Phosphate Extraction of Transuranic Compounds

The active extractant for this solvent extraction process would be the same as used in the PUREX process, which is 30 percent TBP in a hydrocarbon diluent. In the first extraction, U, Pu, and Np would be extracted into the organic phase. The extracted Pu and Np would be selectively stripped into an aqueous phase and sent to the HLW vitrification process. The U would be stripped separately in a third processing step, and recovered for reuse by re-extraction and re-stripping. This U (approximately 1,400 mt [1,500 tons]) would be available for reuse if a market for the U could be found.

N-diisobutylcarbamoylmethylphosphine Oxide Solvent Extraction

The raffinate from the first TBP cycle would be sent to a N-diisobutylcarbamoylmethylphosphine oxide (CMPO) solvent extraction process to remove trivalent lanthanides, americium, and bismuth. The solvent would be 0.2 molar CMPO and 1.4 molar TBP in a hydrocarbon diluent, which has also been proposed for the transuranic extraction (TRUEX) process. Americium and trivalent lanthanides would be stripped from the organic phase into dilute nitric acid. Bismuth would be removed separately in a separate wash step with a sodium carbonate and EDTA solution.

Am and Lanthanide Ion Exchange

This separation would be accomplished by band displacement cation exchange using cation exchange resins loaded in sequence. Concentrate from CMPO stripping would be loaded on the resin in preparation for separation by displacement cation exchange. Elution of the resin would be with diethylenetriaminepentaacetic acid (DTPA) onto a second zinc-loaded resin. Continued elution would occur through a series of columns established discrete bands of metal ions in sequence depending on the formation constants of the metal ion DTPA complexes. The elution effluent would be divided into three portions. The first and third portions would be sent to the LAW process stream. The second portion would be sent to the HLW process stream.

Crown Ether Solvent Extraction

The raffinate from CMPO extraction would contain Cs, Sr, and Tc, and would require further processing to remove these elements. This raffinate would be concentrated by evaporation, and subsequently contacted with a crown ether solvent (0.2 molar in diluent) to remove these elements. They would be stripped in a second contact, and the strip solution would be concentrated by evaporation and then sent to the HLW process stream.

Ammonium Phosphomolybdate Ion Adsorption

The final acidic processing step would use ammonium phosphomolybdate (APM) to remove Cs from the raffinate from the crown ether extraction process. The adsorbent would be 10 percent APM on an alumina substrate. Because Cs cannot readily by eluted from APM, the loaded sorbent would be transferred to the caustic leach step of the sludge dissolution process. The caustic leach would dissolve 90 percent of the sorbent, releasing Cs into the basic leach liquid.

Removal of Radionuclides From Alkaline Liquid

Cesium Ion Exchange

The combined liquid from caustic leach and complexant destruction would be evaporated to 7 molar sodium hydroxide and put through ion exchange columns containing a resorcinol-formaldehyde ion exchange resin that removes Cs from basic solutions. Four ion exchange columns would be used, with three used for extraction, and the fourth undergoing elution with 1 molar formic acid. The eluted Cs would be sent to HLW process stream.

Strontium Removal by Silicotitanate

The basic stream from Cs ion exchange would be sent to a column containing crystalline silicotitanate, where the Sr in solution would be adsorbed irreversibly. The Pu and Cs could also be adsorbed on the silicotitanate. Because elution is not possible, the loaded adsorbent would be transferred to the acid dissolution reactors, where the silicotitanate would be dissolved, releasing Sr into acid solution.

Technetium Ion Exchange

The raffinate from Sr removal would be sent to strong base anion exchange columns where Tc would be removed as the pertechnetate ion (TcO4-). Elution from the ion exchanger would be by 6 molar nitric acid. The eluant would be concentrated by evaporation and sent to HLW treatment. Nitric acid would be recovered from the evaporator overheads and recycled. The raffinate from Tc removal would be sent to the LAW process stream.

High-Level Waste Concentration and Denitration

From the separation steps described previously, the HLW streams would be combined and concentrated by vacuum evaporation to remove nitric acid until the remaining liquid was a 3 molar nitric acid. The dilute overheads from the evaporator would be sent to acid recovery for reuse as a bulk chemical. The 3 molar nitric acid and the raffinate from the Cs ion exchange process would be combined and undergo denitrification by reaction with sucrose. Sufficient sucrose would be supplied to achieve 0.5 molar nitric acid in the liquid after sucrose conversion. This liquid would be fed to a HLW centrifuge process along with undissolved solids from the final acid dissolution step. The NO_x produced would be sent to the acid recovery system for conversion to nitric acid.

Low-Activity Waste Concentration

The LAW streams from the previously described sections would be combined and concentrated by evaporating water to a 7 molar sodium hydroxide solution. The evaporator bottoms product would form the feed to the LAW calcination process, while the evaporator overheads would be used for dilution water or recycled to wash operations in the various separation processes. The LAW remaining following the separations processes would contain approximately 0.32 MCi of radioactivity including: 7.0E-02 MCi of Cs and Ba, 1.10E-02 MCi of Sr and Y, 1.56E-04 MCi of Tc-99, and 1.22E-03 MCi of TRU isotopes.

Recovery and Reuse of Bulk Chemicals

The recovery and reuse of bulk chemicals would take place in four major unit operations. These would be water evaporation and reuse, nitric acid distillation, nitrate destruction, and recovery and recycle of sodium hydroxide. Water from the various process evaporators would ultimately be routed to a wash water tank, where the recycled water would be used to meet the dilution requirements of other parts of the process. Acidic evaporator overheads would be contacted with the NO_x streams from the denitration and calcination steps. Hydrogen peroxide and air would be added to convert the NO_x to nitric acid. The resulting dilute acid would be concentrated to recover the nitric acid, and the water formed would be used as recycle. The caustic slurry produced in the calcination operation would be evaporated to produce a strong sodium hydroxide solution, which would be recycled to meet process requirements. Excess caustic slurry would be disposed of with the LAW.

Removal of Heavy Metals

A chromium-reduction process would be included to reduce chromium $(Cr)^{+6}$, which is mobile in groundwater, to Cr^{+3}, which precipitates as the hydroxide and does not have a high mobility. While this would keep the Cr from entering the groundwater, the process would result in a Cr product that would require disposal as a mixed waste. The process would employ the addition of 1.5 molar ammonium hydroxide as a reductant, which would be expected to reduce 99 percent of the Cr. Nitrogen gas would evolve during the reduction reaction and would be vented to the process stack. Insoluble Cr would be removed after reduction by centrifuging, and the solids would be sent to a separate waste processing step.

Clean Salt Process

This process represents a concept that potentially would reduce the LAW volume. The primary salts produced by the process would be sodium nitrate and aluminum nitrate. There is a concern that Cs-137 would also be extracted by the process and cause Cs-137 to enter the LAW stream. Varying degrees of decontamination could be achieved by increasing the number of recrystallization stages that are used on the waste stream.

B.3.7.4 Description of Immobilization and Off-Gas Treatment

High-Level Waste Melter

The evaporator bottoms from the HLW evaporator would be routed to the melter feed section. After sampling, cooling, and adjusting the slurry, it would be transferred to the melter feed system. This would be a batch system, which would mix the slurry and glass-forming frit. This mixture would then be continuously fed to the HLW melter system. The high temperature of the melter would convert the incoming feed slurry to molten glass containing 20 percent waste oxides. The HLW melter would be joule-heated and operate at a temperature of 1,200 C (2,200 F). Volatilized melter feed components would form a separate off-gas stream that would pass to off-gas processing. Periodically the molten glass would be poured into cylindrical stainless steel canisters. The glass-filled canisters would be plugged and welded shut before being decontaminated to remove surface decontamination. The cooled canisters would be taken to interim onsite storage before final transportation to the potential geologic repository.

High-Level Waste Off-Gas Processing

The HLW off-gas processing for the Ex Situ Extensive Separations alternative is similar to the HLW off-gas processing for the Ex Situ Intermediate Separations alternative. Each of the tank waste alternatives that uses high-temperature processing (vitrification or calcination) would make extensive use of recycle streams to recycle back into the treatment process volatile radionuclide and chemical constituents captured in the off-gas systems. The recycle streams would be used to minimize the generation of secondary waste. For this alternative, it has been determined that a bleed stream would be required for each alternative to avoid a continuous buildup of certain volatile radionuclide and chemical constituents, namely Tc-99 and Hg, in these recycle streams. For comparison purposes, it has been assumed for this alternative that the bleed stream percentage would be the same one percent of the recycle stream and that this secondary waste stream would be stabilized by some low temperature process (such as grout). The HLW off-gas system would receive hot gases from the HLW melter. The gases would be first cooled and scrubbed with water to remove most of the particulates and water soluble materials. The quenched off-gas would pass through a mist eliminator to remove fine water droplets and then through HEPA filters to remove the majority of the radionuclide particles. The scrubbed off-gases would flow to an SO_2 adsorption process and a catalytic NO_x reactor before being discharged. The SO_2 would be removed by adsorption on CuO beds prior to NO_x destruction. The desorbed sulfur as hydrogen sulfide would be converted into elemental sulfur by a Claus Unit, which would discharge its sulfur product to the LAW vitrification facility for use in LAW cullet disposal.

Low-Activity Waste Melter

Evaporator bottoms from the LAW evaporator would be sampled, cooled, and adjusted before being transferred to the LAW melter feed system. The melter feed and dry-glass formers would be fed into a combustion melter where they would combine and form molten LAW glass. The LAW glass would exit the melter and pass through a quenching and crushing stage resulting in pea-sized fractured glass known as cullet. The final design decision concerning the form of the LAW glass has not yet been made. While this alternative is based on the concept of glass cullet, ultimately other forms such as canisters or monoliths could be chosen. For purposes of calculating impacts for this EIS, it was assumed that the cullet would be analyzed to ensure that it meets product specifications, mixed with a matrix material, placed into large disposal containers, and transported to onsite vaults for disposal. The final waste form matrix for the cullet has not been specified. Various types of waste form matrices available are discussed in Section B.9.3.

Low-Activity Waste Off-Gas Processing

The LAW off-gas processing for the Ex Situ Extensive Separations alternative is similar to the LAW off-gas processing for the Ex Situ Intermediate Separations alternative. The LAW off-gas system would receive hot gases from the LAW melter. The gases would be first cooled and scrubbed with water to remove most of the particulates and water soluble materials. The quenched off-gas would pass through a mist eliminator to remove fine water droplets and then through HEPA filters to remove the majority of the radionuclide particles. The scrubbed off-gases would flow to an SO_2 adsorption process and a catalytic NO_x reactor before being discharged to the atmosphere. The recovered SO_2 would be converted into elemental sulfur by a Claus Unit, which would discharge its sulfur product to the LAW vitrification facility for use in LAW cullet disposal.

Low-Activity Waste Calcination

The bottoms from the LAW and other feed streams would be fed to a modified plasma arc calcination process for destroying nitrate and recovering sodium hydroxide. The main modification would be using ammonia as the combustion fuel. The calciner feed would be heated to 800 C (1,470 F) under atmospheric pressure that would vaporize the contained water and destroy sodium nitrate. The calciner off-gases would be quenched, water scrubbed, reacted to remove NO_x, filtered, and sent to the process stack. The calciner molten salt stream would then be redissolved in a water quench. The quench solution would be expected to contain the majority of the Cs and Tc.

Post Remediation

When processing of the tank waste has been completed, the processing facilities would be decontaminated and decommissioned in the following manner.

- Processing equipment will be decontaminated sufficiently to allow onsite disposal in a low-level waste burial ground.
- Processing facilities will be decontaminated to the extent possible and then entombed in place. The exact materials which will be used to cover processing facilities have not been decided.

B.3.7.5 Implementability

The Ex Situ Extensive Separations alternative has the same uncertainties for retrieving and transferring the waste as those listed for the Ex Situ Intermediate Separations alternative (Section B.3.5.4). In addition, this alternative consists of concepts that are intended to reduce the volume of HLW. Many of these concepts have no testing to affirm their applicability. The key issues relating to this alternative are:

- The performance of key processes has been assumed in the absences of substantive data. Further testing and development would be required to ensure that the processes would function as intended and make the required separations; and
- Quantitative performance requirements have not been established for many of the processes and functions. Further engineering would be dependent on developing a process that will meet the quantitative performance

requirements.

The HLW canister s produced under this alternative would have a higher thermal loading than other alternatives and the assumed method of interim onsite storage, which relies on dry storage with passive cooling, would require further evaluation. This alternative may require using a storage facility with active cooling to remove decay heat generated by the vitrified HLW.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components are adequately treated during waste processing and vitrification.

B.3.8 EX SITU/IN SITU COMBINATION ALTERNATIVE S

B.3.8.1 General Description of the Alternative s

The Ex Situ/In Situ Combination 1 and 2 alternatives were developed to assess the impacts that would result if a combination of two or more of the tank waste alternatives were selected for implementation. Because the tank waste differs greatly in the physical, chemical, and radiological characteristics, it may be appropriate to implement different alternatives for different tanks. There is a wide variety of potential combinations of alternatives that could be developed, and there are many potential criteria that could be used to select a combination of alternatives for implementation. The Ex Situ/In Situ Combination 1 and 2 alternative s described in the following text were developed to bound the impacts that could result from a combination of alternatives, and are intended to represent a wide variety of potential alternatives that could be developed to remediate the tank waste.

The Ex Situ/In Situ Combination alternative s represent a combination of the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives. Under the approach used to represent this alternative, tanks would be evaluated on a tank-by-tank basis to determine the appropriate remediation method based on the contents of the tank. The objective would be to effectively treat the tank waste in a manner that has acceptable risk and less overall cost than the Ex Situ Intermediate Separations alternative. This objective could be achieved by selecting tanks for ex situ treatment based on their contribution to post-remediation risk. Those tanks that are not selected for ex situ treatment would be treated in situ by filling and capping. Waste from tanks selected for ex situ treatment would be retrieved from the tanks and transferred to processing facilities for treatment. Closure activities would consist of filling those tanks selected for ex situ treatment with gravel and constructing a Hanford Barrier over all tank farms as well as the LAW retrievable disposal vaults from ex situ treatment.

Ex Situ/In Situ Combination 1 Alternative

Approximately one-half of the volume of the tank waste would be treated by the ex situ method and one-half would be treated by the in situ method. By selectively retrieving tanks for ex situ treatment, approximately 90 percent of the contaminants that contribute to long-term risks would be disposed of ex situ while retrieving only 50 percent of the waste.

Ex Situ/In Situ Combination 2 Alternative

Approximately 30 percent of the volume of the tank waste would be treated by the ex situ method and 70 percent would be treated by the in situ method. By selectively retrieving tanks for ex situ treatment, approximately 85 percent of the contaminants that contribute to long-term risks would be disposed of ex situ while retrieving only 30 percent of the waste.

B.3.8.2 Selection Process

Ex Situ/In Situ Combination 1 Alternative

There are many potential criteria that could be used to develop a selection process. Additional waste characterization and analysis would be necessary to implement this alternative. The Ex Situ/In Situ Combination 1 alternative presented in the EIS is an alternative that was developed to represent the numerous alternatives that could be chosen. For example purposes, this EIS has examined a selection process based on retrieving those tanks containing substances that represent the greatest risk to human health. This example selection process may not be the exact selection criteria that would be chosen, but it illustrates the impacts of the Ex Situ/In Situ Combination 1 alternative.

The objective of the selection process was to examine the published characteristics of the radionuclides in the tanks and select the minimum number of tanks to be retrieved that would result in a risk of contracting cancer to a hypothetical onsite farmer in the future that would be comparable to the ex situ alternatives. Examining the risk calculations results for the Ex Situ Intermediate Separations alternative demonstrated that recovering 90 percent of the mobile constituents from the tanks would meet the established criteria and result in residual risks that fall between those for Ex Situ Intermediate Separations and In Situ Fill and Cap alternatives . The risk calculations showed that the long-term risks were caused by the mobility of four tank waste constituents: U-238, Tc-99, C-14, and I-129. Consequently, the selection process chosen was one in which 90 percent of these mobile constituents would be retrieved, assuming that 99 percent of the contents of any given tank could be retrieved. The selection process for the DSTs and SSTs was based on the same principle. Similarly, risk calculations showed that only a single chemical constituent, the nitrate anion, resulted in a Hazard Index (HI) value of greater than 1.0 for the hypothetical onsite farmer in the future. Because nitrate is present in all the tanks in amounts far exceeding those of the radionuclides (107,00 mt), virtually all of the tanks would have to be retrieved to recover 90 percent of this constituent.

The tank inventory for the SSTs showed the following amounts for the mobile species: U (1,423 mt); Tc-99 (1.64 mt); I-29 (0.24 mt); and C-14 (0.004 mt). The U is present in amounts almost 1,000 times greater than the remaining mobile elements. The selection process started by assuming retrieval of the tank with the greatest published U content, tank TX-113. The next tank selected was the one with the second highest U content, tank BY-104. The selection process was repeated until the cumulative U recovery was 90 percent, and was then repeated for the remaining three mobile elements until their cumulative recovery reached 90 percent. The results of this procedure, as displayed in Figure B.3.8.1, show that the cumulative retrieval of the constituents of concern would be 90 percent by the time that 60 SSTs have been retrieved. This procedure would also recover approximately 85 percent of the Cs and 65 percent of the Sr remaining in the SSTs.

Figure B.3.8.1 Ex Situ/In Situ Combination 1 - Single-Shell Tanks

For the DSTs, the procedure was similar, but modified slightly because the published data (WHC 1995d) do not report U in the DSTs. The selection process for the DSTs was to retrieve the tanks based on their Tc-99 content until the cumulative recovery was 90 percent, then retrieve additional tanks as required until the cumulative recovery of C-14 was 90 percent. The results of this modified procedure, as displayed in Figure B.3.8.2, show that the cumulative retrieval of Tc-99 and C-14 would be 90 percent when 10 selected tanks have been retrieved. This process would recover approximately 85 percent of the Cs and Sr in the DSTs. While the selection process was directed towards retrieving mobile groundwater radionuclides, an additional benefit was retrieving 69 percent of the nitrate and waste from 25 of the 50 current Watchlist tanks.

Figure B.3.8.2 Ex Situ/In Situ Combination 1 - Double-Shell Tanks

Ex Situ/In Situ Combination 2 Alternative

The selection process described for Ex Situ/In Situ Combination 1 was modified to provide for the ex situ treatment of the largest contributors to long-term risks (Tc-99, C-14, I-129, and U-238) while limiting the waste to be processed. This modified selection process also included Np-237 in the tank selection process. This modified selection criteria resulted in 25 tanks selected for ex situ treatment instead of 70 tanks, based on the currently available characterization data. The actual number of tanks selected would be based on future characterization of the tanks.

By selecting the appropriate tanks for ex situ treatment, up to 85 percent of the constituents that are the greatest contributors to long-term risk would be disposed of ex situ while retrieving approximately 30 percent of the waste. Under the Ex Situ/In Situ Combination 2 alternative with the retrieval of approximately 25 selected tanks, 85 percent of Tc-99, 80 percent of C-14, 80 percent of I-129, and 50 percent of the U-238 would be retrieved rather than 90 percent as with the Ex Situ/In Situ Combination 1 alternative (Figure B.3.8.3).

Figure B.3.8.3 Ex Situ/In Situ Combination 2 - Single- and Double-Shell Tanks

B.3.8.3 Facilities to be Constructed

Ex Situ/In Situ Combination 1 Alternative

Construction activities required for this alternative would involve constructing all of the facilities identified in the Ex Situ Intermediate Separations alternative and In Situ Fill and Cap alternative, but at a reduced scale. For the ex situ portion, the volume of waste requiring treatment and immobilization would come from 70 tanks instead of 177 tanks. In situ treatment would be required for the remaining tanks.

The following list identifies the major activities that would take place during the construction phase for the ex situ component of the Ex Situ/In Situ Combination 1 alternative:

- Install retrieval and transfer facilities;
- Construct separations facilities;
- Construct a HLW vitrification facility;
- Construct a LAW vitrification facility; and
- Construct a LAW disposal facility (vaults).

For the in situ component of this alternative, the following construction activities would take place:

- Install gravel handling systems; and
- Construct gravel storage sites for stockpiles.

A detailed description of facilities to be constructed for the Ex Situ Intermediate Separations alternative is included in Section B.3.5.2. A description of facilities to be constructed for the In Situ Fill and Cap alternative is included in Section B.3.3.2.

Ex Situ/In Situ Combination 2 Alternative

Construction activities required for this alternative would involve constructing all of the facilities identified in the Ex Situ Intermediate Separations alternative and In Situ Fill and Cap alternative, but at a reduced scale (Figure B.3.8.4). For the ex situ portion, the volume of waste requiring treatment and immobilization would come from 25 tanks instead of 177 tanks. In situ treatment would be required for the remaining tanks.

Figure B.3.8.4 Ex Situ/In Situ Combination 2 Facility Layout

The following list identifies the major activities that would take place during the construction phase for the ex situ component of the Ex Situ/In Situ Combination 2 alternative:

- Install retrieval and transfer facilities;
- Construct separations facilities;
- Construct a HLW vitrification facility;
- Construct a LAW vitrification facility; and
- Construct a LAW disposal facility (vaults).

For the in situ component of this alternative, the following construction activities would take place:

- Install gravel handling systems; and
- Construct gravel storage sites for stockpiles.

A detailed description of facilities to be constructed for the Ex Situ Intermediate Separations alternative is included in Section B.3.5.2. A description of facilities to be constructed for the In Situ Fill and Cap alternative is included in

Section B.3.3.2.

B.3.8.4 Description of the Process

Processing Retrieved Waste

The waste that would be retrieved under either of the combination alternatives would be treated using the process identified for the Ex Situ Intermediate Separations alternative. For further details of the process, see Section B.3.5.

Processing Nonretrieved Waste

Tanks that would not be selected for retrieval under either of the combination alternatives would be treated in situ using the methods identified in the In Situ Fill and Cap alternative. For further details of this alternative, see the In Situ Fill and Cap alternative in Section B.3.3.

Post Remediation

After remediation, tank farm closure and decontamination and decommissioning would take place. Tank farm closure would involve the following activities:

- Retrieved tanks would be stabilized with gravel (in situ tanks would have been stabilized during in situ operations);
- Tank farm structures such as MUSTs, pump pits, valve boxes, and diversion boxes would be stabilized with grout; and
- Hanford Barriers would be constructed over SSTs, DSTs, and LAW retrievable disposal vaults.

Decontaminating and decommissioning equipment and processing facilities would include disposing of noncontaminated material by entombing in place onsite and disposing of contaminated equipment and materials at onsite low-level waste burial grounds.

B.3.8.5 Implementability

Because these alternatives represent a combination of alternatives, the implementability is also a combination of those issues identified in discussing the implementability of both the In Situ Fill and Cap alternative and the Ex Situ Intermediate Separations alternative (Sections B.3.3.4 and B.3.5.4, respectively). However, developing acceptable tank selection criteria is unique to the Ex Situ/In Situ Combination 1 and 2 alternatives and would require more complete and accurate waste characterization than currently exists . There are numerous ways to fully develop these alternatives. The final selection criteria would be based on tank characterization program results, short-term versus long-term risks, and additional development of the Ex Situ Intermediate Separations and In Situ Fill and Cap alternatives.

The in situ portion of these alternatives would not meet the RCRA land disposal requirements for hazardous waste or DOE policy to dispose of readily retrievable HLW in a geologic repository. The ex situ portion of these alternatives would meet all regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components would be adequately treated during processing or vitrification.

B.3.9 PHASED IMPLEMENTATION ALTERNATIVE

B.3.9.1 General Description

The Phased Implementation alternative would provide a mechanism to implement tank waste remediation in a two-step process. The first phase would be a proof-of-concept demonstration phase of the separations and immobilization processes for selected tank waste. The first phase would use demonstration-scale treatment facilities. The second phase would involve scaling up or replacing the demonstration-scale processes to treat the remaining tank waste. The Phased

Implementation approach could be applied to any of the tank waste alternatives involving waste treatment; however, for purposes of analysis the Ex Situ Intermediate Separations alternative with some additional separations was selected as a representative alternative for analysis (Figure B.3.9.1). The description of the Phased Implementation alternative and the estimates for resources and emissions were developed from the Ex Situ Intermediate Separations alternative. This basis included vitrified LAW glass cullet as a LAW form and vitrified borosilcate glass as a HLW form. Other types of glass or waste forms could be selected for HLW or LAW treatment; however, they would have to meet the repository acceptance criteria or performance assessment criteria.

Figure B.3.9.1 Phased Implementation

B.3.9.1.1 Phase 1

Under Phase 1, readily retrievable, well-characterized waste from the DSTs (including SST saltwell liquids transferred to DSTs) would be retrieved and processed in two separate demonstration facilities. One of the facilities would process liquid waste to produce an immobilized LAW, while the other facility would produce an immobilized LAW and vitrified HLW. The facility with both LAW and HLW immobilization could be constructed as separate facilities.

Retrieval

Liquid waste retrieval for LAW treatment would be accomplished by using existing waste transfer systems currently installed in the DSTs. The waste identified for HLW processing would be retrieved from selected tanks containing higher concentrations of HLW constituents. The waste identified for HLW processing would be sludge washed to reduce the volume of vitrified HLW. The washed sludges would be transferred directly to the HLW treatment facility for vitrification. The HLW that would be conditioned and retrieved under currently planned demonstrations for retrieval as sludge washing would be used as feed for HLW processing.

Separations

Separations would consist of performing a solid-liquid separation followed by additional chemical processing steps on the liquid stream to remove HLW and TRU constituents to the extent required to meet specifications for the immobilized LAW.

Immobilization

The LAW would be processed using a technology that would meet LAW acceptance specifications. The acceptance specifications would have specific requirements for size, chemical composition limits, isotopic content, and physical parameters. The immobilized LAW waste would be placed into containers for interim storage as future onsite near-surface disposal. For purposes of analysis in this EIS, vitrification was selected as the immobilization process.

The HLW would be processed into a borosilicate glass form that would meet the established waste form acceptance criteria at the potential geologic repository. The HLW would be placed into canisters and overpacked into HMPCs for handling and transport. The HMPCs would be transported to an onsite interim storage facility pending offsite disposal at the potential geologic repository.

Disposal

There would be no disposal component for Phase 1 of the Phased Implementation alterative. The immobilized LAW and HLW would be packaged and stored onsite in interim storage facilities and disposed of during the implementation of Phase 2.

B.3.9.1.2 Phase 2

Following the successful implementation of Phase 1, Phase 2 would be implemented to complete the tank waste remediation. Under Phase 2, the waste remaining in the tanks and MUSTs would be retrieved and processed in new full-scale facilities. The new full-scale facilities would be two 100 mt/day (110 ton/day) LAW facilities and one 10 mt/day (11 ton/day) HLW facility.

Retrieval

Waste retrieval for Phase 2 would involve constructing and operating a full-scale retrieval system that would be capable of retrieving as much waste as practicable (assumed to be 99 percent) from all SSTs, DSTs, and MUSTs. The waste retrieval systems and processes used for Phase 2 would be the same as those described for the Ex Situ Intermediate Separations alternative.

Separations

Separations would consist of the same processes described for the Ex Situ Intermediate Separations alternative, followed by additional chemical processing steps on the LAW stream to remove HLW and TRU constituents to the extent required to meet specifications for the immobilized LAW.

Immobilization

The HLW and LAW immobilization processes used during Phase 2 would be the same processes demonstrated during Phase 1.

Disposal

The disposal of immobilized HLW and LAW would be the same for the Ex Situ Intermediate Separations alternative. The immobilized LAW would be placed into disposal containers at the treatment facility and transported to an onsite near-surface retrievable disposal facility.

The vitrified HLW would be placed into canisters, packaged into HMPCs, and placed in an aboveground storage facility. The canisters would then be shipped to the potential geologic repository for permanent disposal.

B.3.9.2 Facilities to be Constructed

B.3.9.2.1 Phase 1

This alternative would involve constructing two independent waste treatment facilities. One facility would produce immobilized LAW and the other facility would produce immobilized LAW and vitrified HLW. Each treatment facility would be constructed with support facilities as required to support each operation, as shown in Figure B.3.9.2.

Figure B.3.9.2 Phased Implementation Facility Layout

Necessary pipelines would be constructed from the designated tanks in the 241-AP Tank Farm to the treatment facilities. Additional pipelines would be constructed between the existing waste transfer system and the HLW processing facility. These pipelines would either be buried or constructed on grade inside a shielded pipe run.

The existing Canister Storage Building would be modified to accommodate interim storage of HLW canisters. This would include modifying the underground vaults and ventilation system to accommodate the physical and thermal leaching associated with interim storage of all HLW produced during Phase 1.

The existing grout vaults would be modified to accommodate interim LAW storage of the containerized LAW during Phase 1 operations. This would include modifications to the existing vaults to allow placement and interim storage of the LAW disposal containers pending future retrieval and disposal during Phase 2.

Separations Facilities

Each of the waste treatment facilities would include an integral separations and immobilization facility. The separations facilities would include the processing equipment to filter solids and remove selected radionuclides from the waste stream.

Low-Activity Waste Immobilization

Both of the waste treatment facilities, which would include LAW immobilization facilities, would be sized to produce the equivalent of 20 mt/day (22 tons/day) of vitrified waste at a sodium oxide loading of 15 weight percent. This basis was used to estimate the required facility size and resource requirements.

The facility that only treated LAW would be smaller than the combined LAW plus HLW facility and would have an overall footprint of 40 by 120 m (130 by 390 ft). The facility that treated LAW and HLW would have an overall footprint of 60 by 120 m (200 by 390 ft).

High-Level Waste Immobilization

The HLW immobilization facility would be sized to produce the equivalent of 1 mt/day of vitrified waste at a waste oxide loading of 20 weight percent.

Support Facilities

Each of the processing facilities would require its own support facilities. These facilities would include:

- Cold chemical storage, supply, and makeup;
- Substation and electrical distribution;
- Cooling tower;
- Operations control;
- Regulated entrance building;
- Emergency generator;
- Emergency response center;
- Operations support buildings;
- Process chemical storage; and
- Process water and potable water lines. These would be installed to connect the sites with existing distribution lines in the 200 East Area.

B.3.9.2.2 Phase 2

Construction activities required for Phase 2 would involve constructing all of the facilities identified in the Ex Situ Intermediate Separations alternative, but with reduced scale waste treatment and support facilities (Figure B.3.9.3). Because Phase 1 operations would produce up to 13 percent of the immobilized LAW volume, the size of the treatment facilities required for the Phase 2 would be approximately the same as the ex situ treatment described for the Ex Situ Intermediate Separations alternative. The facilities that would be constructed for Phase 2 operations would include:

- Waste retrieval and transfer facilities as described for Ex Situ Intermediate Separations;
- Two separations and LAW treatment facilities that would be similar to the vitrification facility described for the Ex Situ Intermediate Separations alternative, each with a 100-mt/day (110-ton/day) capacity ;
- A 10-mt/day (11-ton/day) HLW vitrification facility that would be similar to the HLW vitrification facility described for the Ex Situ Intermediate Separations alternative;
- Support facilities that would provide utilities, resources, and personnel support to the Phase 2 treatment facilities;
- A LAW disposal facility that would provide for retrievable disposal of LAW produced throughout Phase 1 and Phase 2 (this facility would be the same as the LAW disposal facility described for the Ex Situ Intermediate Separations alternative);
- A HLW interim storage facility for interim storage of the HMPCs; and
- Hanford Barriers over the LAW retrievable disposal facility and tank farms following waste remediation.

Figure B.3.9.3 Phased Implementation (Total Alternative) Facility Layout

B.3.9.3 Description of the Process

B.3.9.3.1 Phase 1

Overview

The following processes would be included to treat tank waste under Phase 1:

- Retrieve selected waste for LAW treatment;
- Retrieve selected waste for HLW treatment;
- Transfer liquid waste for LAW treatment to a receiver tank;
- Following sludge washing, transfer selected waste for HLW processing directly to the HLW plant;
- Perform separations to remove Cs, Tc, Sr, TRU elements, and sludges from the LAW feed stream;
- Store the separated Cs and Tc produced during separations at the treatment facilities, or package and transport the separated Cs and Tc to onsite interim storage for future waste treatment;
- Return sludges containing Sr and TRU waste separated during LAW treatment to the DSTs for storage;
- Vitrify both the LAW and HLW;
- Place the vitrified HLW into canisters;
- Place the vitrified LAW into containers; and
- Transport the immobilized waste to onsite interim storage facilities.

Each waste treatment facility would be designed, built, and operated separately. It is assumed that the technologies selected for the separations and immobilization processes would produce a waste form that meets DOE specifications. Therefore, the process description for the Phased Implementation alternative has been developed using the Ex Situ Intermediate Separations alternative, with additional separations processing as a basis. This approach provides for analyzing the alternative using representative technologies.

Tank Waste Retrieval and Transfer

The first step in waste processing would be to recover and transfer waste to be treated at LAW facilities from the tanks to the DST feed tanks. The waste feed to the LAW facilities would be retrieved and transferred in batches from selected DSTs into two existing DSTs designated as feed tanks. Each LAW facility would have one designated DST as a feed tank. The waste feed stream for LAW treatment would be primarily DST liquid waste but could include SST saltwell liquids or SST waste recovered during retrieval demonstrations. The waste feed to the HLW plant would be retrieved and transferred separately. The selected waste for HLW treatment would be sludge washed and the washed solids would be routed directly to the HLW processing facility. The waste treated at the HLW facility would be HLW recovered directly from selected tanks and may or may not include the HLW that would be separated at the LAW treatment facilities.

Liquid waste retrieval and transfer would use equipment and systems currently in place in the DST farms. Sludge washing and slurry pumping using techniques identified for the Ex Situ Intermediate Separations alternative would be used to retrieve waste for treatment at the HLW facility.

Separations

For purposes of analysis, the separations processes described for the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives were used.

The specific technologies used for separations and immobilization have not been defined, and therefore are not specifically identified or discussed for this alternative. The separations and immobilization technologies used for waste immobilization would be controlled by waste product specifications, which would control the physical properties, chemistry, radionuclide content , and volume of the immobilized LAW and HLW.

Separations prior to LAW immobilization would be performed to remove the Cs, Tc, Sr, TRU elements, and entrained sludge particles from the waste stream. The separated Cs and Tc radionuclides would either be stored at the treatment facilities or packaged in canisters for onsite dry storage, the treated sludges along with the Sr and TRU elements would be returned to the DSTs for storage, and the treated liquid waste stream would then be immobilized.

Immobilization

The LAW waste stream would be immobilized using a technology to treat the waste that would yield a stabilized waste product similar to vitrified glass with regard to waste performance characteristics. Vitrification was assumed for purposes of evaluation. The immobilized LAW would be placed into canisters approximately 1.8 m long by 1.2 m wide by 1.2 m high (6 ft long by 4 ft wide by 4 ft high).

The immobilized LAW would be sealed in steel containers at the Phase 1 treatment facilities for interim storage and eventual onsite disposal. The sealed LAW containers would be transported to the four existing grout vaults nearby for temporary storage until the Phase 2 LAW onsite disposal vaults are ready to receive the containerized LAW material. The Phase 1 immobilized LAW would be transported to this new disposal vault site to be entombed with the Phase 2 LAW waste.

The DST waste would be retrieved and transferred to the receiver tanks or in the case of the HLW, directly to the HLW processing facility. Waste from the receiver tanks would be transferred to the treatment facilities on an as-needed basis. The HLW would be vitrified into borosilicate glass. The HLW plant would be designed to produce the equivalent of 1 mt/day of HLW glass at a 20 weight percent waste oxide loading. The vitrified HLW would be placed directly into canisters. The HLW canisters (0.61 m [2 ft] in diameter by 4.57 m [15 ft] long) would be placed in transportation casks and transported to the Canister Storage Building for interim storage. The canisters would be removed from the transportation casks and placed into storage tubes at one of the Canister Storage Building vaults.

Each of the waste treatment facilities would operate off-gas treatment systems that would include control technologies for priority pollutants and radionuclides. The treatment of the off-gas would be similar to the processes and equipment as described for the Ex Situ Intermediate Separations alternative.

B.3.9.3.2 Phase 2

Overview

The tank waste treatment process for Phase 2 would include 1) retrieving the waste from tanks; 2) separating the LAW from the HLW; 3) immobilizing the LAW stream; 4) vitrifying the HLW stream; 5) disposing of the LAW onsite; 6) temporarily storing the HLW; and 7) transporting the HLW to the potential geologic repository at a future date. The processes used for waste treatment during Phase 2 would be the same processes demonstrated during Phase 1 operations.

Tank Waste Retrieval and Transfer

The process used for waste retrieval and transfer during Phase 2 would be the same as the process described for retrieval under the Ex Situ Intermediate Separations alternative. Waste retrieval during Phase 1 mainly would consist of removing liquid waste from DSTs. These DSTs would require additional waste retrieval during Phase 2 to remove sludges and meet requirements for waste residuals.

Separations

Separations processes used during Phase 2 would be the same processes that were developed and demonstrated during Phase 1. The LAW remaining following the separations process would contain approximately 17 MCi of radioactivity, including 10 MCi of Cs and Ba, 6.8 MCi of Sr and Y, 2.59E-02 MCi of Tc-99, and a total of 1.22E-02 MCi of TRU isotopes.

Immobilization

Immobilization of the HLW and LAW streams during Phase 2 would use the same processes that were developed and demonstrated during Phase 1. The HLW treatment during Phase 2 would also include vitrifying the Cs and Tc waste that was separated to produce the LAW during Phase 1 operations. The operation of the Phase 1 treatment processes would allow for optimizing the processes used during waste treatment at the new Phase 2 facilities.

Post Remediation

The post-remediation process for this alternative would be the same as that described for the Ex Situ Intermediate Separations alternative. When tank waste processing has been completed, the processing facilities would be decontaminated and decommissioned in the following manner:

- Processing equipment would be decontaminated sufficiently to allow onsite disposal in a low-level waste burial ground.
- Processing facilities would be decontaminated to the extent possible and then entombed in place. The exact materials that would be used to cover processing facilities have not been defined.

B.3.9.4 Implementability

Because the Phased Implementation alternative is only a demonstration-scale facility, many of the implementability issues surrounding the ex situ alternatives are reduced in complexity. Issues relating to implementing this alternative can be grouped into the following categories:

- Capability to produce immobilized waste within the waste form specifications developed; and
- Successful operation of the Phased Implementation alternative (Phase 1) is critical to the follow-on implementation of Phase 2 (the completion of retrieval treatment and disposal activities).

Phase 1 shares some of the same implementability issues as the Ex Situ Intermediate Separations alternative and the Ex Situ Extensive Separations alternative because several of the separations and treatment processes that would be used during Phase 1 were assumed to be similar to the processes described for those alternatives. Performance of key processes has been assumed in the absence of substantive data. Cost estimates have a high degree of uncertainty because some of the processes are unproven.

The phased implementation approach provides the opportunity for significantly improving the process design and facility configuration for Phase 2. Lessons learned and processing experience gained during Phase 1 would be applied to the construction and operation of Phase 2 facilities. This approach would allow for increased operating efficiency during Phase 2.

During Phase 2, the waste would be retrieved from the tanks using the same processes as the other ex situ alternatives, and thus Phase 2 shares the same implementability issues regarding retrieval as the other ex situ alternatives.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components are adequately treated during waste processing or vitrification.

B.4.0 CAPSULES

The following sections describe each of the capsule alternatives. The capsules are currently defined as waste by-product, which means they are available for productive uses if uses can be found. If and when the capsules are determined to have no potential productive uses, it is assumed they would be subject to management and disposal as HLW under TWRS. The discussion includes a general description of the alternative followed by a description of the construction activities that would be included if the alternative were implemented. The discussion continues with a description of the process/operation and ends with a discussion of key issues associated with implementing the alternative. Engineering data for each alternative can be found in Section B.11.0.

B.4.1 NO ACTION ALTERNATIVE (CAPSULES)

B.4.1.1 General Description

The No Action alternative for the capsules would consist of continued safe management. Currently, the capsules are stored in water basins in WESF. Additional capsules are being returned to the Hanford Site and would be stored in the water basins. The capsules and basins would be maintained and administrative controls would prevent inadvertent human intrusion. WESF is scheduled to be decontaminated and decommissioned within the next 10 years, and administrative controls would be assumed to be effective until an alternative waste storage facility could be constructed. If this alternative is selected, within the next 10 years DOE and Ecology would need to decide on a strategy for continued storage elsewhere or select a disposal alternative for the capsule contents. This will be considered in the Cs and Sr capsule management plan.

Monitoring and maintenance activities for the capsules involve calculating the annual inventory, physically verifying that the inner capsule can still move independently of the outer capsule (Cs capsules only), and using online radiation monitors to detect pool cell water contamination. The annual inventory provides the exact storage location and accountability for all of the Cs and Sr capsules stored at WESF.

The Cs capsules are clunk tested on a quarterly basis. This involves physically grasping one end of a capsule with a pool tong and rapidly moving the capsule vertically approximately 15 cm (6 in.). This allows the inner capsule to slide within the outer capsule, making a clunk sound that is easily heard and felt by the operator performing the test. This test verifies that the capsule has not bulged. A capsule that failed the clunk test would be removed from the storage basins and placed into a hot cell for additional evaluation.

Leak detection in the storage basin would be performed by online beta monitors that would be set to alarm when the activity present in the pool water exceeded a set level.

Maintenance of the storage facility includes maintaining the electrical and mechanical systems required to safely operate the facility. This would include life extension or replacement for failed or aging equipment.

This alternative would meet all applicable regulations (Volume One, Section 6.2).

B.4.2 ONSITE DISPOSAL ALTERNATIVE

B.4.2.1 General Description

This alternative would consist of packaging the capsules into sealed canisters and placing them in a newly constructed subsurface disposal facility in the 200 Area. This alternative would be similar to the in-place stabilization and disposal alternative addressed in the Hanford Defense Waste EIS for Cs and Sr capsules (DOE 1987).

The Cs and Sr capsules would remain in storage in a series of water-filled storage pools at WESF until the modified capsule packaging facility was completed. They would be retrieved from the storage pools and inspected for surface contamination, corrosion, structural defects, and heat content before placing them in a capsule vault. The capsules would be stored in the vault until they would be transferred to the canister-packaging facility, also a part of WESF.

At the WESF canister-packaging facility, the capsules would be placed in a seal-welded canister, which would be placed in drywells for onsite disposal. Two to four capsules would be placed in a canister depending on heat load. The sealed canister package would be leak tested, ultrasonically scanned, checked for surface contamination, and decontaminated before being transported to the subsurface disposal facility. A shielded transporter would place the canister in the drywell.

For this alternative, it was assumed that the capsules would remain in dry-storage with administrative controls in effect (WHC 1995h). For the purpose of calculating the potential impacts, it is assumed that the controls would be terminated after 100 years.

B.4.2.2 Facilities to be Constructed

The capsule packaging operation would be performed in the existing WESF Building located in the 200 East Area, next to B Plant. Figure B.4.2.1 provides a plant layout diagram of WESF. The approximate dimension of the WESF Building is 90 by 120 m (300 by 400 ft).

Figure B.4.2.1 Waste Encapsulation and Storage Facility

Modifying existing hot cells and/or constructing new hot cells would provide the capabilities required for the capsule-packaging operation. There are currently eight hot cells: A, A Cell Hood, B, C, D, E, F, and G. Each cell has a viewing window and ports for two manipulators, except for G Cell, which has two viewing windows (each window has two ports for manipulators). Three additional hot cells would be constructed for the capsule-packaging facility for inspection, weld stations, weld integrity tests, contamination checking, and decontamination. In addition, facilities would be modified and/or constructed for capsule disposal vaults, canister storage and testing, and canister packaging operations.

A drywell disposal facility would also be constructed. The ground surface of the storage area would be graded flat and nearly level with only enough slope to provide for surface drainage. A total of 672 drywells (584 canisters plus 15 percent contingency) would be drilled to a depth of 4.6 m (15 ft). They would be arranged in a grid pattern (5 m [16.4 ft] center-to-center) occupying a surface area of 3.8E+04 m^2 (195 by 195 m) (640 by 640 ft) with a 30-m (100-ft) buffer. The site selected for the drywell disposal facility is near the western boundary of the 200 East Area. Figure B.4.2.2 illustrates the drywell disposal facility casing assembly, and Figure B.4.2.3 is a representation of a drywell disposal array.

Figure B.4.2.2 Capsules Drywell Disposal Assembly

Figure B.4.2.3 Capsules Onsite Disposal Arrangement (Conceptual)

B.4.2.3 Process Description

The process activities for the Onsite Disposal alternative are divided into four major operations. A process flowsheet is provided in Figure B.4.2.4.

Figure B.4.2.4 Onsite Disposal Alternative - Process Flow Diagram

Waste Encapsulation and Storage Facility

The Cs and Sr capsules would be stored in the water-filled storage pools at WESF until a capsule-packaging facility is completed. When the capsule-packaging facility is completed, the capsules would be remotely removed from the pool and placed in an inspection cell where they would be checked for surface contamination, corrosion, structural defects, and heat content before being moved to the capsule-packaging facility. Capsules that fail inspection would undergo decontamination, rework, and testing until the capsules meet the requirements for the canister-packaging operation. After passing inspection they would be stored in the capsule vault until being transferred to the canister-packaging operation.

Capsule Packaging Facility

The capsules would be remotely removed from the vaults and then would be placed in racks and inserted into canisters. The loaded canister would then be remotely moved to a weld station where the lid would be welded in place. The canister would then undergo leak testing, ultrasonic scanning, and examination for surface contamination.

The canisters (3 m [10 ft] long) used for Onsite Disposal would be smaller than the canisters (4.5 m [15 ft] long) used for packaging and shipping to an offsite potential geologic repository. The canisters used for Onsite Disposal would be 0.3 m (1 ft) in diameter and 3 m (10 ft) long.

The allowable heat load for Onsite Disposal would be smaller than the allowable heat load for disposal at a potential geologic repository. The drywell heat load limit would be 0.55 kW per canister, which is estimated to be one to four capsules per canister (WHC 1995h). The canisters are expected to contain about three Sr capsules or four Cs capsules. Table B.4.2.1 summarizes the estimated capsules and canisters required for onsite disposal.

Table B.4.2.1 Estimated Capsules, Sealed Canisters, and Multi-Purpose Canisters

Disposal

After placing the capsules into canisters, the canisters would be transported by a shielded vehicle for placement in near-surface drywells to provide long-term, passively-cooled storage. There would be one canister per drywell. After placing the sealed canisters into the drywells an intrusion prevention barrier would be placed over each drywell.

Monitoring and Maintenance

All of the canisters in the drywell disposal facility would be closely monitored for radiological and nonradiological emissions. All associated equipment, instrumentation, and controls would be maintained. Continuous security and monitoring and maintenance operations would be performed for a period of 100 years, at which time institutional control would cease.

B.4.2.4 Implementability

Implementing the alternative would involve mechanical handling of the capsules and canisters and thus presents no new technology uncertainties that would require extensive research and development. One issue that would require evaluation would be the corrosion of the drywell casing and the performance of the disposal configuration.

This alternative would not meet the land disposal requirements of RCRA for hazardous waste. Near-surface disposal of HLW may not meet DOE Order 5820.2A requirements for disposal of readily retrievable HLW in a potential geologic repository (Volume One , Section 6.2).

B.4.3 OVERPACK AND SHIP ALTERNATIVE

B.4.3.1 General Description

For this alternative, the capsules would continue to be stored in a series of water-filled storage pools at WESF until a modified WESF capsule-packaging facility is completed. The capsules would be retrieved from the water-filled storage pools, inspected for surface contamination, corrosion, structural defects, and heat content, and temporarily placed in a capsule vault. The capsules would be stored in the capsule vault until they could be packaged into sealed canisters in the canister-packaging operations.

At the capsule-packaging facility, the sealed canisters would be packaged into HMPCs and placed in the onsite HLW interim storage facility. Monitoring and maintenance would be performed at the onsite interim storage facility while HMPCs are in temporary storage (WHC 1995h).

B.4.3.2 Facilities to be Constructed

The capsule-packaging operation would be performed in the existing WESF Building, whose location and size are described in the Onsite Disposal alternative (Section B.4.2.). While the building modifications would be almost identical, areas for overpacking the canisters into HMPCs would be constructed only for this alternative. Temporary storage for the HMPCs loaded with canisters would be on an engineered storage pad either in place of or near the interim storage of vitrified HLW with the approximate dimensions of 130 by 150 m (430 by 500 ft). The pad would have a stormwater collection and monitoring system, which would provide for collecting and decontaminating spills.

B.4.3.3 Process Description

The process activities for this are divided into five major operations. The process flowsheet for this alternative is provided in Figure B.4.3.1. Final design of the canister packaging would include design criteria for waste acceptance at the potential geologic repository.

Figure B.4.3.1 Overpack and Ship Alternative - Process Flow Diagram

Waste Encapsulation and Storage Facility

As in the Onsite Disposal alternative, the Cs and Sr capsules would be stored in the water-filled storage pools in WESF until a capsule-packaging facility is completed. When the facility is in operation, the capsules would be remotely removed from the pools and placed in an inspection cell where they would be checked for surface contamination, corrosion, structural defects, and heat content before transferring them to the capsule-packaging facility. Capsules that fail the inspection would undergo decontamination, rework, and testing until the capsules meet the requirements for the canister-packaging operation. After passing inspection they would be stored in the capsule vault until they could be transferred to the canister-packaging operation. The capsule vault is a shielded storage room that is used for storing the inspected capsules prior to loading into canisters, which are 4.57 m (15 ft) long.

Capsule Packaging Facility

In this operation, the capsules that were stored in the vaults would be transported to the capsule-packaging area, and placed in racks that would be loaded into canisters. Depending on the heat emitted by each canister, five to nine capsules would be loaded in one canister. After loading, the canisters would be moved to a weld station where the lid would be welded in place.

The seal-welded canisters would undergo leak testing, ultrasonic scanning, and checking for surface contamination. If the canister is found to be contaminated, it would go to electropolishing decontamination before overpacking in HMPCs. The HMPC can hold a maximum of four canisters.

The canisters used for packaging and shipping the capsules to an offsite potential geologic repository would be larger than the canisters used for drywell storage. The canisters used for packaging the capsules under this alternative would be 0.61 m (2 ft) in diameter and 4.57 m (15 ft) long. The allowable heat load for onsite disposal is 1.17 kW per canister for Cs and 0.80 kW per canister for Sr. Each canister would be expected to hold five to nine Cs or Sr capsules. Table B.4.2.1 summarizes the number of capsules, canisters, and HMPCs required to implement this alternative.

Onsite Interim Storage

The loaded HMPCs would be stored ready for transport on a separate engineered pad with dimensions of 130 by 150 m

(430 by 500 ft) until the potential geologic repository is available. Loading of the capsules into the canisters and loading of the canisters into the HMPCs would be expected to be accomplished near the scheduled time for transport to the repository so that loaded HMPC interim storage would be minimized.

Monitoring and Maintenance

All the HMPCs would be closely monitored for radiological and nonradiological emissions. All associated equipment, instrumentation, and controls would also be maintained. Continuous monitoring and maintenance would be performed at the onsite interim storage facility until the HMPCs would be transported to the potential geologic repository.

Transport to the Potential Geologic Repository

When the potential geologic repository is ready to accept processed HLW the HMPCs would be removed from the onsite interim storage facility and transported by railcar to the repository.

B.4.3.4 Implementability

Implementability of this alternative could be affected by the acceptability of the packaged capsules at the potential geologic repository. The acceptability issue involves the waste form. The solubility of this waste may ultimately exceed the HLW acceptance criteria. The Cs and Sr salts would not be immobilized under this alternative but instead would be packaged to provide two additional barriers for containing the capsules. If it is determined that the salt form of these waste would not meet the Waste Acceptance Criteria, the capsule contents would have to be removed and processed appropriately to meet the Waste Acceptance Criteria. Further evaluation would be required to resolve technical and programmatic concerns associated with disposal of the Cs and Sr capsules in the potential geologic repository.

This alternative may not meet the land disposal restrictions of RCRA because of the characteristic corrosivity of the CsCl and SrF_2. Assuming the waste is mixed waste, it would not meet the DOE restriction against disposal of mixed waste in the first potential geologic repository.

Also, the powder waste form of the SrF_2 may not meet the waste acceptance requirement to immobilize particulate waste (Volume One, Section 6.2).

B.4.4 VITRIFY WITH TANK WASTE ALTERNATIVE

B.4.4.1 General Description

This alternative would consist of continued storage of capsules in water-filled storage pools inside WESF until the HLW vitrification facility is completed. Then the capsules would be retrieved from the storage pools and transferred to the HLW vitrification facility, which would include equipment to chemically process, if necessary, and blend the Cs and Sr with the tank waste feed to the HLW vitrification process. The remainder of the process would be similar to the process described for vitrifying HLW under the Ex Situ Intermediate Separations alternative (Section B.3.5).

As part of the HLW glass, the Cs and Sr would be monitored in temporary storage and transported by railcar to the potential geologic repository.

B.4.4.2 Facilities to be Constructed

The dismantling of Cs and Sr capsules and the processing of Cs and Sr salt would be integrated with the HLW vitrification facility. For this alternative, the Cs and Sr capsules dismantling facility would be built as part of the HLW vitrification facility.

The capsule processing facility would include hot cells to open the double-walled capsules, mixing and storage tanks for CsCl, a pulverizer and slurry tank for SrF_2, chemical processing facilities if required, pumps for blending Cs or Sr compounds with HLW slurry prior to vitrification, and decontamination facilities for the empty capsules.

B.4.4.3 Process Description

The process activities for the extensive immobilization option are divided into four major operations, as shown on the flowsheet in Figure B.4.4.1.

Figure B.4.4.1 Vitrify with Tank Waste Alternative - Process Flow Diagram

Capsules Retrieval From Waste Encapsulation and Storage Facility Storage Pool

The Cs and Sr capsules would be stored in water-filled storage pools at WESF until the HLW vitrification facility is completed and ready for operation. The capsules would then be remotely retrieved, loaded in casks, and transported by truck to the capsule-dismantling hot cells that would be part of HLW vitrification facility.

Dismantling and Removal of Capsules Content

At the dismantling facility, the outer and inner walls of the capsules would be remotely cut open to remove the CsCl and SrF_2 salts, and the empty Cs and Sr capsules would be decontaminated and disposed of with other low-level metallic waste.

Blending Cesium Chloride or Strontium Fluoride with HLW Slurry

The CsCl would be dissolved in water, blended with the HLW slurry from the tank farms, and used as feed to the vitrification facility. The SrF_2 would be pulverized and then water would be added to make a slurry with a solids content of less then 4 volume percent. The SrF_2 slurry would then be mixed with the HLW slurry and used as feed to the vitrification facility. An alternative treatment for the halides would be to convert them to nitrates prior to vitrification if the halide salts cannot be directly fed to vitrification.

Chemical Processing of Capsule Contents

This processing converts the halides to nitrates. The dissolved CsCl would be processed through ion exchange columns where the chloride ion would exchange for a nitrate ion, resulting in a cesium nitrate solution. Two ion exchange columns would be used to allow alternate processing and regeneration cycles. Regeneration would be with 1 molar nitric acid.

The pulverized SrF_2 would be dissolved in sulfuric acid to produce a precipitated strontium sulfate and gaseous hydrofluoric acid that would be sent to the off-gas processing facility. The strontium sulfate would be reacted with sodium carbonate to form strontium carbonate. The last processing step would be to react the strontium carbonate with nitric acid to form a solution of strontium nitrate.

High-Level Waste Vitrification

The Cs and Sr salts would be blended with the tank waste and fed to the HLW melter feed section. The HLW would be stored onsite until the potential geologic repository is ready to accept HLW. When the potential geologic repository is ready to accept processed HLW, the Cs and Sr (as part of the HLW glass) would be transferred to the repository.

B.4.4.4 Implementability

This alternative could only be implemented if one of the tank waste ex situ alternatives or the Ex Situ/In Situ Combination alternative were selected. Chemical processing could be required to remove the chloride and fluoride from the Cs and Sr salts so that they meet the feed specifications that would be developed for the HLW vitrification feed stream. Further study would be required to determine if the capsule contents could be successfully treated as part of the calcination feed stream. Regenerating the Cs ion exchange media produces hydrochloric acid. Neutralizing the hydrochloric acid may produce a secondary waste product requiring further treatment and disposal. The production of hydrofluoric acid during strontium processing would require additional off-gas processing and would produce magnesium fluoride, which would require disposal as a secondary waste.

This alternative would meet all applicable regulations for disposal of hazardous, radioactive, or mixed waste assuming that the hazardous waste components are adequately treated during waste processing or vitrification.

B.5.0 TANK CLOSURE

This section describes the representative tank closure process that has been included in the alternatives to allow an equitable comparison of alternatives. Closure is a term that refers to the final disposition of the tanks and associated piping, any residual waste that remains in the tanks following remediation, equipment that may be left in the tanks, and any soil or groundwater contamination associated with the tank farm operations.

Under the Tri-Party Agreement, both SSTs and DSTs are RCRA hazardous waste management units that will be eventually closed under State Dangerous Waste regulations (WAC 173-303). Three options exist for this closure: 1) clean closure, involving removal of all waste and waste constituents, including tank, debris, contaminated equipment, and contaminated soil and groundwater; 2) modified closure, which involves a variety of closure methods but requires periodic (at least once after 5 years) assessments to determine if modified closure requirements are being met; and 3) closure as a landfill with waste remaining in-place and corrective action taken for contaminated media under post-closure requirements. All three options require the submittal and approval of closure plans by Ecology. There is currently insufficient information available to make a decision on how to close the tanks, so closure is not within the scope of this EIS. However, decisions (such as the percent of waste recovery) on how to treat and dispose of the tank waste may impact the level of closure activities in the future.

To provide information on how closure activities would be affected by remediating the tank waste, a representative approach to tank closure (closure as a landfill) has been included in each of the TWRS alternatives to allow an equitable comparison of the alternatives. This is described in the following text.

Closure would address 149 SSTs, 28 DSTs, and approximately 60 MUSTs and includes the other ancillary equipment associated with waste tank activities. Closure would apply as follows.

- Both the SSTs and DSTs would be stabilized to prevent dome collapse by gravel filling for all ex situ vitrification alternatives and the In Situ Fill and Cap alternative. The gravel-fill process would involve the uniform distribution of sized, crushed rock throughout the tank including the tank dome, using a gravel slinger. This commercially-proven technology is used in filling ship holds and silos with materials such as grain or cement. Tests performed at the Hanford Site have verified the use of this technology with local materials in a tank-like environment.
- Ancillary equipment and MUSTs would be grout filled for stabilization in all treatment alternatives with the exception of the No Action and Long-Term Management alternatives. Ancillary equipment and MUSTs would not be excavated or packaged. Ancillary equipment would include diversion boxes, catch tanks, valve and pump pits, process pits, diverter stations, receiver vaults, condensate tanks, risers, transfer piping, and piping encasements associated with SST operations. Pipelines would include lines between tanks and process facilities, air and steam supply lines, raw water lines, and drains.
- During tank farm closure, ancillary equipment items and MUSTs would be stabilized in place with an appropriate grout material. The physical immobilization of contaminants provided by grout could be augmented by using sequestering agents, such as zeolites, that would be capable of chemical bonding with contaminants. If ancillary equipment was plugged at one or more points, several access ports would have to be installed to ensure complete grout filling.
- For purposes of assessing the environmental impacts associated with dispositioning of ancillary equipment and MUSTs as part of closure, it was assumed that the entire void volume within the ancillary equipment would be filled with grout and that no ancillary equipment or Inactive MUSTs would be excavated, packaged, or disposed of as LAW or mixed waste (WHC 1995i).
- Surface barriers (Hanford Barriers) would be placed over SSTs and DSTs for all alternatives except the No Action and Long-Term Management alternatives . Barriers would also be placed over the LAW vaults described in the Ex Situ Intermediate Separations, Ex Situ No Separations, Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1 and 2, and the Phased Implementation alternatives.

B.6.0 THE HANFORD BARRIER

This section describes the multi-layered barrier, or Hanford Barrier, which is included in all alternatives that include closure activities as a representative surface barrier (cap) for closure as a landfill.

The Hanford Barrier would be a horizontal, multi-layered above grade engineered soil structure whose function would be to isolate the waste site from the environment by preventing or reducing the likelihood of wind erosion, water infiltration, and plant, animal, and human intrusion. It would be composed of 10 layers, with a combined thickness of 4.5 m (14.8 ft), and placed over the top of the stabilized tanks and the LAW disposal sites. Each Hanford Barrier would extend an additional 9 m (30 ft) beyond the perimeter of the area to be protected. Performance objectives of the Hanford Barrier system would include the following:

- Function in a semi-arid to sub-humid climate;
- Limit the amount of water migration through the waste to near zero amounts;
- Be maintenance free;
- Minimize the likelihood of intrusion by plants, animals, or people;
- Limit the amount of gases released;
- Minimize erosion;
- Meet or exceed RCRA cover performance requirements;
- Isolate waste for a minimum of 1,000 years; and
- Be acceptable to regulators and the public.

B.6.1 DESCRIPTION OF THE BARRIER LAYERS

The layers of the barrier are described from the top down. The Hanford Barrier design is provided in Figure B.6.1.1.

Figure B.6.1.1 Hanford Barrier

Top Vegetative Cover

The top vegetative cover would be for water retention and removal. Five species of perennial grasses would be planted across the barrier top. Seeding would include disking the soil, applying granular fertilizer, and seeding with a perennial grass mixture. To help establish cover grass, the site would be mulched with straw, which would be crimped into the soil to minimize wind erosion until the vegetation cover is developed.

Top (First and Second) Barrier Layers

The first barrier layer would consist of topsoil with a pea-gravel mixture; the second layer would consist of topsoil without pea-gravel. The first layer would be 1 m (3.3 ft) of sandy silt to silt loam soil with a 15 percent by weight admixture of pea-gravel. This layer would be placed loosely with a bulk density of 1.46 grams(g)/cm^3 (18.7 pounds [lb]/ft^3). The second layer would have the same type of topsoil; however, the bulk density would be approximately 1.38 g/cm^3 (86 lb/ft^3). These two layers would manage water by storing precipitation, providing a media for the growth of cover vegetation, and allowing evaporation and transpiration by the cover plants. The proposed topsoil would be obtained from a borrow site.

Third Barrier Layer

The third layer would be a geotextile, used primarily to separate topsoil layers from the sand filtration layer. After construction is completed, this geotextile would no longer have a specific function and therefore its long-term durability is not an issue.

Fourth and Fifth Barrier Layers

The fourth layer would be a sand filter, and the fifth layer would be a gravel filter. The purpose of these two layers would be to prevent migration and accumulation of fine-textured topsoil in the basalt layer. A capillary barrier, which occurs when a layer of fine-textured soil overlays a layer of coarser-textured soil (e.g., sand, gravel, or rock), would be created at the interface between the geotextile and the fourth layer (sand filter). Surface tension effects within the pore space of fine-textured soil would exert a negative pressure on the contained soil moisture. For moisture to drain out of fine-textured soil, surface tension would have to be overcome by developing gravitational pressure (hydraulic head) within the layer. In effect, some portion of the full thickness of this fine-soil layer will have to become completely saturated before drainage could occur. The sand filter would be 0.15 m (0.5 ft) deep, and the gravel filter would be 0.3 m (1 ft) deep. Both layers would be obtained from a borrow site.

Sixth Barrier Layer

The sixth layer would be constructed of coarse basalt smaller than 25 by 5 cm (10 by 2 in.). The basalt layer would control biointrusion from plant roots, burrowing animals, and humans. The basalt would impede exploratory drilling. A subsurface layer consisting of loose fractured rock would pose a particularly adverse drilling condition for the following reasons:

- Circulation could not be maintained;
- Cuttings could not be adequately removed from the hole;
- The drill bit could not receive adequate lubrication; and
- Firm contact could not be maintained between the bit and the rock.

All of these factors would contribute to high bit wear and minimum advance of the drill hole. In addition, the layer would prevent moisture retention because large void spaces will enable water to drain into the seventh layer.

Seventh Barrier Layer

The seventh layer would be for lateral drainage. It would consist of screened material having a diameter of 1 millimeter (mm) (0.04 in.) or greater, which would give a hydraulic conductivity of at least 1 cm/sec (0.4 in./sec). This layer is part of contingency planning; any water draining to the seventh layer would be collected and/or diverted to the edge of the cover because of the 2 percent slope. This layer would be approximately 4 m (13 ft) below final grade to protect against frost penetration.

Eighth Barrier Layer

The eighth layer would consists of asphalt that would serve as a low-permeability barrier and as a secondary biointrusion barrier. The asphalt would be a durable asphaltic concrete mixture consisting of double-tar asphalt with added sand as a binder material. This layer would be 0.15 m (0.5 ft) thick with a hydraulic conductivity of approximately 1.0E-8 cm/sec. Natural analog studies estimate that this asphalt could remain functional for a period of 5,000 years or more as long as the asphalt remains covered and protected from ultraviolet radiation and freeze and thaw activity. To provide additional protection against leakage, the asphaltic concrete would be coated with a sprayed asphaltic coating material, which would be puncture-resistant, flexible, and easy to apply. The asphaltic coating material would have a permeability value of about 1.0E-11 cm/sec.

Ninth Barrier Layer

The ninth layer would be an asphalt base course that would provide a stable base for constructing the asphalt layer.

Tenth Barrier Layer

The tenth layer would contain grading fill that would establish a smooth, planar base surface for constructing the barrier layers. The sites covered by the Hanford Barrier would be contoured and graded for a uniform slope of 2 percent.

Locations to be Covered

The following locations would be covered with a Hanford Barrier:

- Tank Farm A (SST 6 tanks): 0.86 hectares (ha) (2.13 acres [ac]);
- Tank Farm AN (DST 7 tanks): 1.30 ha (3.21 ac);
- Tank Farm AP (DST 8 tanks): 1.17 ha (2.89 ac);
- Tank Farm AW (DST 6 tanks): 0.91 ha (2.26 ac);
- Tank Farm AX (SST 4 tanks): 0.63 ha (1.55 ac);
- Tank Farm AY (DST 2 tanks): 0.37 ha (0.92 ac);
- Tank Farm AZ (DST 2 tanks): 0.37 ha (0.92 ac);
- Tank Farm B (SST 16 tanks): 1.85 ha (4.57 ac);
- Tank Farm BX (SST 12 tanks): 1.54 ha (3.80 ac);
- Tank Farm BY (SST 12 tanks): 1.55 ha (3.84 ac);
- Tank Farm C (SST 16 tanks): 1.89 ha (4.68 ac);
- Tank Farm S (SST 12 tanks): 1.57 ha (3.89 ac);
- Tank Farm SX (SST 15 tanks): 1.91 ha (4.72 ac);
- Tank Farm SY (DST 3 tanks): 0.65 ha (1.61 ac);
- Tank Farm T (SST 16 tanks): 1.85 ha (4.57 ac);
- Tank Farm TX (SST 18 tanks): 2.46 ha (6.09 ac);
- Tank Farm TY (SST 6 tanks): 0.87 ha (2.16 ac);
- Tank Farm U (SST 16 tanks): 1.89 ha (4.67 ac); and
- LAW disposal vault.

B.6.2 SUMMARY OF BORROW SITES AND BORROW MATERIALS

There are three sites assumed in the engineering data packages for borrow materials. These are Pit 30, which would supply sand and aggregate; the Vernita Quarry, which would supply riprap; and McGee Ranch, which would supply silt. These areas are also potential borrow sites. A decision on exactly which borrow site would be used and to what extent they would be used would be made through future NEPA analysis . The following is a brief description of the location and estimated distance of the potential borrow sites used for calculation purposes .

These potential borrow sites have been evaluated previously (BHI 1995) with respect to site proximity, availability of borrow material, transportation, safety, and land reclamation. This preliminary analysis indicated that all the potential borrow sites were suitable sources of borrow material. Figure B.6.2.1 shows the location of the proposed borrow sites.

Figure B.6.2.1 Potential Borrow Sites for TWRS

Pit 30

The potential Pit 30 borrow site is an existing and established borrow pit, located approximately centrally with respect to the 200 Areas. The estimated haul distance is 10 km (6 mi) round-trip to the 200 East and 200 West Areas.

Vernita Quarry

The potential Vernita Quarry borrow site is located east of State Route 24 near the Vernita Bridge. It was probably originally used to support highway construction. Distance estimates (one-way) are 12 km (7 mi) from the 200 West Area and 19 km (12 mi) to the 200 East Area.

McGee Ranch

The potential McGee Ranch borrow site is located west of State Route 24 and north of Route 11A. Distance estimates (one-way) are 11 km (6.5 mi) to the 200 West Area and 18 km (11 mi) to the 200 East Area.

Borrow Material Quantities

The estimated quantities of borrow materials taken from the various engineering data packages are shown on the following three tables. Table B.6.2.1 shows borrow materials used during construction and operation for the alternatives. Table B.6.2.2 shows borrow materials that are estimated for backfilling the empty tanks for all of the ex situ alternatives. Table B.6.2.3 shows the data for borrow materials used in the construction of the multi-layered barriers (Hanford Barriers), which may be placed over the tanks and vaults. In this table, each group of alternatives uses the same quantity of borrow materials.

Table B.6.2.1 Borrow Site Summary - Materials Used During Construction and Operations

Table B.6.2.2 Borrow Site Summary - Materials Used for Backfill of Empty Tanks for all Ex Situ Alternatives

Table B.6.2.3 Borrow Site Summary - Materials Used for Construction of Hanford Barriers

B.7.0 SITING OF FACILITIES

This section describes the preliminary siting study that was performed to develop a representative site for impact assessment purposes.

The site optimization process would be implemented to ensure that new facilities would be located at a site that meets facility requirements and minimizes the impacts associated with construction and operations. The site optimization process would involve identifying and evaluating sites based on selection criteria that incorporate stakeholder values.

The site optimization process for the TWRS sites is an ongoing program whose function is to identify a site that best meets the selection criteria. The in situ alternatives would be sited at the existing tank farms and would require site selection for support facilities. For the ex situ alternatives, the area proposed for potential sites has been restricted to in and around the 200 East Area. The 200 Areas have been heavily used for fuel reprocessing and waste management and disposal activities. The 200 East Area location was selected for the following reasons.

- Based on the TWRS Facility Configuration Study (Boomer et al. 1994) and the TWRS Process Flowsheet (Orme 1994), pretreating tank waste (if done in an existing tank) would be done by the in-tank sludge washing process in the 200 East A Farm Tank Complex. Tank waste from the 200 West Area would be retrieved to the SY Tank Farm and transferred cross-site to the AW Tank Farm where in-tank sludge washing would be performed. Waste in the 200 East Area would be retrieved to the AN Tank Farm where it would be washed and separated into HLW and LAW streams. The LAW streams would be pumped to the AP Tank Farm and then to the pretreatment and LAW vitrification facilities. The HLW streams would be pumped directly from the AN and AW Tank Farms to the HLW vitrification facility or to interim storage.
- The Hanford Site has consolidated activities over the past 20 years in the 200 East Area, as opposed to the 200 West Area, which has placed much of the necessary facilities and infrastructure in and around the 200 East Area.
- There is more available, useable land in the 200 East Area than the 200 West Area (i.e., land that is unused or is not reserved for other use).

B.7.1 SELECTION CRITERIA

Hanford Site evaluation criteria used for evaluating potential sites considered stakeholder values, regulatory compliance issues, costs, and risks. In a site selection study the selection criteria described in the following sections have been based on stakeholder values, regulatory compliance, and cost and risk reduction (Shord 1995 and Jacobs 1996).

B.7.1.1 Protect the Environment

Cultural, Archeological, and Historical Sites

The TWRS remediation site shall not have any areas of cultural, archeological, or historical significance that cannot be reasonably mitigated.

Ecological

The TWRS remediation site shall not have any areas of ecological impact that cannot be reasonably mitigated.

Groundwater Protection

The Columbia River shall be protected, and groundwater contamination will be dealt with realistically and forcefully.

This issue concerns the ability of the Hanford Site to meet Federal, State, and local requirements for protecting groundwater. Factors include the 1) impact of previous Hanford Site practices (e.g., liquid effluent discharges, SST leaks, disposal actions) on groundwater under the Site; 2) hydrology of the Site; and 3) the impact of the Site on proposed future Hanford Site disposal operations (e.g., LAW disposal).

Harm During Cleanup

Establishing the TWRS complex (on the particular site) shall cause no irreparable harm to the environment.

Natural Resource Damage

The TWRS remediation site shall minimize and avoid any impacts to natural resources.

B.7.1.2 Protect Public/Worker Health and Safety

Transportation

Waste will be transported safely, and measures will be taken to prepare for emergencies. The transportation of radioactive and hazardous waste and material through populated areas will be kept to a minimum.

Exposures

Exposures will be as low as reasonably achievable. The TWRS remediation site shall minimize the adverse impacts on the health and safety of personnel. The concept of reducing the exposure of workers to radiological and hazardous substances to as low as reasonably achievable principles will be considered.

Accidents on the TWRS Complex

The TWRS remediation site will minimize the effects of possible accidents at adjacent facilities on the TWRS complex.

Accidents from the TWRS Complex

The TWRS remediation site will minimize the effects of possible accidents at the TWRS complex and its associated facilities (e.g., transfer lines) on adjacent facilities.

B.7.1.3 Use the Central Plateau Wisely for Waste Management

Land use planning for the TWRS remediation site should be in concert with and not conflict with other land use planning documents.

B.7.1.4 Promote Local Economic Development

The TWRS remediation site will capture economic development opportunities locally by being conducive to privatization of facilities.

B.7.1.5 Support the Tri-Party Agreement

The TWRS remediation site will support meeting the Tri-Party Agreement schedule and get on with cleanup to achieve substantive progress in a timely manner.

B.7.1.6 Consider Cost Impacts

The following cost impacts shall be considered.

Construction Costs

Utilities

The installation/upgrade costs of electricity, raw water, sanitary water, steam, and telecommunications. Existing and planned utilities will be considered.

Railroads

The installation/upgrades costs of rail and roads.

Liquid Effluent Disposal

The installation of liquid effluent disposal lines from the complex to the liquid effluent disposal system.

Sanitary Sewer

The installation costs of a sanitary sewer to tie into the planned 200 East Area sanitary sewer system (Project L-116).

Storm Water Runoff

The installation costs of a system to channel stormwater away from the site.

Construction Proximity

The ability to locate temporary construction support facilities close to the facilities being constructed and the availability of adequate laydown and construction support areas.

Construction Commonality

Maximize the use of common construction support needs (laydown areas, utilities, parking, batch plant, offices, shops, warehouse, and change rooms) between project or construction phases of multiple facilities of the same project.

Site Preparations

Costs associated with earth-moving activities necessary to complete construction. Factors include topography, site irregularities, and finish grade elevation. The removal/relocation of existing structures are additional factors.

Operating Costs

Operating costs between the various sites shall be qualitatively assessed and shall include items such as facility and feed/waste transfer costs of flushing, diluting waste, concentrating diluted waste (evaporating waste to manage DST space), and line drain back.

B.7.1.7 Provide Flexibility

Provide flexibility in the following areas.

Site Expansion

Adequate expansion area should be available for future TWRS facility needs. Although the expansion area cannot be quantified at this point, more potential expansion area is preferable to less.

Facility Relationships

The TWRS remediation site should allow the interacting of process facilities to maximize use of common support facilities and utilities and facilitate flows (tank waste transfers, raw materials, effluent disposal, process waste streams) between process facilities and related operations.

Compatibility

The TWRS remediation site should be compatible with ongoing programs, current construction projects, and planned projects.

Proximity

The TWRS remediation site should possess the ability to 1) move the vitrified waste to HLW interim storage and subsequently to final storage offsite; and 2) retrieve LAW from onsite disposal for repackaging for offsite shipment.

Contracting Flexibility

The TWRS remediation site should be conducive to the use of innovative contracting concepts such as 1) fixed-price contracts for design, construction, startup, and initial operations; and 2) privatization. Ease of access, interfaces with site operations, and the potential to encounter unforeseen conditions are to be considered.

B.7.1.8 Reduce Risks

Reduce risks (technical, regulatory, operational, construction, and planning) in the following areas.

Hydraulics

The potential for transfer line plugging should be minimized to the extent possible. Factors to be considered should include waste transfer system configuration (i.e., number of process pits), line traps, quantity of flush water after each transfer, line drain back to low point, number of low points in system, dilution requirements to mitigate plugging of transfer system, pumping requirements (to minimize the use of pump booster stations), and siphoning effect between the shipping location and the processing facilities. In essence, the inner tank/facility piping should be free draining (to the extent practical) to the transfer destination.

Proximity to Existing Facilities

The distance between the processing facilities for pretreatment/LAW treatment and HLW, and the DSTs existing in the 200 East Area (A Farm Complex) shall be kept to a practical minimum.

Interferences and Contamination

Minimize potential problems to be encountered during construction and operation due to existing above or belowground structures or radioactive/hazardous contamination.

Seismic

The distance to known earthquake faults shall be taken into consideration.

Site Activities

The impact on other Hanford Site activities and operating facilities during construction and operation should be kept to a minimum.

Decontamination and Decommissioning

The decontamination and decommissioning activities in the 200 East Area should be considered in siting the TWRS complex. This would include the decontamination and decommissioning impact of other facilities in the area on the TWRS complex and the ultimate decontamination and decommissioning of the TWRS complex.

Design

The need for new technology/design complexity should be minimized.

B.7.2 RECOMMENDATION

The final site selection for the facilities associated with the ex situ alternatives has not been made. However, a recommended site has been nominated based on the applicability of the eight criteria that were given previously and adopted for use in this EIS. The selection process focused on six alternate layouts in the 200 East Area. Each layout was evaluated and given a numerical ranking for each of the eight criteria. Comparison matrix was then constructed to compare the ranking of each layout. The location and size of the highest ranking layout are shown as Site C in Figure B.7.2.1. Sites A, B, and D included alternate layouts that did not score as high for locating the full-scale treatment facilities.

Figure B.7.2.1 Potential Site Location

For purposes of the EIS, a combination of Site B and Site C has been assumed to be a representative site capable of accommodating the full-scale processing facilities, LAW disposal, and HLW temporary storage for all ex situ alternatives. Site B has been assumed to be a representative site for locating the Phase 1 treatment facilities under the Phased Implementation alternative (WHC 1996). These sites are considered to be representative sites for the purpose of alternative evaluation. This does not preclude other sites from ultimately being selected and appropriate NEPA analysis will be completed prior to final site selection . To support the analysis of environmental impacts in this EIS, the representative site is used as the location where each of the ex situ alternatives would be located. All of the ex situ alternatives will be treated as if they were located on the representative site.

B.8.0 MAJOR ASSUMPTIONS

To develop engineering data required to perform impact analyses for each of the alternatives discussed in the EIS, assumptions were made regarding the technologies that have been configured to create a remediation alternative. These assumptions were based either on the best information available, applications of a similar technology, or engineering judgement. By definition when an assumption is made there is some level of uncertainty associated with it that can be expressed as a range for the assumed value that reasonably could be expected. This section identifies the major assumptions used for the alternatives and the uncertainties associated with the cost estimates . Uncertainties associated with the engineering data are discussed in Volume Five, Appendix K.

B.8.1 IN SITU ALTERNATIVES

It was assumed that there would be no leaks from the SSTs or DSTs during the administrative control period for the No Action, Long-Term Management, or In Situ Fill and Cap alternatives. This assumption is based on ongoing SST interim stabilization to remove pumpable liquids, the ability to detect and recover leaks from the space between the inner and outer liners of the DSTs, and ongoing monitoring activities within the tank farms. The SSTs and DSTs were assumed to maintain their structural integrity throughout the administrative control period under the No Action and Long-Term Management alternatives.

The In Situ Vitrification, In Situ Fill and Cap, and the in situ portion of the Ex Situ/In Situ Combination alternatives were assumed to require additional characterization data to evaluate the acceptability of in-place disposal and address RCRA land disposal requirement considerations. This requirement would be in addition to the current characterization requirements for the ex situ alternatives. These additional characterization efforts could involve extensive laboratory analysis of additional tank samples and may require modifications to the tanks to install additional risers for sampling access.

In Situ Vitrification

The in situ vitrification system was assumed to be capable of vitrifying each of the tanks to the required depth resulting in a consistent waste form. It was also assumed that the variation in waste composition and inventory from tank to tank would not impact the ability to produce an acceptable waste form.

In Situ Fill and Cap

The concentrated liquid waste contained in the DSTs was assumed to be acceptable for gravel filling. Under the In Situ Fill and Cap alternative, the DST liquids would be concentrated using the 242-A Evaporator to remove as much water from the waste as possible but would still contain substantial volumes of liquid. It has been estimated that concentration by the 242-A Evaporator would reduce the current liquid volumes contained in the tanks by approximately one-third (WHC 1995f).

B.8.2 EX SITU ALTERNATIVES

Waste Retrieval Efficiency

The waste retrieval function described for the ex situ alternatives was assumed to remove 99 percent of the waste volume contained in each tank during waste retrieval. Under this assumption, 1 percent of the tank volume would be left in-tank as a residual. It was further assumed that the 1 percent waste volume represented 1 percent of the waste inventory on a chemical and radiological basis.

The amount and type of waste that would remain in the tanks after retrieval is uncertain. The Tri-Party Agreement

(Ecology et al. 1994) set a goal for the SSTs that no more than 1 percent of the tank inventory would remain as a residual following waste retrieval activities. The engineering data for the waste retrieval and transfer function common to all ex situ alternatives was developed using 99 percent retrieval as a goal. However, achieving this level of tank waste retrieval may require extraordinary effort and cost, and it may not be practicable to achieve 99 percent retrieval from all tanks.

Releases During Retrieval

Retrieval of SST waste under each of the ex situ alternatives was assumed to result in the release of 15,000 L (4,000 gal) from each SST to the soils surrounding the tank during retrieval operations. It was also assumed that the contaminant concentrations in the liquids released were at maximum predicted concentrations using the congruent dissolution model. See Volume Four, Section F.2.2.3 for a discussion on the congruent dissolution model. No leakage was assumed to occur from the DSTs during retrieval operations because DSTs have provisions for leak containment and collection . This assumption is based on having 67 known or suspected SSTs that have leaked in the past (Hanlon 1995). Most of the SSTs were built in the 1940's and now are about 50 years old. The leakage volume estimate was based on current information from the waste retrieval program and on the assumption that the average leakage from an SST would be one order of magnitude lower than the maximum release estimated for tank 241-C-106 during sluicing operations. The maximum leak estimated from tank 241-C-106 during sluicing operations was 150,000 L (40,000 gal). Th e leak estimate for tank 241-C-106 assumes that the leak occurs early in the sluicing operation, leak detection devices and controls fail, sluicing operations proceed without these leak detection devices, the leak(s) occur at the bottom of the tank, and the remaining sludge does not plug any leaks (DOE 1995d).

The assumption that each of the 149 SSTs leaks 15,000 L (4,000 gal) during retrieval is conservative and provides an upper bound of 2,260,000 L (596,000 gal) on the calculated impacts from tank leakage during retrieval. Total leakage from all SSTs during retrieval operations would be expected to be lower than the bounding values used because of the following assumptions.

- Seventy-five percent of the tanks that are known or suspected leakers are assumed to have leaked at the air-water interface on the sidewall of the tank and would remain above the liquid level during sluicing (51 tanks).
- Twenty-five percent of the tanks that are known or suspected leakers are assumed to have leaked at or near the tank bottom and would be retrieved using a robotic arm based system (16 tanks). The robotic arm based system would not use the large volumes of liquids required for sluicing operations.
- Leak detection systems would be used during waste retrieval operations, and indications of tank leakage during retrieval would result in actions taken to minimize leakage. These actions could include switching to robotic arm based systems or limiting the amount of sluicing liquid in the tank.
- Administrative controls would be used to monitor liquid inventories.
- There is a tendency for solids in the sludge to plug any leaks.
- The free liquid in the tanks during sluicing could be pumped out in a short time using the transfer pumps.

The most probable occurrence of a leak during sluicing would involve the sluicers opening a plugged leak in the tank wall. The waste leakage during sluicing would be any free-standing liquid above the level of the leak point and the sluicing stream as it impacts the tank wall. Based on historical leak rates of other SSTs, the actual leaked volume is expected to be on the order of a few thousand liters (a few thousand gallons) (DOE 1995d). DOE currently is working with Ecology to define the operating envelope for allowable leakage during retrieval. Final design of the waste retrieval systems would include measures to detect control leakage.

Tank Residuals

The residual contaminants left in the tanks would either be insoluble and hardened on the tank walls and bottom or be of a size that could not be broken up and removed from the tanks. In either case, the residual would have low solubility because the retrieval technologies proposed would use substantial quantities of liquid in an attempt to dissolve or suspend the waste during retrieval. Because of the uncertainties regarding the amount and type of residual waste that would remain in the tanks, a conservative assumption was made to bound the impact of the residual waste. For purposes of the analysis, it was assumed that 99 percent recovery would be achieved for ex situ alternatives, and the residual waste left in the tanks would contain 1 percent of all the original tank inventory, including the water-soluble contaminants.

The assumption that the 1 percent tank residuals following retrieval represent 1 percent of the original tank inventory is conservative because it assumes that soluble and insoluble constituents would remain as residuals in the same proportions as the original tank inventory. The effect of retrieving less than 99 percent of the waste volumes from the tanks during retrieval would be an increase in the amount of waste left in the tanks and corresponding increases in groundwater contaminant concentrations and post-remediation risk. The in situ and combination alternatives leave substantially more waste onsite for disposal and provide an upper bound on the impacts associated with the amount and type of waste that is disposed of onsite.

A nominal case retrieval release and residual tank inventory was developed to assess the impacts that would result from nominal, as compared to bounding, assumptions for tank releases during retrieval and the residual waste left in the tanks following retrieval. Additional information on the nominal case is provided in Section B.3.0.

The nominal retrieval release inventory was developed by assuming that the waste would be diluted by one-third by adding water during waste retrieval. Possible dilution ratios that would be used during waste retrieval range from 3:1 to 10:1. Thus, the dilution factor of one-third assumed for the nominal case is a conservative assumption and is substantially lower than the dilution factions that would be obtained using 3:1 or 10:1 dilution ratio. These dilution ratios represent the amount of liquid required to mobilize the waste solids and would be made up of existing tank liquids and water additions. The nominal case retrieval release volume was assumed to be 15,000 L (4,000 gal) from each SST and the contaminant concentrations were assumed to be two-thirds of the bounding case. The average volume of waste released from each SST during retrieval was not reduced for the nominal case because insufficient information is available to support a lower average release volume. The volume of waste released during retrieval would depend on the ability to detect a leak and take corrective action.

The nominal tank residual inventory was developed by modifying the bounding tank residual inventory to reduce the mobile constituents of concern based on solubility. The mobile constituents of concern were evaluated because of their contribution to post-remediation risk. The isotopes C-14, Tc-99, and I-129 were reduced for the nominal case tank residual inventory to 10 percent of the bounding tank residual inventory. This is based on the assumption that 90 percent of the residual inventory of these isotopes would be soluble in the retrieval liquids and would be retrieved from the tanks for ex situ treatment. Typical sludge wash factors representing the solubility in water for each of these isotopes are as high as 99 percent. The nominal case residual was limited to 90 percent to account for conditions where the scale and hardened sludges were not exposed to the sluicing liquid during retrieval. Table B.8.2.1 shows the nominal and bounding residual inventories for select mobile constituents.

Table B.8.2.1 Tank Residual Inventory in Curies

Assumptions Affecting HLW Volume

The major factors that affect the volume of HLW produced by any of the ex situ alternatives include waste inventory, waste loading (glass specifications), blending, and the efficiency of the separations processes.

The waste inventory that has been used for all alternatives is provided in Volume Two, Appendix A along with a discussion on data accuracy and uncertainty.

Waste loading is the mass fraction of the nonvolatile waste oxides in the vitrified waste. The waste oxide loading would be controlled by the amount of glass formers that are added during the vitrification process. The higher the waste loading, the more waste that would be contained in the vitrified glass and the lower the waste volume.

Blending is the mixing of the waste from different tanks during retrieval to obtain an average waste feed stream for treatment. Because there are 177 tanks that contain waste and the waste composition varies from tank to tank, it would be difficult to achieve a completely uniform blending of the waste during retrieval.

Separating the waste into HLW and LAW streams for treatment would involve various processes to physically or chemically separate specific constituents in the waste stream. The separations efficiency would be a measure of how well these processes work and would define the amount of each constituent that would be processed in the HLW and LAW treatment facilities.

The assumptions used for each of the factors described previously and their combined affect on the overall volume of HLW and LAW are discussed in the following sections.

Waste Loading

The waste loading for all ex situ treatment alternatives except for Ex Situ No Separations was assumed to be 20 weight percent waste oxides for the HLW and 15 weight percent sodium oxide for the LAW. The waste loading for the Ex Situ No Separations alternative was assumed to be 20 weight percent sodium oxide.

Waste loading was assumed to be 20 weight percent waste oxides (this includes all waste constituents that would be converted to oxides in the vitrified waste form, excluding the sodium and silica contained in the tank waste) for HLW glass for each alternative that would involve separating the HLW and LAW. Because the No Separations alternative would not separate the HLW and LAW, all of the sodium in the waste inventory would be converted into the HLW glass and the methodology described for the other alternatives would not be valid. The 20 weight percent sodium oxide loading for the No Separations alternative would result in a glass that would be equivalent to established glass compositions defined in the Waste Acceptance System Requirements Document (DOE 1995s). The Waste Acceptance System Requirements Document does not set specific limits for the different constituents that make up waste loading, but instead requires that for acceptance a waste form must be equal to or better than the reference glass.

The waste loading would affect the volume of waste that would be produced from a given amount of waste. This volume, along with the operating schedule and the assumed operating efficiency, would determine the size of the processing facilities and the operating resource requirements required to support the process. A decrease in waste loading would then translate into a larger volume of vitrified waste, larger treatment facilities or longer operating schedules, increased resource requirements, and higher disposal cost.

Waste loading may typically range from 20 to 40 weight percent waste oxides with 30 to 35 weight percent loading used as a target value. The Defense Waste Processing Facility glass has a design basis waste loading of 25 weight percent and a maximum waste loading of 38 percent (DOE 1995s).

The waste loading for all alternatives that would produce LAW was assumed to be 15 weight percent sodium oxide. The volume of LAW produced affects the size and number of LAW disposal vaults that would be built onsite.

Waste Blending

Each of the ex situ alternatives that use vitrification as an immobilization technology have assumed a waste blending factor of 1.2 for the HLW to account for variations in the composition of the waste during retrieval operations. Variations in the waste feed composition would not affect the calcined product that would be produced by the Ex Situ No Separations (calcination) alternative. Uniform blending would require simultaneous retrieval from specific groups of tanks to deliver a uniform average feed stream to the treatment facilities. The blending factor would be multiplied by the volume of HLW produced under uniform blending conditions to calculate the volume of HLW expected due to variations in the waste feed. Because variations in the waste feed composition would not be expected to affect the LAW vitrification process, a blending factor of 1.0 was assumed for LAW. One of the major sources of uncertainty associated with developing a retrieval sequence that would achieve a uniform blending was the lack of accepted tank-by-tank inventory data. The HLW blending factor for Hanford tank waste was the recommendation of an independent technical review team (Taylor-Lang 1996) .

Separations Efficiencies

The volume of vitrified HLW produced would be a function of the waste loading and the mass of waste to be vitrified. Reducing the HLW volume through separations processes would therefore require separating the nonradiological constituents from the HLW constituents during the pretreatment process. The lower bound on the number of canisters that could be produced would be controlled by the heat-generating limit of 1,500 W per canister (DOE 1995q). This heat-generating limit would provide a lower bound on the number of 1.2- m^3 (41 -ft^3) canisters of 177 for the tank waste and 298 for the tank waste combined with the Cs and Sr capsules (WHC 1995e). The following flowsheet assumptions would affect the volume of HLW produced:

Intermediate Separations, Phased Implementation, and ex situ portion of the Ex Situ/In Situ Combination 1 and 2 alternatives :

- The enhanced sludge washing process would solubilize 85 percent of the aluminum, 75 percent of the Cr, and 70 percent of the phosphate into the liquid phase, and following solid-liquid separations these would be included in the LAW feed;
- Solid-liquid separation would assume gravity settling in the tanks followed by decanting of the liquid. The solids settling process was assumed to achieve 50 weight percent solids.

Extensive Separations:

- Solid liquid separations would use centrifuges capable of achieving 0.1 percent solid in clarified liquids.
- Acid-side dissolution of the solid phase species would assume between 50 and 90 percent dissolution in a two-step dissolution process. This would include recycling 95 percent of the undissolved solids from the second acid dissolution step back to the caustic leaching step to begin another dissolution cycle. The remaining 5 percent of the undissolved solids would be sent to the HLW process. There is uncertainty in the optimistic acid-side dissolution assumptions that are critical to the volume of HLW produced by the extensive separations process.

The volume of HLW produced would directly impact the number of HLW packages requiring disposal at the potential geologic repository, which in turn would affect the cost associated with disposal. The number of HLW packages produced would also determine the number of offsite shipments required to transport the immobilized HLW to the potential geologic repository. The waste loading would also determine the concentration of radiological contaminants in the waste form. There would be a relationship between the waste loading, number of shipments (probability of an accident), and the concentration of contaminants in the waste form (consequence of an accident). As the waste loading increased, the probability of an accident would go down because there would be fewer trips required to transport the waste, but the consequences of an accident would go up because there would be a higher concentration of contaminants in the waste form (see Appendix E, Section E.15.0 for a discussion of accident uncertainties).

Canister Size and Type

Two sizes of HLW canisters were assumed for the ex situ alternatives. All of the ex situ alternatives except the No Separations alternative assumed a canister size of 0.6-m inside diameter by 4.57-m long (2-ft inside diameter by 15 ft long) with a net volume capacity of 1.17 m^3 (41 ft^3). The Ex Situ No Separations alternative (both vitrification and calcination) assumed a canister size of 1.7-m diameter by 4.6 m long (5.5-ft diameter by 15 ft long) with a net volume capacity of 10 m^3 (360 ft^3).

It is recognized that these sizes are larger than the 0.62-m^3 (22-ft^3) standard size canister that is identified for canistered HLW in the current waste acceptance requirements at the potential geologic repository (DOE 1995q). However, the DOE Office of Civilian Radioactive Waste Management has recently acknowledged the technical acceptability of a longer canister (e.g., 0.6-m diameter by 4.6 m long [2-ft diameter by 15 ft long]) for Hanford HLW (Milner 1996). The larger 10-m^3 (360-ft^3) canister assumed for the No Separations alternative was not evaluated for acceptance by the Office of Civilian Radioactive Waste Management. The large canister would occupy the same space as a standard waste package. The standard waste package would consist of four 1.2-m^3 (41-ft^3) canisters within a large disposal container. The design of the waste package and canister sizing has not been finalized.

B.8.3 COST UNCERTAINTY

Cost uncertainty for the various tank waste treatment alternatives has been evaluated using Decision Science

Corporation's Range Estimating Program for personal computers. The Range Estimating Program has been applied to thousands of diverse problems by thousands of users. The Range Estimating Program inputs allow the user to specify a simple range rather than require selection of a probability density function. The Range Estimating Program outputs identify, quantify, and rank the risks.

The upper level of the cost range for new technologies was estimated such that there was a high certainty that its capital or operating cost would not be exceeded. This upper level (as a percent of the estimated cost) varied up to a high of plus 200 percent based upon the degree of uncertainty and complexity of the technology. The use of this high-range level addressed the concerns expressed in the System Requirements Review, Hanford Tank Waste Remediation System Final Report issued April 1995, which indicated that actual costs of new technology facilities of the type under consideration herein can often exceed estimated costs by a factor of two or more (DOE 1995s).

The information presented in Table B.8.3.1 identifies a range for the total estimated cost of each alternative. This range represents the calculated variation in estimated cost that could occur for any of the alternatives. This range is a function of input parameters such as the level of design development, uncertainties associated with implementability, and assumptions made for the relative uncertainty of different cost components. The total estimated cost range is statistically based and was obtained through a Monte Carlo simulation. The input parameters are based on the alternatives described in the EIS; however, major changes to the waste inventory, conceptual designs, or major assumptions would change the estimated cost range.

Table B.8.3.1 Comparison of Tank Waste Alternatives Cost Uncertainty

Input to the Range Estimating Program was based on best available information, conceptual cost estimates, and engineering judgement (Jacobs 1996).

B.9.0 TECHNOLOGIES

As discussed in Section B.2.0, there are numerous technologies that could be used for remediating tank waste. Technologies are specific processes that form the building blocks of the alternatives. Alternatives are then made up of a set of technologies that have been designed to function together.

Technologies that were not included in the alternatives that were developed for impact analysis, but are still viable as potential components of a remediation alternative are discussed in this section. For example, the technology selected for inclusion in the alternatives for immobilizing the LAW was vitrification. However, the ceramic waste form may also be viable and could be substituted as a LAW immobilization process.

B.9.1 IN SITU WASTE TREATMENT TECHNOLOGIES

In Situ Grout

Grout is a common solidification and stabilization technology used in managing hazardous waste. Stabilization is a process in which additives are mixed with the waste to minimize the rate of contaminant migrating from the waste form. Solidification is a process in which additives are mixed with the waste to yield a physical waste form, as measured by properties such as permeability and compressive strength, that is acceptable for waste storage or disposal. Performance measures used to evaluate solidification and stabilization technologies are obtained through leaching tests that provide data on the rate at which contaminants are released from the waste form under the action of water.

In situ grout is a technology that could be used to immobilize the waste and stabilize the tanks as an option to the waste drying and gravel filling operations described in the In Situ Fill and Cap alternative. Applying this technology would involve adding a grout mixture to each of the tanks, mechanically mixing the waste with the grout mixture, and stabilizing the tanks by filling the dome space with grout. Using this technology would leave the waste its current locations for disposal as in the In Situ Fill and Cap alternative, except that the waste would be solidified in a grout matrix instead of dried. After completing grouting operations, a Hanford Barrier would be installed over each of the tank farms.

A pozzolan-based grout formulation made up of sand, flyash, water, cement, and air entrainment additive could also be used (WHC 1995f). Pozzolanic materials can react with lime in the presence of water to produce a solid cement-like material. Flyash is the most commonly used pozzolanic material. Other types of grout formulations include cement-based thermoplastics and organic polymer-based grouts. Implementation of this technology would require the following actions:

- Reduce the volume of liquid in the DSTs by evaporation;
- Construct a TFCF over each tank farm;
- Remove the soil covering the top of each tank;
- Remove the top of each tank (dome) for access by the grout mixer; and
- Mix the waste mechanically in each tank with the grout mixture.

Grouting the tank waste in situ would result in a waste form with lower contaminant leachability compared to drying the waste and filling the tanks with gravel. However, if the rate of water infiltration to the waste form is controlled by using an effective surface barrier, the infiltration rate becomes the controlling factor in contaminant flux. Thus, the difference in performance of the in situ grout waste form in the In Situ Fill and Cap alternative is expected to be minor when a Hanford Barrier is used.

The impacts associated with implementing the in situ grout technology would be bounded by the impacts associated with the In Situ Vitrification alternative and the In Situ Fill and Cap alternative. In situ grouting would require a TFCF during operations, which would greatly increase the capital cost requirements and construction personnel levels over levels estimated for the In Situ Fill and Cap alternative. The capital costs and construction staffing requirements would approach those estimated for the In Situ Vitrification alternative. In addition, there would be an increase in offsite transportation associated with in situ grouting to bring the grout forming materials onsite.

In Situ Vitrification of Individual Tanks

The In Situ Vitrification alternative is based on the assumption that during operations, because of overlapping melt regions, the entire tank farm would be vitrified. In situ vitrification is a technology that could be applied to vitrify individual tanks or selected areas within the tank farms. Because the molten region would expand during vitrification, some overlapping of vitrified areas between tanks would be expected.

Minimal impacts would be associated with vitrifying the individual tanks and minimizing the vitrified region between the tanks as opposed to vitrifying the entire tank farm area. Using alternative confinement concepts that provided confinement and off-gas collection for an individual tank may reduce the construction and resource impacts compared to those associated with building a TFCF over each tank farm. This technology is not mature enough to accurately define the limits of the vitrified zone.

Use of Previously Contaminated Materials

To assess impacts and estimating costs, this EIS has assumed that all fill and borrow material is uncontaminated. However, it may be possible to use slightly contaminated material for glass formers in the in situ vitrification process. This alternate material must be characterized so that it would be added in the correct proportions and potential exposures would be within Site and DOE limits. The impacts associated with using previously contaminated materials would include a slight increase in groundwater contamination and potentially higher costs associated with added characterization and personnel protection. The amount of LAW from other areas would be reduced.

B.9.2 WASTE RETRIEVAL AND TRANSFER TECHNOLOGIES

The function of waste retrieval and transfer technologies is to remove the waste from the tank and transfer the waste to a treatment facility. Waste retrieval and transfer technologies are applicable to all ex situ alternatives where waste treatment will occur outside of existing storage tanks.

Retrieval Criteria

The current waste retrieval criteria is assumed to be capable of removing 99 percent of the existing waste volume from each tank during retrieval operations. This assumption is based on judgement and waste retrieval operations performed at the Hanford Site in the past. The current physical form of the waste stored in some of the SSTs appears to have dried and aged to the point that waste retrieval assumptions based on past practices may not be valid, and the criteria of 99 percent waste retrieval from each tank may be impractical or impossible using current retrieval concepts.

Retrieving 99 percent of the tank waste would leave a residual waste inventory of 1 percent in each tank. This 1 percent residual would be treated as a source of contamination that would, after a long period of time, migrate out of the tanks and become available for transport through the vadose zone. The rate of migration and transport of the contaminants would be highly dependent on the rate at which water infiltrates the residual waste, which would be controlled by installing a Hanford Barrier over the tank farms following retrieval.

Retrieving less than 99 percent of the tank waste would result in a larger residual inventory being left in the tanks for disposal. In turn, this large tank waste residual inventory would result in increased levels of long-term risk associated with the release and migration of contaminants associated with the larger residual inventory.

Retrieval Using Alkali Solutions

Retrieving alkali soluble residuals is a technology that could be used during retrieval operations for any of the ex situ alternatives. Retrieving alkali soluble residuals would involve washing the tanks with an alkali (sodium hydroxide) solution to remove the alkali soluble portion of the remaining waste solids for additional processing. Retrieving alkali soluble waste could allow increased retrieval for certain types of tank waste. The impacts of using this technology would be increased chemical additions to the waste inventory and potentially lower residual waste inventory left in the tanks following retrieval.

Retrieval Using Acid Solutions

Dissolving tank residuals in acid is a technology that could be used during the retrieval operations for any of the ex situ alternatives. This technology could be used to dissolve hardened sludges and waste that could not otherwise be retrieved, which would help achieve a specific retrieval criteria. The dissolving action of the acid on the residual waste would also act on the interior of the tank and could open or enlarge an existing leak path. This technology would be most applicable to DSTs because the outer tank shell would contain any leakage developed by the inner shell. Implementing this technology would require controls to minimize the potential for increased tank leakage. The impacts of using this technology would be increased chemical additions to the waste inventory and potentially lower residual waste inventory left in the tanks following retrieval.

Tank Waste Retrieval Technologies

Many different technologies to retrieve the tank waste have been identified and evaluated (Boomer et al. 1993). The function of a retrieval technology is to remove the waste from the underground storage tanks in a safe, effective, and efficient manner that meets a defined retrieval criteria for the volume of waste retrieved. Retrieval technologies that have been identified and could be used to retrieve tank waste during any of the ex situ alternatives include.

- Mechanical retrieval would use a mechanical device like a back-hoe bucket or skip hoist to mobilize the waste and remove it from the tank. Mechanical retrieval would require an arm-based maneuvering device that would permit remote operation of the retrieval system.
- The Houdini waste retrieval system is a small, remotely-controlled robotic crawler type vehicle that is being evaluated at other DOE sites for waste retrieval operations. This type of technology could be selectively applied following other retrieval technologies to achieve retrieval criteria. The Houdini system being developed would collapse to fit through existing tank openings and would have mechanical attachments that would be used to break up and mobilize waste.
- Pneumatic retrieval is similar to hydraulic retrieval methods except that air would be used to move the waste as opposed to liquid.

Subsurface Barriers

Subsurface barrier technology could be used during retrieval operations for any of the ex situ alternatives. Subsurface barriers are most suitable for use in conjunction with hydraulic retrieval technologies, which have a higher potential for SST leakage. Subsurface barriers would not stop a leak but would provide containment to control the migration of tank leakage. Subsurface barriers are impermeable layers that would be installed in the soil surrounding a tank to contain any leakage that might occur during waste retrieval operations. The possibility of using subsurface barriers derived from concerns about using hydraulic sluicing for retrieval, and because some of the SSTs are either confirmed or assumed leakers. The function of the subsurface barriers would be to prevent tank leakage from migrating beyond the barrier into the vadose zone. This would help leak cleanup by minimizing the volume of contaminated soil.

A study titled Feasibility Study of Tank Leakage Mitigation Using Subsurface Barriers (Treat et al. 1995) has been completed in support of Tri-Party Agreement Milestones M-45-07A (Ecology et al. 1994). This feasibility study assessed:

- The potential environmental impacts of waste storage and retrieval activities without the application of subsurface barriers;
- Functional requirements of subsurface barriers to minimize the impacts associated with waste storage and retrieval activities; and
- The application of existing subsurface barrier technologies and the potential of existing technologies to meet functional requirements for SST waste storage and retrieval activities.

Fourteen different tank waste retrieval alternatives were analyzed in the feasibility study. The alternatives ranged from a No Action alternative, in which none of the waste was retrieved, to clean closure, where waste retrieval activities were assumed to remove 100 percent of the tank waste. The alternatives analyzed represented combinations of technologies for waste retrieval, subsurface barrier containment, tank stabilization, and surface barriers. The 14 alternatives analyzed included 8 alternatives with subsurface barriers and 6 alternatives without subsurface barriers.

The following subsurface barrier technologies were screened in the feasibility study as potential technologies that could be used for subsurface barriers:

- Chemical jet grout encapsulation;
- Freeze walls;
- Jet grout curtains;
- Permeation chemical grouting;
- Wax emulsion permeation grouting;
- Silica, silicate permeation grouting;
- Polymer permeation grouting;
- Formed-in-place horizontal grout barriers;
- Circulating air barriers;
- Radio-frequency desiccating subsurface barriers;
- Sheet metal piling subsurface barriers;
- Close-coupled injected chemical barriers;
- Induced liquefaction barriers;
- Slurry walls;
- Deep soil mixing;
- Soil fracturing longwall mining;
- Modified sulfur cement;
- Sequestering agents;
- Reactive barriers;
- Impermeable coatings;
- Microtunneling;
- In situ vitrification; and
- Soil saw (uses reciprocating high-pressure jets of grit or bentonite to create a vertical barrier).

Screening of the potential technologies resulted in selecting the following five barrier technologies for detailed analysis:

- Close-coupled injected chemical barrier. This would involve injecting chemicals (e.g., portland cement) directly adjacent to the tank sides and bottom. The term close coupled indicates that the barrier would be right next to the tank walls;
- Box-shaped chemical wall. A low-permeability basin would be formed beneath the level of existing soil contamination. This is a stand off type of barrier in which the bottom of the barrier would be sloped to a low point to help collect tank leaks. The barrier would be constructed of a low-permeability material such as portland cement;
- V-shaped chemical barrier. This stand off type of barrier would use angle drilling techniques to construct a V-shaped barrier that would start at the surface on each side of a tank farm and angle down to meet in the middle. The slope of the angled barrier walls would facilitate liquid collection and removal;
- Freeze wall. The V-shaped freeze wall would be similar to the V-shaped chemical barrier except that ice would be used instead of chemicals to create the barrier; and
- Circulating air barrier. The circulating air barrier would rely on water evaporating from the soil, limiting the ability of a leak to migrate through the vadose zone.

A comparative risk assessment and cost estimate was made for each of the alternatives evaluated in the feasibility study. This analysis provided an evaluation of the impacts of waste storage and retrieval with and without the use of subsurface barriers. The following conclusions were drawn from the subsurface barrier study.

- All functional requirements can potentially be satisfied using any of the subsurface barrier options evaluated. This conclusion is clarified with the observations that 1) little data on the performance of subsurface barriers exist; and 2) the draft functional requirements are largely and appropriately qualitative at this early state of development.
- Using any of the subsurface barrier concepts in general applications to tank farms would result in relatively small incremental reductions in the risk level achievable using baseline retrieval technologies (traditional sluicing, empty tank stabilization, and surface barriers).
- The cost-effectiveness of the subsurface barriers, calculated by the method most favorable to subsurface barriers, is about 1E-04 times that of surface barriers, and 1E-02 times that of the set of baseline technologies. Uncertainty in the performance of subsurface barriers is high, but because the impact of subsurface barriers on risk and cost-effectiveness is low, even the best-case assumptions of subsurface barrier performance have a relatively small effect on overall risk and cost-effectiveness of SST disposal options.

Waste Transfer Technologies

The function of waste transfer technologies in each of the ex situ alternatives would transport the waste as it was retrieved from the tanks to a nearby processing facility. The method of waste transfer would be through a pipeline. An alternate transfer technology would be containerized waste transfer. Containerized transfer of the waste would involve placing the waste into a container as it came from the retrieval system and transporting the containers to the waste treatment facility. Containerized waste transfer is better suited to mechanical and pneumatic transfer methods than hydraulic retrieval methods. Containerized transfer would avoid the potential mixing of incompatible tank waste. The impact of containerized waste transfer between the tanks and the treatment facility would include:

- Increased radiological exposure;
- Increased onsite transportation; and
- No construction of the waste retrieval annexes described in the ex situ alternatives.

Truck Transfer

Truck transfer of waste using a modified tanker trailer truck or an LR-56(H) truck (specially designed vehicle for onsite transfers) is a technology that could be used as an alternative to the transfer of waste through pipelines. It could also be used to support various characterization activities and pretreatment/treatment activities. This waste transfer technology would use trucks to transport liquid waste between permanent or portable loading facilities. Waste transfer using trucks is better suited to limited waste volumes and intermittent transfers.

Truck transfer of waste was evaluated in the SIS EIS (DOE 1995i) as an alternative to constructing a replacement cross-site transfer system to transfer waste from 200 West to 200 East Area. A modified tanker trailer with a capacity of 19,000 L (5,000 gal) and the LR-56(H) with a capacity of 3,800 L (1,000 gal) were evaluated as options to pipeline transfer for an estimated 2E+07 L (5E+06 gal) of waste from the 200 West Area to the 200 East Area.

The analysis performed for the SIS EIS concluded that the environmental impacts associated with truck transfer of waste were not appreciably different from those associated with pipeline transfer except in the area of worker exposure. Worker exposure would be higher due to increased exposure for the truck driver and the workers involved with load and unload facility operations.

Table B.9.2.1 summarizes the number of LR-56(H) truck trips estimated to transfer waste from T Plant and PFP. The number of trips associated with using the modified tanker trailer would be fewer because of the larger capacity. These estimates were developed using the T Plant and PFP waste volume projections.

Table B.9.2.1 Estimated Truck Trips Required for T Plant and PFP Waste Transfers

The impacts from the transfer of the projected PFP and T Plant waste were estimated to be similar to the impacts associated with implementing the replacement of transfer lines. Implementing truck transfer to transport waste from T Plant and PFP to the DSTs in the 200 East Area would require constructing or upgrading loading facilities and improving Site roads to accommodate the trucks. The worker exposure associated with truck transfer of the waste would be higher than the exposure associated with pipeline transfer of the same waste.

LR-56(H) Truck for Transporting Liquid Radioactive Waste

The LR-56(H) truck is a specifically designed vehicle for transporting liquid radioactive waste between areas on the Hanford Site. The vehicle is designed to U.S. Department of Transportation standards and regulatory standards specific to the Hanford Site. The design includes lead shielding around a tank (capacity approximately 3,800 L [1,000 gal]) with redundant level and temperature monitors, alarms, and pumps for waste transfer. The truck can use either portable or permanent waste loading facilities at the point of origin and at the destination point.

Liquid waste could be transferred from such locations as PFP, T Plant, the 300 Area facilities, 100 Area, and the 400 Area to waste processing facilities or to the DST system . Other uses of the truck to transfer liquid waste could include transferring the following waste into the TWRS management system:

- 100 Area cleanout waste from the 100 Area facilities;
- 300 Area fuel supply cleanout, waste from the 340 Building, and other 300 Area facilities;
- Miscellaneous transfers within the 200 Areas where pipeline transfer would not be an option due to failure, nonexistence, or lack of compliance status of existing lines;
- MUSTs cleanout across the Hanford Site; and
- Accumulations of contaminated rainwater (not greater in activity than HLW contained in DSTs/SSTs) from areas such as diversion boxes or tank vaults as needed to prevent spillage or leakage to ground.

B.9.3 EX SITU WASTE TREATMENT TECHNOLOGIES

Ceramic Waste Forms

Ceramic materials encompass a broad group of nonmetallic, inorganic solids with a wide range of compositions and properties. Their structure may be either crystalline or glassy. The ceramic form is often achieved by high-temperature treatment (burning or firing). Ceramics are stable, durable, and considered very leach resistant. Ceramics could be used in place of vitrified glass as an immobilization treatment for either HLW or LAW in any of the ex situ alternatives.

Immobilizing the tank waste using ceramic technologies would involve 1) retrieving the waste from the tanks; 2) potentially separating the waste into HLW and LAW components; and 3) performing waste pretreatment, which could include calcining, adding ceramic formers, and thermally treating in the range of 1,200 C (2,200 F) to obtain the desired properties.

Tailored ceramics have been identified and evaluated for immobilization of tank waste. Tailored ceramics refer to a mixture of different types of ceramic formers developed to immobilize a waste stream. Each of the different types of formers used would have the ability to chemically bind a specific waste element. Additional strength and chemical durability can be designed into the waste form when adding an excess of the tailoring species.

The ceramic form evaluated for immobilizing HLW was an aluminosilicate compound, Synroc D, which consists of zirconolite, perovskite, spinel, and nepheline. Sodium would be immobilized in this compound as nepheline. The theoretical sodium oxide loading based on all formulation assumptions would be 22 weight percent. For application at the Hanford Site, the ceramic form assumed to be produced would consist of nepheline, monazite, and corundum.

Ceramics could be formed into different physical forms including monoliths or pellets. Pellets could be manufactured in a continuously vertical shaft kiln while the ceramic monoliths would require a hot isostatic pressing operation to form the ceramic. Hot isostatic pressing is a commercial process in which the canister containing the waste and ceramic formers is evacuated and placed in a vessel that is pressurized between 15 to 70 MPa (2,000 to 10,000 psi) at a temperature of approximately 1,200 C (2,200 F). With similar waste loadings, the hot isostatic pressed ceramic technology and the vitrification technology would yield similar volumes of waste for disposal.

The impacts of using ceramic-forming technologies to process the tank waste would be approximately the same as those impacts associated with vitrifying the tank waste. Both technologies are ex situ waste treatments used to immobilize the waste. Ceramic technologies would require the following facilities to process the waste:

- Retrieval and transfer systems;
- Separations facilities if required;
- Waste processing facilities;
- Interim storage facilities for HLW; and
- Disposal facilities for LAW.

Vitrification Technologies

Vitrification is a molten glass process in which the waste would be combined with glass-formers and heated to glass-forming temperatures. The melter is the piece of equipment that would take the waste material and glass-formers, heat the feed material to a glass-forming temperature of approximately 1,200 C (2,200 F) where chemical and organic destruction occurs, and output a molten glass product containing the waste.

Vitrification melters vary by their methods of heating the waste, feeding the waste, and the glass product produced. In addition, glass melters can operate in a batch or continuous mode. Some of the melter types identified for potential application to waste vitrification include the following:

- Joule-heated ceramic lined melters;
- Induction melters;
- Microwave melters;
- Plasma-arc melters;
- Transferred plasma melters;
- Fuel-fired melters; and
- Cold-crucible melters that use a cooled-glass skull on the melter walls to prolong melter operating life.

Melters that require a dry waste feed stream would require calcining before being fed. The calcining step would remove excess water, destroy some of the chemical compounds, and convert the major constituent in the feed (i.e., sodium nitrate) into an oxide or a carbonate.

The French have developed and operated vitrification processes using a rotary calcine and metal melter to vitrify waste that resulted from reprocessing spent nuclear fuel from light-water reactors. This process calcines the acidic waste and continuously feeds an induction-heated metal susceptor and crucible. The borosilicate glass product formed is then poured into canisters approximately 1.3 m (4.2 ft) high and 0.43 m (1.4 ft) in diameter (DOE 1990).

The process developed for waste vitrification at the West Valley Demonstration Project in New York State and at the DOE Savannah River Site in South Carolina is the liquid-fed ceramic-lined melter. The liquid-fed ceramic-lined melter is a joule-heated melter developed from commercial ceramic-lined melters for use in vitrifying defense waste (DOE 1990).

The impacts associated with selecting a different melter type for the ex situ vitrification alternatives would involve potential changes in volume, composition, and treatment for the melter off-gas, changes in the resources required to fire the melter, and possible facility impacts required to accommodate the space requirements for the melter and off-gas equipment. For example, fuel-fired melters would generate a larger volume of off-gas than other melter types. This larger off-gas volume would require larger treatment equipment in the off-gas train for emissions control. One potential benefit of using a fuel-fired melter would be the higher throughputs that could be achieved. Some melter types might not be suitable for scaling up to high capacity and would require multiple melters operating in parallel to achieve high capacity production rates, which may increase the size of the facility.

Calcination Technologies

Calcination is the process of removing water and heating the waste to a temperature sufficiently elevated to decompose some of the chemical compounds such as hydroxides or nitrates. Calcination differs from vitrification in that calcination temperatures would not necessarily cause the reacting materials to melt and form a glass. The calciner is the piece of equipment that would heat the feed material to a calcination temperature of approximately 700 C (1,300 F) where the chemical and organic destruction occurs and output a solid waste product.

Calciners can vary by their methods of heating and feeding the waste, and the solid characteristics of the waste produced. Some of the calciner types identified for potential application to waste calcination include the following:

- Spray calciners;
- Rotary calciners;
- Fluid bed calciners;
- Indirect fired calciners; and
- Electrically heated calciners.

The impacts associated with selecting a different calciner type for the calcination alternative would involve potential changes in: volume, composition, and treatment for the calciner off-gas; changes to or elimination of the compaction step required for the solid produced; changes in the resources required to fire the calciner; and possible facility modifications required to accommodate the space requirements for the calciner, compactor, and off-gas equipment.

Alternate Glass Compositions

Borosilicate glass is based on a composition of silicon dioxide, boron trioxide, sodium oxide, and lithium oxide. Borosilicate glass has been chosen by most countries as the standard final waste form for either HLW or LAW disposal. For possible use at the Hanford Site, borosilicate glass was chosen over other waste forms for its durability, ability to accommodate a varied range of waste feeds, and its adaptability for radioactive waste processing at an industrial level (DOE 1990).

Other types of glass, including the soda lime glass that would be produced by the Ex Situ No Separations alternative, could be selected as glass types for the final waste form for vitrified tank waste. The type of glass selected for use in the vitrification process is controlled by the types and proportions of glass formers used. The driving factors for selecting a glass type include waste loading, leachability, processability, and waste acceptance criteria at the potential geologic repository.

The impacts associated with changing the composition of glass produced in the vitrification process would be minimal for any of the ex situ vitrification alternatives provided the waste loading remained approximately the same. The glass waste loading limitations control the volume of final waste product requiring disposal. This in turn could have substantial impacts associated with transportation of the glass and charges assessed by the repository.

Separations Technologies

Separations refers to a broad range of technologies for removing or separating selected chemical constituents from other constituents. Application of separations processes would typically be designed to remove specific constituents from material flow streams within a processing plant and could be carried out in either a continuous or batch process. These processes fall into the general categories of chemical, physical, or a combination of chemical and physical.

New separations processes that show potential benefits in the areas of improved separations efficiencies, economic benefits, reduced secondary waste generation, superior performance, or environmental impacts are continually being identified and developed for potential application. One example is the application of amorphous silica gels that can be tailored to sequester selected elements at a specific pH.

The process described for the Ex Situ Extensive Separations alternative contains many but not all of the concepts that potentially could be used to extract specific components from the waste. Other concepts have been proposed that would potentially enhance the separation of other HLW components. However, adding other processes to the flowsheet would have a negligible effect on the impacts of this alternative. The quantity of HLW sent to the repository would not be materially decreased.

Off-Gas Treatment Technologies for Radionuclides

The design of off-gas treatment systems for each alternative would ensure that emissions of radionuclides would be below regulatory limits. For the In Situ Vitrification alternative, the probability of a cancer fatality to the maximally-exposed individual in the general public from exposure to routine off-gas emissions would be 1.6E-11. For the Ex Situ Intermediate Separations alternative, the probability of a cancer fatality to the maximally-exposed individual in the general public from exposure to routine off-gas emissions would be 3.3E-06. Volume Three, Appendix D of the EIS provides further discussion of the risk associated with each alternative. Should it be determined that radionuclide emissions from the stack gases were to be reduced to levels more restrictive than current regulations, specific treatment technologies would be examined on a case-by-case basis.

The I-129 in the tank waste would be volatilized as I_2 during thermal treatment processes. Gaseous iodine would not be captured using traditional HEPA filtration. Two technologies that could be used to capture gaseous iodine would be adsorption on activated carbon and reaction with silver to form silver iodide. Recovering iodine in minute amounts is expected to be inefficient.

The control of C-14 emissions from any of the thermal treatment processes would be difficult. During vitrification the C-14 would be oxidized to CO_2 along with all other nonradioactive carbon in the waste stream. The CO_2 containing the C-14 would make up a small percentage of the total CO_2 in the off-gas stream. However, any treatment technology used to capture the C-14 would have to capture all of the CO_2. This potentially could be done by passing the off-gas through a recovery system in which CO_2 is precipitated as calcium carbonate via reaction with a lime scrubbing solution. This process would generate a substantial secondary waste stream that would require further processing and disposal.

For the Ex Situ No Separations (Calcination) alternative process, the majority of C-14 present would be incorporated into the waste product in the form of solid carbonate salts. Only a small percentage of C-14 would be released as CO_2 gas.

Grouting of Retrieved Tank Waste

Grouting of the retrieved tank waste is a technology that could be applied to any of the ex situ alternatives. As previously described, grout is a common solidification and stabilization technology employed in the management of hazardous waste. Grout is a general term that refers to a waste form obtained by mixing waste with chemical additives to stabilize and immobilize the hazardous constituents. The grouting process applied to the ex situ treatment of the tank waste would involve waste retrieval and transfer to a grout facility where the waste would be mixed with appropriate mixtures of grout formers. After the grout was mixed, it would be placed into containers for solidification and disposal.

Grouting of tank waste has been extensively studied at the Hanford Site for use as a technology for LAW disposal. Grouting of the LAW was selected as the LAW treatment method in the Hanford Defense Waste EIS (DOE 1987). The LAW described in the Hanford Defense Waste EIS included liquid waste from the tanks (after separation of HLW components) and secondary waste from the HLW vitrification facility, which would consist of waste from canister decontamination, drying of feed material, and off-gas treatment. As a result of a revised technical strategy and stakeholder input, grouting of LAW was replaced by vitrification of LAW as the proposed waste treatment technology. Even with this strategy, there still will be a requirement to grout the LAW generated as secondary process waste from the HLW vitrification facility and the additional LAW vitrification facility. However, this grouting facility would be greatly reduced in size.

The impacts associated with grouting the tank LAW for onsite disposal instead of vitrifying the LAW would include the following:

- Potentially increased volume of waste requiring disposal. The estimated volume of grouted LAW would be approximately three times the volume of vitrified LAW. This would increase the number of vaults and the permanent land use commitment for disposal vaults by 14 ha (35 ac);

- Increased contaminant flux out of the waste form during groundwater leaching because of a higher leachability of grout compared to glass. This would result in some increase in the long-term risk. Leachability and long-term impacts could be reduced by additional treatment such as calcination before grouting. However, calcination of the LAW would be necessary, which would result in emissions and short-term risk approximately equal to vitrification; and
- Reduced complexity of the processing facility resulting in potential reduced capital cost requirements and reduced resource requirements. A grout facility (transportable grout facility) was constructed and operated in the 200 East Area in the late 1980's. It is currently in standby and could be restarted, which would avoid some capital cost. Capacity of the plant is about 500 tons per day.

Low-Activity Waste Disposal Technologies

There are a number of disposal technologies being used or developed for LAW. These technologies use a multiple barrier system, which include the solidified LAW form itself as well as primary and secondary containment methods for the solidified LAW.

The primary containment for the solidified LAW form could be metal, concrete, or a hybrid fiber-reinforced concrete. These containers, which would be made in various shapes and sizes, are commonly referred to as drums, canisters, or containers. The primary container would be placed in a belowgrade or abovegrade secondary containment vault constructed of concrete and/or an engineered soil structure. Alternately, the vaults would be the primary and only containment for the solidified LAW.

The most important protection against releases of contaminants after disposal in a multiple barrier system is considered to be the solidified waste form itself. Because complete isolation by land disposal is difficult, the practicality of minimizing releases through improved waste forms is now recognized as both desirable and necessary. The primary function of a waste form is the retention of its hazardous and radioactive components. Also important is its structural stability for handling, transportation, storage, and disposal. Numerous materials are being used or developed for the solidification of LAW. A short description of the main categories of these materials is given as follows. Some of the following categories (e.g., a modified sulfur cement to bond a LAW glass cullet) can be combined.

- Hydraulic cements are binders that harden by chemical reactions with water. The major types of cement of interest to waste immobilization are portland, blast furnace slag, pozzolanic, aluminous, and masonry.
- Modified sulfur cement is a recently developed material that is commercially produced in the United States. The basic raw material is elemental sulfur reacted with a small percentage (5 percent) of polymer to improve physical properties. Sulfur cement is highly resistant to alkaline and acidic environments. Sulfur cement has been proposed as a waste form matrix for vitrified LAW cullet in previous engineering studies and in the engineering data packages developed for this EIS. The stability of sulfur as a matrix has not been demonstrated. The reaction of modifiers with sulfur to form a linear polymer is exothermic and requires 24 hours to complete (Boomer et al. 1993). Further investigation would be required during the design phase to determine the viability of the cullet in sulfur waste form.
- Glasses are high-melting-point materials, generally inorganic oxides, which on cooling, form an amorphous structure. For solidification, waste solids are generally incorporated into the glass structure as oxides produced during the high-temperature (1,200 C [2,200 F]) processing conditions.
- Organic polymers consist of large molecules built up by the repetition of small simple chemical units. Although there are a large number of polymeric materials suggested for the solidification of LAWs, the most prominent systems are epoxies, polyethylene, and unsaturated polyesters.
- Asphalt (or bitumen) is a complex mixture of high-molecular-weight hydrocarbons containing both aliphatic and aromatic constituents. Waste solids are mixed in and coated with liquid asphalt and mechanically held in a solid asphalt matrix after cooling.
- Ceramics encompass a broad group of nonmetallic, inorganic solids with a range of compositions and properties. Waste forms can be crystallized, glass, or chemically-bonded ceramics.

Future evaluations of LAW disposal technologies may result in the selection of other solidified LAW forms or primary/secondary containment methods.

APPENDIX C

ALTERNATIVES CONSIDERED BUT REJECTED FROM FURTHER EVALUATION

ACRONYMS AND ABBREVIATIONS

DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
HLW	high-level waste
LAW	low-activity waste
PUREX	Plutonium-Uranium Extraction
TRU	transuranic
TWRS	Tank Waste Remediation System

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length		**Area**		**Volume**	
cm	centimeter	ac	acre	cm^3	cubic centimeter
ft	foot	ft^2	square foot	ft^3	cubic foot
in	inch	ha	hectare	gal	gallon
km	kilometer	km^2	square kilometer	L	liter
m	meter	mi^2	square mile	m^3	cubic meter
mi	mile			ppb	parts per billion
				ppm	parts per million
				yd^3	cubic yard

Mass		**Radioactivity**		**Electricity/Energy**	
g	gram	Ci	curie	A	ampere
kg	kilogram	MCi	megacurie (1.0E+06 Ci)	J	joule
lb	pound	mCi	millicurie (1.0E-03 Ci)	kV	kilovolt
mg	milligram	Ci	microcurie (1.0E-06 Ci)	kW	kilowatt
mt	metric ton	nCi	nanocurie (1.0E-09 Ci)	MeV	million electron volts
		pCi	picocurie (1.0E-12 Ci)	MW	megawatt

V	volt
W	watt

Temperature

C	degrees Centigrade
F	degrees Fahrenheit

C.1.0 INTRODUCTION

This appendix describes the alternatives that were considered but rejected as inappropriate for detailed evaluation in the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS). Discussion of additional alternatives, which were suggested by the public during the Draft EIS comment period, is contained in Volume Six, Appendix L. The initial range of technology options potentially applicable for remediating the tank waste and cesium (Cs) and strontium (Sr) capsules was developed by the U.S. Department of Energy (DOE) and the Washington State Department of Ecology (Ecology). The full range of alternatives was evaluated by DOE and Ecology and options that were not appropriate for detailed evaluation in the EIS were rejected. In addition, a number of potential alternatives were suggested by the public during the EIS scoping meetings. These alternatives were also evaluated by DOE and Ecology. The alternatives that were determined to be viable were included as alternatives in the EIS and those alternatives determined to be inappropriate for detailed evaluations were rejected from further consideration. The following criteria were used to determine the appropriateness of an alternative.

- Is the alternative relevant to the purpose and need for agency action in this EIS? If not, then the alternative recommended involves a topic or subject that is not part of this EIS and is not relevant or appropriate for inclusion in this EIS.
- Is the alternative technically viable and practicable?
- Can the alternative be designed to be protective of human health and the environment with practicable mitigative measures?
- Is the technology sufficiently mature to allow detailed evaluation? This criteria refers to technologies that are purely theoretical in their potential application to the TWRS project, and the costs and the time required to develop the technology would be exorbitant.
- Is the technology appreciably different than an alternative already included in the EIS or does it offer potential advantages in terms of effectiveness, costs, or impacts to human health and the environment?

If the answer to any of these questions was no, the alternative was rejected from further consideration in the EIS.

The rejected alternatives are divided into two main categories. The categories are 1) alternatives or technologies identified as potential technology options by DOE and Ecology that did not meet one of the criteria identified previously; and 2) alternatives or technologies proposed by members of the public that did not meet one or more of the criteria identified previously. The following sections discuss the content of the rejected alternative or technology and the reason for rejecting it.

C.2.0 ALTERNATIVES AND OPTIONS DEVELOPED BY DOE AND ECOLOGY

The following alternatives were initially identified by DOE and Ecology as being potentially applicable for remediating the tank waste and capsules; however, they did not meet one or more of the criteria identified in Section C.1.0.

C.2.1 RETRIEVAL AND TRANSFER

Open Tank Mining

This retrieval method pertains to an array of potential technologies that rely on mobile surface- or subsurface-based equipment to penetrate the tank, retrieve the waste, and remove the tank. Because this method of waste retrieval would need to be adapted to a radioactive environment, the extensive redesign of existing equipment and further development would result in exceedingly complex and potentially impractical systems. Consequently, the complexity would defeat the perceived benefits. This alternative was rejected from further consideration because it was not technically viable and practicable.

Drift Tunneling

The drift tunneling concept would insert mining equipment into tunnels bored in the side or bottom of the tank. The waste would be loaded into cars that would transport the waste to the treatment facility (DOE 1995a). This concept had the following disadvantages: 1) it would require a hole in the tank below the surface of the waste; 2) it would not be likely that mining equipment could operate across the full distance of a tank; 3) a tunnel would be dug in contaminated soil; 4) the concept is more complex than a mechanical system; 5) it would be difficult to provide confinement for contaminated soil and waste; and 6) loading, transporting, and decontaminating the cars would be impractical. This alternative was rejected from further consideration because it could not be designed to be protective of human health and the environment with reasonable mitigation measures and was not technically viable or practical.

Drag Arm

The drag arm concept would consist of a chopper pump, with a cutter head used to chop up the waste, operating on a blanket of water above the waste (DOE 1995a). This concept had the following disadvantages: 1) it would require a blanket of water over waste, which would increase the potential of large leaks from the tanks; 2) it would not remove waste that has hardened on the sides and bottoms of the tanks; 3) it would not operate in tanks where equipment was disposed; 4) it would not operate in a tank with numerous risers or in-tank debris; 5) it would not remove waste around stiffening angles at sides of tank; and 6) it would be difficult to operate. This alternative was rejected from further consideration because it was not technically viable and practicable.

Mechanical Dredge

The mechanical dredge concept would consist of a floating dredge device used to scoop up the waste as it was pulled along a positioning arm by a drag cable. The device would operate on a blanket of water positioned over the waste (DOE 1995a). This concept had the following disadvantages: 1) it would not operate in tanks with numerous risers or in-tank debris; 2) it would not remove waste near debris; 3) it would require a blanket of water over the waste, which would increase the potential of large leaks from the tanks; 4) it would not remove waste that has hardened on the sides and bottoms of the tanks; 5) it would not remove waste from around stiffening angles at the sides of tanks; and 6) it would be difficult to operate. This alternative was rejected from further consideration because it was not technically viable and practicable.

Load, Haul, Dump, Elevate

The load, haul, dump, elevate concept would use a self-propelled front loader-type device to scoop up the waste and transport it to a bucket or belt conveyor that would transport it out of the tank (DOE 1995a). This concept had the following disadvantages: 1) it would not operate on an uneven waste surface; 2) it would sink below the surface on soft waste; 3) the use of buckets and belt conveyors would not be suited for remote operation; and 4) it would have difficulty operating around tank risers and other debris. This alternative was rejected from further consideration because it was not technically viable and practicable.

Continuous Miner and Elevator

The continuous miner and elevator concept would use a self-propelled mining system introduced into the tank through a large opening in the top of the tank. The miner mechanism would propel itself around the inside of the tank, mechanically chewing and cutting up the waste then transporting the waste out of the tank with a bucket or belt conveyor (DOE 1995a). This concept had the following disadvantages: 1) a self-propelled vehicle would not work well on an uneven surface of tank waste; 2) a miner would sink below the surface of soft waste; 3) mechanical conveyors would not work remotely; and 4) a continuous miner would have difficulty operating around tank risers. This alternative was rejected from further consideration because it was not technically viable and practicable.

C.2.2 SEPARATIONS (Boomer et al. 1993)

Radio-Frequency Plasma Torch and Plasma Centrifuge

This method of processing would involve separating an ionized plasma stream into heavy and light fractions. The system would consist of a radio-frequency induced plasma torch dissociator and an electromagnetic plasma centrifuge. The torch would use ionized inert gas to create a plasma dissociation zone where compounds in the feed stream would ionize into their constituent elements. Heavy mass particles would be separated from lighter mass particles in the plasma centrifuge. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation.

Selective Leaching Processes

This process represents an intermediate position between simple water washing and dissolution of the sludge and would involve the selective removal of chemical components or groups of components. Because testing is still in the laboratory phase, this alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation.

Sodium Nitrate Crystallization

This technique would involve partitioning acidified waste solutions into a small volume of sludge and a much larger volume of sodium nitrate. If used, this technology would be applied to aqueous solutions of saltcake. The solution would be adjusted to a pH level of 1 to 2, and the solution would be thermally concentrated to exceed the solubility of sodium nitrate, which is removed by filtration. One perceived technical disadvantage would be the creation of additional sodium nitrate when the solution pH is adjusted. Because laboratory-scale development is currently underway, this alternative was rejected from further consideration because it was not sufficiently mature to allow detailed evaluation.

Precipitation Removal of Transuranic Elements, Strontium-90, and Technetium-99 from Alkaline Solution

This process would involve removing transuranic (TRU) elements, strontium-90 (Sr-90), and technetium-99 (Tc-99) from the alkaline waste by such techniques as hydroxide adjustment, sulfide precipitation, or formation of insoluble phosphates. Because initial laboratory scouting tests are just underway, this alternative was rejected from further consideration because it was not sufficiently mature to allow detailed evaluation.

Nickel Ferrocyanide Precipitation of Cesium-137

This process would co-precipitate cesium-137 (Cs-137) with the addition of nickel salts and ferrocyanide. In the 1950's, Cs-137 was removed on a large scale from alkaline bismuth phosphate waste. The process was later adapted to precipitate Cs-137 from the Plutonium-Uranium Extraction (PUREX) Plant high-level waste (HLW). This alternative was rejected from further consideration because it did not appear to offer a substantial processing advantage over conventional ion exchange techniques.

Sodium Titanate Precipitation from Alkaline Solutions

This process would consist of removing Sr-90 and TRU elements by co-precipitation with sodium titanate in alkaline solutions. This process has been demonstrated on a laboratory scale at the Savannah River Site. The disadvantage of this alternative was that initial test work indicated complexed species are not co-precipitated, meaning that Sr-90 and TRU elements would remain in solution unless the complexing agents were previously destroyed. As a result, this alternative was rejected from further consideration because it was not technically viable and practicable.

Bismuth Phosphate Precipitation of Transuranic Elements

Bismuth phosphate was one of the first processes used in acidic solutions to co-precipitate plutonium and neptunium. The disadvantage of this alternative was that the process would not function properly in alkaline media and would not remove trivalent americium (Am^{+3}) even from acidic solutions. This alternative was rejected from further consideration because it was not technically viable and practicable.

Zirconium Phosphate Sorption

This process would use zirconium phosphate in a manner similar to an ion exchange resin. Zirconium phosphate would form a gelatinous amorphous solid of variable composition, which would adsorb cations because of an electrostatic charge formed at the surface. At present, there is only laboratory experience on this process; however, it is known that zirconium phosphate is unstable in the alkaline solutions such as the tank waste. This alternative was rejected from further consideration because it was not technically viable and practicable.

Molecular Recognition Removal of Transuranic Elements, Technetium, Strontium, and Cesium

This process would consist of extracting TRU elements, Tc, Sr, and Cs by a crown ether fixed on a solid substrate similar to an ion exchange media. This process would be a theoretical adaptation from using crown ethers in liquid-liquid extraction systems. This alternative was rejected from further consideration because it was not sufficiently mature to allow detailed evaluation.

Zeolites

This concept is based on using inorganic ion exchangers to remove Cs-137 from solution. The zeolite would be employed in columns similar to that of conventional ion exchange resins. Because the zeolite could not be eluted by nitric acid, which would destroy the loading capacity, it would be used once and then added to the feed to HLW vitrification. Because of the large increase in volume of HLW glass that would be produced, this alternative was rejected from further consideration because it was not considered technically viable and practicable.

Removal of Cesium-137 and Technetium-99 by Solvent Extraction

Various solvent extraction processes have been demonstrated on a bench scale and in some cases on a pilot scale for removing Cs-137 and Tc-99 from highly basic solutions. This concept had the following disadvantages: 1) the tendency to form aqueous-organic emulsions in alkaline media would lead to incomplete phase separation; 2) the polar solvents required to give acceptable phase separation are often toxic and possibly carcinogenic; and 3) large amounts of nitric acid would possibly be needed for elution. This technology was rejected because it is not considered technically viable and practicable.

Steam Reforming of Volatile Organic Compounds

This process would use the reaction of methane and steam with volatile organics at high temperatures and pressures to produce gaseous products such as carbon monoxide and hydrogen. The organics would be volatilized in fluid bed reactors. This concept had the following disadvantages: 1) many of the complexing agents in the waste would not be volatile and would remain in solution; and 2) high temperatures and flow problems with the waste would possibly cause problems in fluid bed reactors. This alternative was rejected from further consideration because it was not technically viable and practicable.

Oxalate Precipitation

The oxalate ion could be used to precipitate trivalent and quadravalent actinides and trivalent lanthanides from dilute nitric acid solution. The precipitated oxalates would be removed by mechanical means such as filtration. This technology was rejected from further consideration because it was not appreciably different and better than methods addressed in the EIS.

Lanthanum Fluoride Precipitation

This process would be used to precipitate TRU elements and lanthanides by adding hydrofluoric acid to acidified tank waste. The precipitate would subsequently dissolve in a mixture of nitric acid and aluminum nitrate. This alternative was rejected from further consideration because it was not appreciably better than the methods addressed in the EIS.

Antimonic Acid Sorption of Strontium-90

In this process, crystalline antimonic acid would selectively sorb Sr-90 from highly acidic nuclear waste solutions. This concept has not been developed further because laboratory testing has shown that no suitable eluting reagent has been identified. In addition, only small quantities of antimonic acid have been produced. This alternative was rejected from further consideration because it was not technically viable and practicable.

Phosphotungstic Acid Precipitation of Cesium-137

Phosphotungstic acid would precipitate Cs-137 in nitric acid solutions. Plant-scale recovery of Cs-137 from PUREX Plant waste has been routinely performed. The precipitated product has been recovered and subsequently purified. Because this method of precipitation would only remove 95 percent of the Cs-137, leaving 5 percent to be recovered by routine ion exchange methods, this alternative was rejected from further consideration because it was not technically viable and practicable.

Actinide Extraction Using Diamides

This process would consist of solvent extraction methods using diamides, which are bifunctional organic molecules that will extract +3, +4, and +6 actinides from strong nitric acid solutions. This concept is still in the laboratory experimentation phase. Other extractants are expected to provide superior performance. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation.

Actinide Extraction Using Carbamoylmethyl Phosphonate

The carbamoylmethyl phosphonate reagent would extract the same elements as the diamides (i.e., +3, +4, and +6 actinides). However, a more preferred extractant would be carbamoylmethyl phosphine oxide. Carbamoylmethyl phosphine oxide would be a stronger extractant and has been used successfully in bench-scale experimentation. This alternative was rejected from further consideration because it was not technically viable and practicable.

Americium Trivalent Extraction Using Dibutylbutylphosphonate

Dibutylbutylphosphonate is a phosphorus compound that has been proven to be a powerful extractant of Am^{+3} from acid solutions. However, the process development had many difficulties in controlling solution pH during extraction. The diluent employed was carbon tetrachloride, which is highly carcinogenic. This alternative was rejected from further consideration because it was not technically viable and practicable.

Cesium and Strontium Extraction Using Cobalt Dicarbolide

This solvent-extraction process would extract Cs and Sr from nitric acid solutions. Stripping would be accomplished by using strong nitric acid. Russian and Czech processes have been tested using toxic nitrobenzene as the diluent, although essentially no experimental work with dicarbolide extractants has been performed in the United States. This alternative was rejected because it was not technically mature enough for evaluation and was not better than methods addressed in the EIS.

Magnetic Separation and Flotation of Sludge Components

Magnetic separation and flotation of sludge components are physical separation processes that would potentially be applied to sludges to preferentially remove and separate components based on their magnetic characteristics and surface chemistries. The processes are commonly used in the mineral processing industries to separate the components of mined ores. These processes have not been tested for removing selected components from the tank waste sludges. Even in favorable circumstances, a certain percentage of the target material will commonly not be recovered. This alternative was rejected from further consideration because it was not technically viable and practicable.

C.2.3 WASTE TREATMENT FOR ONSITE DISPOSAL OF LOW-ACTIVITY WASTE (Boomer et al. 1993)

Electrolytic Denitration of Alkaline Nitrate Solutions

This process, which would use direct current to reduce nitrate in solution, has been the subject of limited investigation. This process was not evaluated because chromium inhibits denitration and toxic bismuth salts must be added to block the inhibiting effect. This alternative was rejected from further consideration because it was not technically viable and practicable.

Direct Calcination of the Low-Activity Waste

In this process the low-activity waste (LAW), without reducing agents such as sugar, would be fed directly into a calciner that would heat the material sufficiently to decompose carbonates, hydrates, and other compounds. This process was not selected for detailed evaluation because of the nature of the LAW feed to the calciner. This feed was composed of a major proportion of sodium hydroxide and sodium nitrate. The sodium salts would decompose in the calciner and form sodium oxide. Before the sodium nitrate and sodium hydroxide could heat sufficiently to calcine, they would melt and the molten salts would create a mush with the other solids in the calciner. This alternative was rejected from further consideration because it was not technically viable and practicable.

Inorganic Binders Used Directly on Dried Low-Activity Waste

In this process the dried LAW would be mixed with an inorganic binder that would immobilize the dried waste. However, no suitable binder material was identified. Both sulfur and lead had been mentioned as candidate binders. Both of these potential binders presented problems in their application. Sulfur binders may react with sodium nitrate in the waste, which is a powerful oxidizing agent. Lead binders would be expected to be unsatisfactory because the dried salts would float on the lead. In addition, the toxicity of lead would also lead to its rejection as a processing option. This alternative was rejected from further consideration because it could not be designed to be protective of human health and the environment with reasonable mitigative measures.

Bitumen Binders Used on the Dried Low-Level Waste

For this potential process the LAW would be mixed with a bitumen binder to immobilize the dried waste. This process had the following disadvantages: 1) fire hazard; 2) softening temperature; 3) radiation resistance; and 4) potential reactions of the bitumen with the nitrate in the salts. This alternative was rejected from further consideration because it could not be designed to be protective of human health and the environment with reasonable mitigative measures.

Hot Pressing, Hot Isostatic Pressing, Cold Pressing and Sintering, and Pellitization and Sintering

These compaction processes have been commonly used in industry to agglomerate powders of various kinds such as metals or ceramics. In the hot processing process, the powder first would be compacted with enough force to hold its shape; the compacted shape, then would be heated (in a protective atmosphere if required) until the particles fused at their surfaces and formed a durable shape that would withstand further handling and storage. These processes have only been applied on a laboratory scale. While hot pressing has been used in a demonstration program in Australia, none of these processes have the testing and demonstrated full-scale operation of vitrification. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation.

C.2.4 WASTE TREATMENT FOR OFFSITE DISPOSAL OF HIGH-LEVEL WASTE

Concrete Formed Under Elevated Temperature and Pressure

The ingredients for this process would generally be portland cement, fly ash, sand, clays, and waste (Boomer et al. 1993). This process would use accelerated curing at high temperature and pressure to produce solids that are strong and relatively impermeable. Initial tests on a high sodium nitrate waste produced a waste form that exuded liquid and cracked easily. This process might give more favorable results when the concentration of sodium salts is decreased, but no further test results were available. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation. This waste form would not meet the current waste acceptance systems requirements for the potential geologic repository (DOE 1995q).

Supergrout and Sludge in Concrete

In the supergrout and sludge in concrete processes, additives would be used in the grout to decrease the leachability of radionuclides and improve the properties of the final concrete. Supergrout would be a grout mixture of waste, special additives, and cement. Sludge in concrete would be HLW directly mixed with grout-forming materials at ambient temperatures and pressures. Waste oxide loadings for these forms have been generally less than those for vitrified products while leaching rates have been greater. These alternatives were rejected from further consideration because they were not technically viable and practicable. This waste form would not meet the current waste acceptance systems requirements for the potential geologic repository (DOE 1995q).

Aqueous Silicates

This waste form would incorporate an alkaline radioactive waste and a clay to form stable aluminosilicate minerals. This process had the following disadvantages: 1) the leaching rate of this waste form exceeded that of other waste forms; 2) immersion in water caused the waste form to crack and swell; and 3) waste loading for these salt forms was less than that for vitrified products. This alternative was rejected from further consideration because it was not technically viable and practicable. This waste form would not meet the current waste acceptance systems requirements for the potential geologic repository (DOE 1995q).

Multiphase High-Level Waste Forms, Including Cement Matrix, Coated Ceramic, Metal Matrix, and Sulfur Matrix

This process would result in a waste form consisting of two parts. The first part would typically be glass or ceramic in the form of marbles or cullet. The second form would be a matrix that covered the glass or ceramic and filled the interstices between the marbles or cullet. No advantage would be gained by using these forms for HLW because the glass or ceramic would be less reactive than the matrix material. The multiphase forms would occupy a higher volume than the glass or ceramic. This waste form would not meet the current waste acceptance systems requirements for the potential geologic repository (DOE 1995q). These alternatives were rejected from further consideration because they could not be designed to be protective of human health and the environment with reasonable mitigative measures.

C.2.5 IN SITU DISPOSAL (Boomer et al. 1991)

Heated Air Drying of Salts

This process would dry the saltcake by inserting a network of piping into the saltcake and forcing large volumes of heated air through the voids in the saltcake. However, excessive pressure would be required to force air through deep layers of the saltcake and could force solution to leak from the tanks. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation.

Resistance Heating and Induction Heating of Salts

During this process resistance heaters or induction coils would be inserted in the saltcake for drying the salts. This process had the following potential disadvantages: 1) poor heat transfer characteristics of the salts would result in excessive heating and possible melting adjacent to the heating elements or induction coils; 2) excessively high power consumptions and current densities would be expected; and 3) induction heating of very large volumes of salts has not been attempted. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation and is not technically viable and practical.

Electroosmotic Water Removal from the Saltcake

During this process fluids would diffuse through a semipermeable membrane under the influence of an electric field. This process has not been analyzed further because of the low mobility of water through salt at low moisture concentrations, and the difficulty in maintaining an effective electric field over large salt volumes. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation.

C.2.6 SPECIALIZED ALTERNATIVES

Seabed Disposal, Space Disposal, Deep Hole Disposal, Ice Sheet Disposal, and Island Disposal

These alternatives would consist of removing the tank waste and capsules from their present locations, packaging them in suitable containers, and transporting them to remote locations for indefinite disposal. These options have been previously investigated for disposal of radioactive waste and have been rejected for further consideration (WHC 1995a). National disposal policy is not within the scope of this EIS.

Geologic Disposal of Tank Contents, Tanks, Equipment, and Contaminated Soil

This alternative would involve removing the tank contents, tanks, ancillary equipment (e.g., pumps, piping), and contaminated soil from their present locations, packaging them in an appropriate manner, and placing them in a suitable potential geologic repository (DOE 1987). Removing the tanks and associated debris is not within the scope of this EIS, but will be evaluated in a future EIS. Therefore, this alternative was rejected from further consideration.

Rock Melting

This alternative would involve pumping HLW into conventionally mined cavities at depths of 1,500 to 1,800 meters (m) (5,000 to 6,000 feet [ft]) (WHC 1995a). The high levels of heat produced by the waste would melt the surrounding rock over time. In time, this melt would resolidify as a low soluble matrix. Using this alternative would require waste that generates extremely high heat. However, the TWRS tank waste (considered as a class) cannot generate the heat required. This alternative was rejected from further consideration because it was not technically viable and practicable, and reevaluating the national HLW disposal policy is not within the scope of this EIS.

Transmutation

This alternative would involve reprocessing the waste by converting it into a form that could be bombarded by radiation, which would convert the long-lived radionuclides into stable or short-lived radioisotopes (WHC 1995a). This alternative had the following potential disadvantages: 1) is anticipated that only 5 to 7 percent of the recycled elements would be transmuted during each reprocessing cycle; 2) it would be expected that it would take up to several decades to develop the advanced technologies that would be required; and 3) it is likely that the fission products would be hazardous and the need for other waste disposal technologies would be necessary. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation.

C.3.0 ALTERNATIVES IDENTIFIED DURING THE EIS SCOPING PROCESS (DOE 1995b)

The following alternatives were identified by the public during the EIS scoping process as potentially applicable for remediating the tank waste and capsules; however, they did not meet one or more of the criteria identified in Section C.1.0. Section 7.0 identifies issues raised by the public that have been included in this EIS.

C.3.1 WASTE STORAGE AND DISPOSAL

Grout the Retired Canyon Facilities with Hot Grout

This alternative would involve grouting the retired canyon facilities. In this alternative, grout would be the primary tank waste disposal method. Existing grout facilities would be used and the grouted waste would be placed in the retired canyon facilities to harden. This option would leave the HLW onsite in a form that could not be transported to a potential geologic repository. Furthermore, the canyon facilities were designed as chemical processing facilities, not as disposal facilities. Certain areas of the canyons were designed to shield radiation but other areas such as hallways were not. In addition, the canyon facilities were not structurally designed to be filled with grout and the facilities would fail over time. This alternative was rejected from further consideration because it was not technically viable and practicable.

Launch to Sun, Seabed Subduction, and Deep Hole Disposal

The first alternative recommended research to develop technology to launch tank waste to the sun or out of the solar system. The second alternative recommended that canisters of waste be inserted into the sea floor at points of subduction so that the material would eventually be drawn deep into the earth's interior. The third alternative suggested storing the materials several thousand feet down in a stable portion of the continent's thick crust. This could be accomplished by drilling standard oil well holes approximately 3,000 m (10,000 ft) down and then stacking stainless steel canisters on top of each other until they reach a depth of about 1,500 m (5,000 ft). The remaining depth of the holes would be filled with inert material (i.e., cement or clean fill). These alternatives have previously been evaluated for the disposal of commercial nuclear waste and have been rejected (WHC 1995a). Furthermore, national HLW disposal policy is not within the scope of this EIS.

Glass Logs in Grout Vaults, Solids in Tanks to Decay

This alternative would use a furnace to turn the liquid waste from the tanks into glass logs. The logs would be stored in grout vaults so that the Cs-137 could decay to innocuous levels. The tank solids would be left in the tanks to decay. This alternative was composed of two parts, each of which is bounded by the alternatives described in Appendix B. The first part addresses the vitrification of the HLW sludges from the tanks and the storage of the resulting glass product in existing grout vaults. The second portion of the alternative pertains to the decay of radionuclides in the tanks over a period of several hundred years. While this proposed alternative contains elements of the alternatives presented in Appendix B of this EIS, it was not accepted for detailed analysis. The vitrification of the sludge separations from the liquid is addressed in this EIS by the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives. However, storing the resultant HLW glass in the grout vaults would not be acceptable. The HLW glass would receive temporary onsite storage, but would eventually be shipped to the potential geologic repository. The short half-life of Cs-137 would cause it to decay faster than most of the radionuclides in the tank waste. This alternative was rejected from further consideration because it could not be designed to be protective of human health and the environment with reasonable mitigative measures.

Railcar Storage of Tank Waste

This alternative proposed using mobile railcars for transporting and storing tank waste. The alternative would use existing sidings plus new sidings with berms and liners or concrete aprons under the cars. These methods would allow adding early extra storage capacity, storing waste of diverse compositions without mixing, and transporting waste without new pipelines. Railcar storage was not a viable method for consideration in this EIS because 1) storing the tank waste in mobile tank cars would not comply with Federal and State regulations; and 2) using mobile railcars could not conform to the constraints of DOE Order 6430.1a with regard to seismic, safety, and shielding considerations. This alternative was rejected from further consideration because it could not be designed to be protective of human health and the environment with reasonable mitigative measures. Transporting waste by railcar is addressed in the Safe Interim Storage of Hanford Tank Waste EIS (DOE 1995i).

C.3.2 VITRIFICATION

Lead or Stainless-Steel Containers for High-Level Waste

This process would immobilize and dilute the radioactive materials in a glassification process, as appropriate. Following glassification, the treated waste would be encased in lead or stainless-steel containers suitable for long-term storage. Because of its ability to attenuate radiation, lead would seem to be a logical material for consideration in enclosing or surrounding HLW. However, lead is a toxic material with low mechanical strength whose use as a container would be inappropriate if a nontoxic alternate material was available. Stainless steel is such an alternate material and has been used in other countries as a container for HLW glass; it is also the container material proposed for the ex situ alternatives. Lead was rejected for consideration as a container material in the EIS because the technology is not appreciably different or better than those addressed in the EIS in terms of effectiveness, costs, or impacts to human health and the environment.

Unenclosed Furnace in Excavation

This alternative proposed building a 50 ton/day furnace using sodium nitrate from the tank waste liquid phase and making the remainder of the tank waste into a glass. The furnace could be built in an excavation in the ground in the 200 Areas. The commentor suggested that tanks would be necessary but no building would be necessary. This alternative would place the vitrification units belowgrade to alleviate the need for concrete shielding. While placing the treatment facilities belowgrade whenever possible might be considered good design practice, the absence of a roof is not protective of human health and the environment. The roof must be present to shield against radiation leakage and scatter. In addition, the roof serves a vital structural function in protecting against seismic events and preventing outside materials from being blown into the building. This alternative was rejected from further consideration because it could not be designed to be protective of human health and the environment with reasonable mitigative measures.

Placing Marbles or Clinkers Into Casks of Currently Contaminated Steel and Concrete

This alternative would store the vitrified waste product as marbles or clinkers in containers made from materials that have been contaminated in previous operations (i.e., contaminated steel or concrete). While recycling materials is becoming more prevalent in the United States, this particular option has not been accepted for further study in the EIS because the contaminated casks could not be shipped offsite safely without overpacking them, which defeats the purpose of the alternative. The casks made from contaminated material would need to be placed in casks made from noncontaminated material for shipment. This option would also involve constructing an additional shielded processing facility that would become contaminated during use. This alternative was rejected from further consideration because it could not be designed to be protective of human health and the environment with reasonable mitigative measures and was not technically viable or practicable.

Interstitial Space Around Clinkers or Marbles Filled with Lead or Graphite from Material Onsite

This option would use lead or graphite as the matrix material surrounding the clinkers or marbles of the vitrified product. Lead is considered to be a toxic material. In addition, the high density of lead would cause the glass to float, which would reduce its effectiveness in filling the interstices in the glass. At present, no experimental work has been done using graphite as a filler material. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation and was not technically viable or practicable.

C.3.3 WASTE TREATMENT

Burn Waste in a Breeder Reactor or Washington Public Power Supply System Reactor

This alternative suggested burning the waste in a breeder reactor or a Washington Public Power Supply System reactor with a result of 30 years of extra power. Under this concept, selected portions of the TWRS waste would be separated and incorporated into the fuel elements to be used in a breeder or power producing reactor. While certain isotopes in the waste would undergo nuclear decay in such an alternative, the vast majority of the waste would still require some sort of chemical separations and subsequent immobilization. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation and it is not technically viable and practicable.

Separation of Tritium

This option would segregate the tritiated waste from the tank waste and store it until the tritium decayed. As no practicable method has yet been discovered to separate tritium from water, the tritiated waste would not be concentrated. This alternative was rejected from further consideration because it was not technically viable and practicable.

C.3.4 HEALTH RISK, SAFETY, AND MITIGATION

Placing Berms Around Tanks

This alternative proposed placing berms around tanks to avoid the potential for an explosion when waste that contained a mixture of chemicals and nitrogen compounds was vitrified in situ. Another alternative proposed placing berms around tanks to avoid an explosion in a tank that would cause explosions in other tanks. This alternative would place berms around tanks to avoid explosions in nearby tanks should one of the tanks explode. However, the tanks are situated underground with approximately 6 m (20 ft) of soil fill between them. Should an explosion occur within a tank, the shock wave would have to penetrate the concrete liner of the tank and pass through the soil to affect the other tanks. The presence of a berm on the surface over the tanks would have little effect on this situation. Consequently, this alternative was rejected from further evaluation because it was not technically viable and practicable.

C.3.5 EMISSIONS, EFFLUENTS, AND MONITORING

Use Activated Carbon Filters and Encase Them in Lead or Stainless-Steel Containers

This alternative proposed trapping radioactive gases in activated carbon filters and encasing them in lead and stainless-steel containers that would be suitable for long-term storage. This recommendation was correct in that it anticipates the use of specialized filters to clean the contaminants from the gas streams from the treatment facilities. Activated carbon could be used to remove organic vapors (hydrocarbons) from gas streams. While small concentrations of hydrocarbons could be in the effluent streams from the treatment facilities, a greater concern would be removing radionuclide particles. This is done most efficiently by using high-efficiency particulate air filters as the last element of the gas treatment process. The used high-efficiency particulate air filters would be placed in LAW disposal vaults rather than encasing them in metal, particularly lead, which is a toxic material. Little experimental work has been done using activated carbon on gas streams generated by vitrification. This alternative was rejected from further consideration because the technology was not sufficiently mature to allow detailed evaluation and it was not technically viable and practical.

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APPENDIX D

ANTICIPATED RISK

ACRONYMS AND ABBREVIATIONS

CC	carcinogenic chemical
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HLW	high-level waste
HSDB	hazardous substance data bank
HSRAM	Hanford Site Risk Assessment Methodology
ICRP	International Commission on Radiological Protection
ILCR	incremental lifetime cancer risk
IMUST	inactive miscellaneous underground storage tank
IRIS	Integrated Risk Information System
LADD	lifetime average daily dose
LAW	low-activity waste
LCF	latent cancer fatalities
LOEL	lowest observed effect level
MEI	maximally-exposed individual

MRA	modular risk assessment
NC	noncarcinogenic chemical
NCRP	National Council on Radiation Protection
NEPA	National Environmental Policy Act
NOAEL	no observed adverse effect level
NRC	Nuclear Regulatory Commission
PUREX	Plutonium-Uranium Extraction
RA	radionuclide
RfD	reference dose
SIF	summary intake factor
SST	single-shell tank
TWRS	Tank Waste Remediation System
URF	unit risk factor
VOC	Volatile organic compound
WESF	Waste Encapsulation and Storage Facility

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length		**Area**		**Volume**	
cm	centimeter	ac	acre	cm^3	cubic centimeter
ft	foot	ft^2	square foot	ft^3	cubic foot
in	inch	ha	hectare	gal	gallon
km	kilometer	km^2	square kilometer	L	liter
m	meter	mi^2	square mile	m^3	cubic meter
mi	mile			ppb	parts per billion
				ppm	parts per million
				yd^3	cubic yard

Mass		**Radioactivity**		**Electricity/Energy**	
g	gram	Ci	curie	A	ampere
kg	kilogram	MCi	megacurie (1.0E+06)	J	joule
lb	pound	mCi	millicurie (1.0E-03 Ci)	kV	kilovolt

mg	milligram
mt	metric ton

Temperature

C	degrees centigrade
F	degrees Fahrenheit

Ci	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

kW	kilowatt
MeV	million electron volts
MW	megawatt
V	volt
W	watt

D.1.0 INTRODUCTION

This appendix describes the analysis of anticipated risk for the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS). Risk is defined as the number or degree of human health or ecological effects from exposure to radiation and chemicals resulting from TWRS activities during and after remediation. The mission of TWRS is to manage and dispose of TWRS waste, including current and future tank waste, associated inactive miscellaneous underground storage tanks (IMUSTs), and cesium (Cs) and strontium (Sr) capsules in an environmentally sound, safe, secure, and cost-effective manner. Sections D.1.0 through D.5.0 of this appendix address the methodology and results of the human health risk assessment. Section D.6.0 presents the methodology and results of the ecological risk assessment. Section D.7.0 presents the methodology and results of the assessment of risks from inadvertent human intrusion into the residual waste after remedial actions are complete. This EIS analyzes the following alternatives for remediation, which are discussed in Volume Two, Appendix B:

- Tank Waste
  - No Action alternative (Tank Waste)
  - Long-Term Management alternative
  - In Situ Fill and Cap alternative
  - In Situ Vitrification alternative
  - Ex Situ Intermediate Separations alternative
  - Ex Situ No Separations alternative
  - Ex Situ Extensive Separations alternative
  - Ex Situ/In Situ Combination 1 alternative
  - - Ex Situ/In Situ Combination 2 alternative
  - Phased Implementation alternative
- Capsule
  - No Action alternative (Capsules)
  - Onsite Disposal alternative
  - Overpack and Ship alternative
  - Vitrify with Tank Waste alternative.

The scope of the risk assessment includes risk associated with conditions during and after the remedial actions. The assessment evaluates three primary types of risk: 1) risk associated with baseline conditions (No Action alternative); 2) risk associated with the TWRS EIS remedial action alternatives; and 3) risk associated with residual (post-remediation) contamination.

Baseline risk is the risk to a land user in the absence of remedial actions. Depending on the land-use scenario, the receptor for baseline conditions may be exposed to contaminated media through one or more pathways. For purposes of this assessment, the No Action alternatives (Tank Waste and Capsules) are considered the baseline.

Remedial action risk is separated into risk from routine operations and risk from accidents. Risk from routine operations is addressed in this appendix and consists of the risk to TWRS workers, noninvolved workers on the Hanford Site, and the general public resulting from remediation associated with the remedial action alternatives. Risk from accidents is addressed in Volume Four, Appendix E.

Post-remediation risk is the risk resulting from residual contamination remaining onsite after remediation is completed. The receptors and potential exposure pathways for post-remediation risk are based on land use and are identical to those used for baseline risk.

Table D.1.0.1 shows the three primary categories of risk along with key assumptions used in the analysis.

Table D.1.0.1 Primary Risk Types and Risk Assessment Assumptions

The objective of this risk assessment is to support the analysis of environmental consequences by providing estimates of the following:

- Noncarcinogenic toxic effects, expressed as a hazard index (HI), attributable to each EIS alternative. The hazard index is a comparison of the estimated exposure to a chemical threshold value below which no toxic effects are expected;
- Latent cancer fatalities (LCFs) and incremental lifetime cancer risks (ILCRs) attributable to each alternative from routine operations during remedial actions. LCFs are the increases in number of cancer fatalities resulting from exposure to potential radiological carcinogens. ILCRs are the increased probability of developing cancer as a result of exposure to chemical carcinogens;
- Incremental lifetime cancer incidence attributable to post-remediation conditions for each alternative and subalternative. Incremental lifetime cancer incidence is the increased probability of an individual developing cancer over a lifetime (70 years) from exposure to potential carcinogens (both radiological and chemical);
- Risk to ecological receptors for all alternatives; and
- Carcinogenic effects attributable to each alternative from inadvertent human intrusion into residual contamination following completion of remedial actions.

D.2.0 METHODOLOGY

Risk associated with TWRS baseline and post-remediation conditions would result from long-term exposure to contaminants. Exposure would be controlled largely by how the land is used, and thus exposure scenarios based on land use serve as the basis for estimating risk. The five exposure scenarios selected for the analysis are the Native American, residential farmer, industrial worker, recreational shoreline user, and recreational land user. The Native American scenario was developed from the Columbia River Comprehensive Impact Assessment (Napier et al. 1996), which was modified at the request of and in consultation with the potentially affected Tribes. This scenario is in its initial stages of development and has not received a complete review by the scientific community, nor has it been approved by the potentially affected Tribes. Therefore, this scenario should be considered preliminary and may have more uncertainty associated with it than the other scenarios. However, the scenario does provide a bounding assessment of the potential health effects to a Native American who might engage in both subsistence lifestyle activities (e.g., hunting, fishing, and use of a sweat lodge) and contemporary lifestyle activities (e.g., irrigated farming). The residential farmer, industrial worker, recreational shoreline user, and recreational land user scenarios are modeled after scenarios in the Hanford Site Risk Assessment Methodology (HSRAM) (DOE 1995c). HSRAM was developed by an interagency working group for risk assessment that included technical representatives from the U.S. Department of Energy (DOE), the Washington State Department of Ecology (Ecology), and the U.S. Environmental Protection Agency (EPA). For each of the five scenarios analyzed, exposure to contaminants transported in four media is considered (i.e., groundwater, soil, surface water, and air).

By contrast, risk associated with operations for the TWRS remedial action alternatives would result from a shorter duration of exposure to contaminants. Such exposure would be largely controlled by the activities and processes associated with a particular remedial alternative or subalternative. The receptors for remediation risk are the TWRS workers, the noninvolved workers at the Hanford Site, and the public. Based on the assumptions listed in Table D.1.0.1, routine operations for the remedial action alternatives would result in atmospheric emissions of contaminants and potential direct radiation exposure from the waste. Air is the only transport medium considered.

Detailed descriptions of the methodology used are presented in Section D.2.1 for baseline and post-remediation risk and in Section D.2.2 for remedial action risk.

D.2.1 BASELINE AND POST-REMEDIATION RISK METHODOLOGY

A modular risk assessment (MRA) methodology was developed to analyze the risk associated with baseline and post-remediation conditions. The modular approach is based on separating the four basic components of the risk assessment process (i.e., source, transport, exposure, and risk) into discrete modules that can be assessed independently and then combined. The key concepts of the modular approach include the following:

- Defining the Hanford Site as a grid of cells, each 1 kilometer (km) by 1 km (0.6 mile [mi] by 0.6 mi);
- Aggregating contaminant sources located within each cell or several cells;
- Using transported unit concentrations (i.e., concentrations based on transport of a unit concentration of each contaminant) to develop concentration estimates at various locations as source terms vary;
- Using well-defined, land-use-based exposure scenarios;
- Using unit risk factors (URFs) (i.e., risk based on exposure to a unit concentration of each contaminant) to facilitate risk estimates as source terms vary; and
- Presenting risk in graphical contour plots developed using Geographic Information System (GIS) software.

The following is an overview of the modular risk-assessment approach.

The Hanford Site was divided into small sections or cells by superimposing a grid, based on state plane coordinates (Cartesian), on a map of the Hanford Site. All source cells (i.e., cells containing tank waste and other contaminant sources from TWRS EIS alternatives) were identified and the contaminants in the individual sources were quantified for both baseline and post-remediation conditions. Data for the individual sources were then aggregated for each source cell.

As an independent step, the release and transport of a unit of concentration of each contaminant from each source cell through different media was modeled for selected time periods ranging from the present to 10,000 years into the future. This time period was chosen because it is consistent with rationale presented by EPA in 40 Code of Federal Regulations (CFR) 191 for assessment of performance of repositories for disposal of radioactive waste. Modeling predicts how a unit concentration of each contaminant moves through the environment into surrounding cells after release from the source cell. This step results in transported unit concentrations for each medium and time period of interest.

Also as an independent step, a URF was calculated based on the dose to a receptor from exposure to a unit of concentration of each contaminant under each land-use scenario. Each scenario was evaluated for all potential transport media. The resultant risk values then were calculated. The source (baseline or post-remediation) was multiplied by the transported unit concentration at the selected time to obtain the future concentration of the source in a given cell (referred to as point concentration). The point concentration then was multiplied by the URF for the given land-use scenario to obtain the risk to a receptor in that cell. This process can be described in the following general equation:

$$(\text{Risk Value}) = (\text{Source}) \cdot (\text{Unit Transport Factor})\ (\text{URF})$$

In the MRA methodology, four data sets were developed for each cell. These data sets consist of the individual source data, transported unit concentrations, URFs, and risk values, which are calculated by multiplying the values in the other three data sets for a given land use. Each of these data sets was considered a module. A computerized spreadsheet was developed for each module to facilitate storage and mathematical manipulation of the data.

In converting exposures to risk, the primary source for health effects conversion factors is the International Commission on Radiological Protection (ICRP) Publication No. 60 (ICRP 1991), which recommends values for the public of 5.0E-04 fatal cancers per rem and 1.0E-04 nonfatal cancers per rem, for a total cancer incidence of 6.0E-04 per rem. The cancer incidence calculations for chemicals and radionuclides based on EPA slope factors include fatal plus nonfatal cancers. The EPA slope factors are not based on use of a single health effects conversion factor, but consider age-specific and organ-specific health risk in estimating the slope factors. EPA suggested use of 7.3E-04 total cancers per rem (for member of the public) for those radionuclides for which slope factors are not provided (by EPA). This factor is not used for analysis.

The modules developed for this risk assessment (i.e., source, unit transport, URF, and risk) are described in more detail in the following sections. The source module is described in Section D.2.1.1 followed by the unit transport module (Section D.2.1.2) and URF module (Section D.2.1.3). The combination of these factors give s an estimate of the human health impacts as described in Section D.2.1.4.

D.2.1.1 Source Module

The source module contains information identifying and quantifying the sources of contamination under current and post-remediation conditions. To assess risk from exposure to contaminants transported through the environment, the amount of the contaminant that would be released into the environment was determined. The amounts released, referred to as release terms, are a calculated fraction of the total contaminant inventories available for release. Release terms are developed as part of the transport modeling process and are discussed in Section D.2.1.2. Contaminant inventories available for release comprise the data tabulated in the source module and are discussed in this section. These inventories are contaminant-specific and given as either inventory amounts or concentrations.

The source module for this assessment is divided into submodules, as shown in Table D.2.1.1. For each submodule shown, contaminant inventories are compiled and tabulated for use in the risk calculation.

Table D.2.1.1 Elements of the Source Module

For post-remediation conditions, source inventories are tabulated for the contamination sources estimated to exist after remedial actions are completed. Depending on the alternative, the anticipated post-remediation sources would consist of tank residuals, in situ disposed tank waste, and engineered storage/disposal facilities. The inventories for these sources are based on engineering analyses of the remedial action alternatives provided in a set of engineering data packages prepared to support this EIS (WHC 1995c, 1995d, 1995e, 1995f, 1995g, 1995h, 1995i, 1995j, and 1995n, and Jacobs 1996). Additional discussion of current and post-remediation inventories is presented in the following sections.

D.2.1.1.1 Current Tank Waste Inventories

Current tank waste inventories were obtained from a supporting document for this EIS (WHC 1995d). Tank inventories are displayed on a total tank basis only (i.e., total inventory for single-shell tanks [SSTs] and total inventory for double-shell tanks [DSTs]). Total-tank inventories are shown in Appendix A, Tables A.2.1.2 and A.2.1.3 for radionuclides and nonradioactive chemicals, respectively.

The groundwater transport modeling separated contaminant sources in the 177 tanks into eight aggregated source areas, each of which contained groupings of either SST farms or DST farms. Tank farms in the 200 West Area were grouped into three source areas, designated 1WSS, 2WSS, and 3WDS (Figure D.2.1.1). Tank farms in the 200 East Area were grouped into five source areas, designated 1ESS, 2ESS, 3EDS, 4ESS, and 5EDS (Figure D.2.1.2). The groupings were based on tank farm location, tank type (SST or DST), and groundwater flow direction.

Figure D.2.1.1 Source Area Locations, 200 West Area

Figure D.2.1.2 Source Area Locations, 200 East Area

To generate inventories for the eight source areas, computer spreadsheets were developed from the data used to generate the tables from (WHC 1995d and Jacobs 1996). The spreadsheets contained farm-by-farm inventories for SSTs and tank-by-tank inventories for DSTs, from which inventories were allocated among the eight source areas.

Quantities of radionuclides are dependent on the time period of interest because of the spontaneous decay of radionuclides. The quantities of radionuclides were available for SSTs for a range of dates, including the year 1995. However, the concentration of radionuclides for DSTs was available only for the year 1999. Because the year 1995 is the designated starting time (T_0) for this risk assessment, a calculation was used to convert the DST inventory quantities to a December 31, 1995 date.

The calculation was performed using the following equation:

$$I_{(1999)} = I_{(1995)}\, e^{-\,?\,t}$$

Where:

$I_{(1995)}$ = Inventory year 1995

$I_{(1999)}$ = Inventory year 1999

? = Decay constant = $\ln 2/T_{1/2}$

t = Decay duration (1999 - 1995 = 4 years)

$T_{1/2}$ = Radionuclide half-life

The short-lived progeny radionuclides were assumed to be in equilibrium with the parents.

Single-Shell Tanks

Current inventories for the five source areas containing SSTs are shown in Volume Two, Appendix A, Tables A.2.1.5 and A.2.1.6. Table A.2.1.5 shows the aggregated inventory of nonradioactive chemicals. Table A.2.1.6 shows the aggregated inventory of radionuclides for December 31, 1995 (totals for December 31, 1999 are also included for comparison purposes). The aggregated inventories were generated by summing the farm-by-farm inventories for the SST farms in each source area.

Double-Shell Tanks

Current inventories for the three aggregated source areas containing DSTs are shown in Volume Two, Appendix A, Tables A.2.1.7 and A.2.1.8. Table A.2.1.7 shows the aggregated inventory of nonradioactive chemicals. Table A.2.1.8 shows the aggregated inventory of radionuclides for December 31, 1995. The inventories were generated by summing tank-by-tank inventories for the DST in each source area.

Miscellaneous Underground Storage Tanks

There are approximately 40 inactive and 20 active MUSTs associated with the tank farms. These MUSTs contain small quantities of mixed radioactive and chemical waste. They contain less than one-half of one percent of the total tank farm inventory. Additional information on the MUST inventory can be found in Volume Two, Appendix A.

D.2.1.1.2 Current Cesium and Strontium Capsule Inventories

Radioactive decay calculations for Cs/Sr capsules stored at the Waste Encapsulation and Storage Facility (WESF) in the 200 East Area of the Hanford Site result in the following quantities:

- Cs: 1,328 capsules, 53.2 million curies (MCi) total inventory; and
- Sr: 601 capsules, 23.1 MCi total inventory.

D.2.1.1.3 Post-Remediation Inventories

The contamination sources anticipated to exist after remediation vary according to each alternative. These sources were identified and quantified based on engineering data packages developed by the Site Management and Operations contractor and the TWRS EIS contractor (WHC 1995c, d, e, f, g, h, j, n, and Jacobs 1996). Depending on the alternative, the post-remediation sources would consist of tank residuals, in situ disposed tank waste, and engineered storage/disposal facilities. Contaminant inventories were developed from the engineering data packages, and entered into the source module for each of these post-remediation sources.

Tables displaying the post-remediation inventories by source for each alternative are presented in Volume Four, Appendix F, Groundwater Modeling.

D.2.1.2 Transport Module

Transport refers to the movement of contaminants in the environment from the source location to the receptor. The transport analysis redistributes the contaminants at locations within and outside the grid cell sources. Transport of contaminants was modeled within the Hanford Site boundary and within an 80-km (50-mi) radius of TWRS facilities.

Development of release terms (i.e., the portion of current or post-remediation inventories in the source module that are estimated to be released from the source) is conducted as part of the transport analyses. Further discussions of the method for developing release terms, along with tables displaying the release terms used for each source, are provided in Volume Four, Appendix F for groundwater releases and in Volume Five, Appendix G for air releases.

Developing transport parameters for contaminants of concern in soil, groundwater, surface water, and air also is conducted during the transport analyses. Transport parameters consist of the contaminant- and site-specific data required to model the atmospheric, groundwater, and surface water transport of contaminants within and outside the boundaries of the Hanford Site. Transport parameters and radionuclide decay estimates result in new media concentrations specific to the location and time period of interest. Transport parameters are discussed further in Volume Four, Appendix F for groundwater transport and in Volume Five, Appendix G for air transport.

Transport modeling for this assessment was conducted as a unit transport analysis. This analysis involved modeling the transport of a single unit of contaminant from TWRS sources through the environment (groundwater, soil, air, and surface water) at different times in the future. Any cells that contain contaminants at the present time are set as the location of a unit inventory or concentration. A unit of contaminant is transported from one medium to other media and from a location (cell) to other locations, as time progresses, using a transport code. The transported unit concentration for each medium at selected modeling time periods (i.e., 300, 500, 2,500, 5,000, and 10,000 years in the future) is estimated and tabulated in the transport module. Point concentrations, which are the future concentrations at a given receptor originating from a particular source, are obtained by multiplying the current and post-remediation inventories by the transported unit concentrations at selected time periods.

D.2.1.3 Exposure Module

Five exposure scenarios were used as the basis for the unit risk calculations: Native American, residential farmer, industrial worker, recreational shoreline user, and recreational land user (DOE 1995c). The Native American scenario represents potential use of the land for a subsistence Native American lifestyle as well as contemporary lifestyle activities such as irrigated agriculture. This scenario includes subsistence activities such as hunting, fishing, and gathering of plants and materials. The residential farmer scenario represents potential use of the land for residential and agricultural production. This scenario includes producing and consuming animal, vegetable, and fruit products. The industrial worker scenario involves mainly indoor activities that include consumption of groundwater , although outdoor activities (e.g., soil contact) also are included. The recreational shoreline user was assumed only to have access to the Hanford Reach of the Columbia River. The recreational land user was assumed to be a random Sitewide land user of the Hanford Site, excluding the Columbia River shoreline. The exposure scenarios were evaluated for five transport media, as appropriate: 1) soil defined per unit mass; 2) soil defined per unit area; 3) groundwater from wells; 4) surface water (including shoreline sediments); and 5) air. Soil was evaluated by mass to account for contaminants transported through the soil, and by area to account for contaminants deposited onto the soil from atmospheric transport.

The exposure module for human receptors is based on land-use patterns. For each grid cell, the exposure pathway and receptors associated with that cell were identified. This was done by activating or deactivating transport media within the cell. For example, by activating the residential farmer scenario, groundwater would be used to irrigate crops that are consumed directly by the surrounding population, and by milk- and meat-producing cattle that are consumed by the surrounding population. By activating the recreational land-user scenario, the groundwater medium would not be included because the recreational land user is assumed not to be a resident of the land and is assumed not to consume water from the aquifer.

The URF is the risk associated with exposure to one concentration unit (e.g., risk per pCi/g for radionuclides in soil, risk per mg/kg for chemicals in soil, risk per pCi/L for radionuclides in water) of a given contaminant for a human exposure scenario. The URFs were developed for each individual exposure pathway (i.e., ingestion, inhalation, and direct contact) for each scenario. Slope factors developed by EPA (Integrated Risk Information System [IRIS] 1995 and Health Effects Assessment Summary Tables [HEAST] 1995) were applied. The exposure module contains a set of URF tables for each exposure scenario and receptor. The URF values presented in the tables of this report were based on the summation of all relevant exposure pathways. For example, the residential groundwater URF values would include ingestion of drinking water, dermal contact while showering, incidental ingestion while showering, and inhalation of volatile emissions from domestic use.

The calculation of URFs is simplified by dividing the equations into two main terms, one containing parameters independent of contaminant properties (summary intake factors) and the other containing parameters dependent on contaminant properties (contaminant-specific parameters). The following sections describe methods used to calculate each of these types of parameters; Section D.2.1.3.1 - Summary Intake Factors and Section D.2.1.3.2 - Contaminant-Specific Parameters. The use of these terms to estimate the URFs then is described in Section D.2.1.3.3 - Unit Risk Factors.

D.2.1.3.1 Summary Intake Factors

Exposure scenarios are described in terms of receptors, exposure media or pathways, and summary intake factor (SIF) values.

- The receptor is the type of human exposed in terms of age, weight, and exposure duration and other factors. Five receptors were modeled: Native American, residential farmer, industrial worker, recreational shoreline user, and recreational land user. Except where noted, receptor parameters used in the analysis are consistent with those established in HSRAM (DOE 1995c).
- The exposure pathway is the medium (e.g., groundwater) and activity (e.g., drinking) that would result in an exposure.
- The SIF value is the amount of exposure to the receptor through the media of interest. The SIF values were derived for each of three toxicity types: NC - noncarcinogenic chemicals, CC - carcinogenic chemicals, and RA - radionuclides.

The SIF concept is presented in HSRAM (DOE 1995c). The concept of SIF values involves structuring the intake equations for each exposure pathway so that contaminant-independent parameters are separated from the contaminant-specific parameters and the initial media concentration. Each exposure pathway model then can be described as the product of three factors: 1) a media concentration, 2) an SIF independent of the specific contaminants, and 3) a factor composed of all contaminant-specific parameters. The equation is as follows:

Where:

Intake = Average daily intake of chemical contaminants (mg/kg day)

Exposure = Total intake or exposure received over the exposure duration (pCi or hour)

C_{iym} = Concentration of contaminant i, of type y, in medium m (mg or pCi per unit quantity of medium liter, kilogram, m^3, or m^2)

PF_{mix} = Contaminant-specific factor for medium m, contaminant i, and exposure pathway x (Strenge-Chamberlain 1994) (units specific to analysis)

SIF_{smyx} = Summary intake factor for scenario s, medium m, contaminant type y, and exposure pathway x (units specific to analysis)

The SIF values were evaluated for each toxicity type (i.e., NC, CC, and RA). The appropriate SIF value was used for each contaminant for the exposure pathway of concern. The methodology for calculating SIF values is described by Strenge and Chamberlain (Strenge-Chamberlain 1994). The SIF values for the five exposure scenarios are described in more detail in the following sections. This is followed by a discussion of the contaminant-specific factors.

Following loss of institutional controls (assumed to be 100 years), the tank contents would be released to subsurface soils and be available for transport to groundwater from infiltration of rainwater and percolation through the soil column. Based on the existing depth of the tanks, the resulting soil contamination would be below the maximum depth of soil likely to be contacted by all potential receptors, with the exception of the intruder scenario. Consequently, the soil medium was not evaluated as a post-remediation transport mechanism for any of the alternatives because the soil contamination was not evaluated for any of the alternatives. Therefore, groundwater is the only post-remediation transport mechanism evaluated for all of the alternatives.

Native American Scenario

This scenario represents exposures received during a 70-year lifetime by a Native American who engages in both traditional lifestyle activities (e.g., hunting, fishing, and using a sweat lodge) and contemporary lifestyle activities (e.g., irrigated farming). The individual is assumed to spend 365 days per year on the Site over a 70-year lifetime. Some activities are assumed to continue year-round while others are limited by climate (e.g., frost-free days).

Pathways for this scenario include those defined for the residential farmer scenario in HSRAM, plus additional pathways representing activities unique to the Native American subsistence lifestyle (e.g., exposures in a sweat lodge). A composite adult was used as the receptor for some of the pathways. The composite adult was evaluated using child parameters for 6 years and adult parameters for 64 years. The child's body weight was assumed to be 16 kilograms (kg) (35 pounds [lbs]), and the adult body weight 70 kg (150 lbs). This approach was used for all contaminant types. Table D.2.1.2 presents the pathways included in the Native American scenario. The exposure parameters for each pathway are presented in Table D.2.1.3. The SIF values for each pathway are presented in Table D.2.1.4.

Table D.2.1.2 Exposure Pathways Included in Native American Scenario

Table D.2.1.3 Native American Scenario Exposure Factors

Table D.2.1.4 Native American Scenario Summary Intake Factors

The ingestion rates of native foods are based on a combination of EPA-suggested intake rates (EPA 1989b), intake rates used for the Columbia River Comprehensive Impact Assessment (Napier et al. 1996), and data provided by the affected Tribes. Ingestion of animal organs and wild bird meat was accounted for by increasing the total meat intake rate. Animal organs were assumed to have contaminant concentrations 10 times the concentration in other animal tissue, and the organ intake rate was assumed to be 10 percent of the intake rate of other animal tissue. Animal meat plus organ intake was assumed to be 300 g/day. Intake of upland game birds and waterfowl was assumed to be 9 g/day and 35 g/day, respectively. The total meat ingestion rate was thus assumed to be 341 g/day. Ingestion of fish organs was accounted for by increasing the fish muscle intake rate in a manner similar to that for ingestion of animal organs. Fish organs were assumed to have contaminant concentrations 10 times the concentration in fish muscle, and the fish organ ingestion rate was assumed to be 10 percent of the fish muscle intake. The total fish ingestion rate was assumed to be 1,080 g/day.

This scenario, by incorporating the subsistence lifestyle activities and native food ingestion rates as described above, results in exposures that are approximately five times higher than the exposures for the residential farmer scenario.

Residential Farmer (Agricultural) Scenario

This scenario represents use of the land for residential and agricultural production. This scenario includes producing and consuming animal, vegetable, and fruit products. The exposures are assumed to be continuous and include occasional surface water-related recreational activities, which include contact with surface water sediments. A composite adult was used as the receptor for some of the exposure pathways. The composite adult was evaluated using child parameters for 6 years and adult parameters for 24 years, with a total exposure duration of 30 years. The child's body weight was assumed to be 16 kg (35 lbs), and the adult body weight 70 kg (150 lbs). This approach was used for all contaminant types. Table D.2.1. 5 presents the pathways included in the residential farmer scenario. The exposure parameters for each pathway are presented in Table D.2.1. 6 . The SIF values for each pathway are presented in Table D.2.1.7 .

Table D.2.1.5 Exposure Pathways Included in Residential Farmer Scenario

Table D.2.1.6 Residential Farmer Scenario Exposure Factors

Table D.2.1.7 Residential Farmer Scenario Summary Intake Factors

The ingestion rates of farm products for the residential farmer are based on EPA-suggested intake rates (EPA 1989b). The individual was assumed to consume a total of 200 g/day of vegetables of which 40 percent is homegrown and contaminated; 140 g/day of fruit of which 30 percent is homegrown and contaminated; 100 g/day of beef of which 75 percent is contaminated; and 300 g/day of dairy products of which 75 percent is contaminated. These intake rates are used by HSRAM and described by EPA as representing reasonable bounding estimates.

Industrial Scenario

The industrial scenario represents potential exposures to workers in a commercial or industrial setting. The receptors are adult employees assumed to work at this location for 20 years and have an average body weight of 70 kg (150 lbs).

The scenario involves mainly indoor activities, although outdoor activities (e.g., soil contact) also are included. These exposures would not be continuous because the worker would go home at the end of each work day. The scenario is intended to represent nonremediation workers assumed to wear no protective clothing. Table D.2.1. 8 presents the pathways included in this scenario. The exposure parameters for each pathway are presented in Table D.2.1. 9 . The SIF values for each pathway are presented in Table D.2.1. 10 .

Table D.2.1.8 Exposure Pathways Included in Industrial Scenario

Table D.2.1.9 Industrial Scenario Exposure Factors

Table D.2.1.10 Industrial Scenario Summary Intake Factors

Recreational Shoreline User Scenario

The recreational shoreline user scenario represents exposure to contamination in the Columbia River and shoreline from recreational swimming, boating, and other shoreline activities. The scenario involves outdoor activities. These exposures would not be continuous, but would occur for 14 days/year for 30 years. Exposures to both adults and children were taken into account using the composite adult described for the residential farmer scenario. Table D.2.1. 11 presents the pathways included in this scenario. The exposure parameters for each pathway are presented in Table D.2.1. 12 . The SIF values for each pathway are presented in Table D.2.1. 13 .

Table D.2.1.11 Exposure Pathways Included in Recreational Shoreline User and Recreational Land User Scenarios

Table D.2.1.12 Recreational Shoreline User Scenario Exposure Factors

Table D.2.1.13 Recreational Shoreline User and Recreational Land User Scenario Summary Intake Factors

Recreational Land User Scenario

The recreational land user scenario represents exposure to contamination from recreational camping, hiking, and other land-based recreational activities. These exposures would not be continuous, but would occur for 14 days/year for 30 years. Exposures to both adults and children were taken into account using the composite adult described for the residential farmer scenario. Table D.2.1.11 summarizes the pathways included in this scenario. The exposure parameters for each pathway are presented in Table D.2.1.14 . The SIF values are the same as those in Table D.2.1. 13 , except that the recreational land user would not have access to or receive exposure from surface or groundwater. To account for this, the groundwater and surface water pathways were left open, but the media concentrations in the model were set to zero for both groundwater and surface water for the recreational land use scenario.

Table D.2.1.14 Recreational Land User Scenario Exposure Factors

D.2.1.3.2 Contaminant-Specific Parameters

The evaluation of the average daily intake and lifetime radiation dose in a particular medium is the product of the SIF value times a contaminant-specific factor. This section discusses the contaminant-specific factors required for each exposure pathway. These contaminant-specific parameters were evaluated the same way for all scenarios. Therefore, the exposure pathways are discussed independently of the scenarios (Equation [1], Section D.2.1.3.1).

Drinking Water Ingestion - The drinking water ingestion pathway has two contaminant-specific considerations: the water-purification factor and decay during transport from either the water pumping station or the location of domestic use. The URF calculations did not use the water-purification factor (i.e., the contaminant concentration in the water was not reduced because of treatment). The transport time was set to 0.5 day for drinking water and all domestic use analyses except for the Native American scenario for which no delay was included . The decay was evaluated as an exponential reduction in concentration during the transport period, based on the half-time for the contaminant in confined water systems (no volatilization loss). For radionuclides, the half-time is the radiological half-life.

Shower Dermal Contact - The shower dermal contact pathway involves dermal contact with water while showering with domestic water. The water concentration was evaluated as described for drinking water. The daily intake estimation required using a skin permeability constant (cm/hour) to estimate the transfer from the skin surface to the blood. In addition, it was necessary to divide the intake estimate for chemicals by the gastrointestinal absorption factor to convert the dermal intake to an equivalent ingestion intake (Strenge-Chamberlain 1994).

Shower Water Ingestion - The shower water ingestion pathway involves inadvertent ingestion of water while showering using domestic water. The water concentration was evaluated as described for drinking water. There are no other contaminant-specific parameters or considerations.

Leafy Vegetable Ingestion - The leafy vegetable-ingestion exposure pathway was used to represent the ingestion of home-grown vegetables by the residential farmer. The contaminant-specific factor includes estimating the uptake from the contaminated medium of concern. This medium may be air, soil (from air deposition), or irrigation water (groundwater or surface water). The methods for estimating plant concentration from the contaminated media are presented in Strenge-Chamberlain (Strenge-Chamberlain 1995). The contaminant-specific parameters involved in this analysis are the soil-to-plant concentration ratio and the atmospheric deposition velocity. Numerical values for these parameters are presented in Strenge-Chamberlain (Strenge-Chamberlain 1994).

Other Vegetable Ingestion - The other vegetable ingestion pathway represents vegetable and fruit crops for which the edible portion is not associated with the leaves of the plant. As for the leafy vegetable ingestion pathway, the methods for estimating plant concentration from the contaminated media are presented in Strenge-Chamberlain (Strenge-Chamberlain 1995). The contaminant-specific parameters were the same as for the leafy vegetable pathway and are described in Strenge-Chamberlain (Strenge-Chamberlain 1994).

Meat Ingestion - Evaluating URFs for the meat-ingestion pathway required estimating contaminant concentration in meat from animals that ingested contaminated feeds and water. As for the leafy vegetable-ingestion pathway, the methods for estimating meat concentration from the contaminated media are presented in Strenge-Chamberlain (Strenge-Chamberlain 1995). The contaminant-specific parameters were the soil-to-plant (animal feed) concentration ratio, the animal feed-to-meat transfer factor, and the atmospheric deposition velocity. These parameters are described in Strenge-Chamberlain (Strenge-Chamberlain 1994).

Milk Ingestion - The milk-ingestion represents the dairy exposure pathway. The analysis required estimating contaminant concentration in cow milk, and was performed in a similar manner to the meat pathway analysis, as presented in Strenge-Chamberlain (Strenge-Chamberlain 1995). The contaminant-specific parameters were the soil-to-plant (animal feed) concentration ratio, the animal feed-to-milk transfer factor, and the atmospheric deposition velocity. These parameters are described in Strenge-Chamberlain (Strenge-Chamberlain 1994).

Fish Ingestion - The fish-ingestion pathway required estimating the concentration of contaminants in edible portions of fish, based on the concentration in surface water. This estimation uses the fish bioaccumulation factor, which is the ratio of contaminant concentration in fish to that in the water. This parameter is described in Strenge-Chamberlain (Strenge-Chamberlain 1994). Note that ingestion of whole fish is considered for the Native American scenario.

Swimming Water Ingestion - Inadvertently ingesting water while swimming involved direct ingestion of surface water.

No contaminant-specific parameters were required.

Swimming Dermal Contact - Direct contact with surface water while swimming would result in absorption of contaminants through the skin. The absorption estimate required a value for the skin permeability constant for each contaminant. In addition, the intake estimate for chemicals must be divided by the gastrointestinal absorption factor to convert the dermal intake to an equivalent ingestion intake. The permeability constant and the gastrointestinal absorption factor are described in Strenge-Chamberlain (Strenge-Chamberlain 1994).

Shoreline Dermal Contact - All the shoreline exposure pathways required estimating the contaminant concentration in sediment based on the concentration in surface water. This transfer was estimated using the model of Soldat et al. (Soldat et al. 1974) as described in Whelan et al. (Whelan et al. 1987). This model estimates the average sediment concentration over a user-defined exposure duration. Transferring contaminants from the sediment to the individual also required a value for the skin absorption fraction for the contaminant. The skin absorption fraction is the fraction of contaminant on skin absorbed into the blood. In addition, the intake estimate for chemicals must be divided by the gastrointestinal absorption factor to convert the dermal intake to an equivalent ingestion intake. This parameter is described in Strenge-Chamberlain (Strenge-Chamberlain 1994).

Shoreline Sediment Ingestion - Inadvertently ingesting sediment while participating in shoreline recreational activities required an estimate of the shoreline sediment concentration. No other contaminant-specific consideration was required.

Soil Ingestion - Inadvertently ingesting soil would involve direct ingestion of the contaminated soil. The soil concentration is defined at the start of the exposure duration. It is necessary to account for the time variation of soil concentration due to loss by volatilization and radioactive decay. The volatilization loss was estimated using the environmental half-time parameter for soil. The time-integral of soil concentration was evaluated over the exposure duration to determine the average soil concentration present. The environmental half-time is described in Strenge-Chamberlain (Strenge-Chamberlain 1994).

Soil Dermal Contact - Contaminant-specific considerations for dermal absorption from soil involved the skin absorption fraction and the same considerations as for loss by volatilization and radioactive decay. The skin-absorption fraction gives the fraction of contaminant on the skin that is absorbed into the blood. In addition, the intake estimate for chemicals must be divided by the gastrointestinal absorption factor to convert the dermal intake to an equivalent ingestion intake. The skin-absorption fraction and the environmental half-time are described in Strenge-Chamberlain (Strenge-Chamberlain 1994).

Air Inhalation - There were no contaminant-specific parameters for inhaling air.

Soil Resuspension Inhalation - Inhaling resuspended soil involved estimating the average soil concentration present over the exposure duration. This analysis involved the same considerations as for loss by volatilization and radioactive decay. There are no other contaminant-specific considerations for this pathway. The environmental half-time is described in Strenge-Chamberlain (Strenge-Chamberlain 1994).

External Exposure from Swimming - There were no contaminant-specific considerations for external exposure to radionuclides while swimming. The water immersion external radiation dose factor was used to estimate an external slope factor for water immersion as described in Section D.2.1.3.3.

External Exposure from Boating - There were no contaminant-specific considerations for external exposure to radionuclides while boating. The water immersion external radiation dose factor was used to estimate an external slope factor for boating as described in Section D.2.1.3.3. A factor of 0.5 was applied to the water immersion external radiation dose factor to approximate the exposure geometry in a boat (half immersion).

External Exposure from Shoreline - This pathway required an estimate of the average radionuclide concentration in shoreline sediment over the exposure duration, just as for the other pathways involving shoreline sediment. There were no other contaminant-specific considerations for external exposure to radionuclides on the shoreline.

External Exposure from Soil - External exposure to radionuclides in soil required estimating the average concentration in soil over the exposure duration. There were no other contaminant-specific considerations for external exposure to radionuclides in soil.

External Exposure from Air - There were no contaminant-specific considerations for external exposure to radionuclides in air. The air immersion external radiation dose factor was used to estimate an external slope factor for air exposure as described in Section D.2.1.3.3.

Sweat Lodge Exposures for Native Americans - Exposures of Native Americans in sweat lodges are evaluated for inhalation intake and dermal contact with water. The transfer of contaminants from the water to the sweat lodge air is estimated using a "volatilization" factor, similar to the EPA/Andelman factor used for indoor inhalation of volatile organic compounds (VOCs) and radon. The steam in the sweat lodge is generated by pouring water onto heated rocks. A volatilization factor of 0.3 L/m^3 is used for all non-volatile contaminants, a factor of 2.5 is used for all VOCs, and a factor of 0.5 is used for radon. The dermal exposure pathway also involves use of the skin permeability factor as described for the shower dermal contact pathway. There are no other contaminant-specific parameters or considerations.

D.2.1.3.3 Unit Risk Factors

Analyzing the URFs provides estimates of health impacts per unit concentration of contaminant in a medium. The contaminants analyzed were the contaminants in the current inventories, which are discussed in Sections D.2.1.1.1 and D.2.1.1.2. The health impact measure used for carcinogenic chemicals and radionuclides was the lifetime cancer incidence from intake received during a defined exposure duration. For noncarcinogenic chemicals, the health impact measure was the HI, which is the ratio of the average daily intake to the reference dose (RfD) (evaluated for ingestion and inhalation intake routes). For each contaminant in the current inventories, the health impacts were conservatively added across all exposure pathways for a given scenario and medium and it is assumed that all chemicals added have the same mechanism of action and affect the same target organ. The following sections describe the methods for evaluation of the URFs. The equations are from Strenge-Chamberlain (Strenge-Chamberlain 1994).

Also of concern are genetic effects from ionizing radiation. Ionizing radiation can produce submicroscopic changes in individual genes (gene mutations) and damage the chromosome structure. Damage to the genes in the germ cell of the testes or ovaries may result in the transmittal of heritable mutations. Little experimental study data exists on humans. Most of the available data are based on experimentation with animals. Within the scientific community, opinions vary about the applicability of the animal study data to humans. A study of 38,000 offspring who had at least one parent exposed to radiation at Hiroshima or Nagasaki showed no statistically substantial effects resulting from the exposure. Based on the human and animal genetic data, the number of genetic effects of an average population exposure of 1 rem per 30-year generation was calculated to be 15 to 40 additional cases of genetic disorders per million live birth offspring. This is compared to the current spontaneous incidence of about 17,300 cases per million (Zenz 1994). Assuming the conservative end of the range of 40 additional cases per million results in a dose-to-risk conversion factor of 4.0E-05 for genetic effects. By contrast, ICRP Publication 60 (ICRP 1991) recommends a dose-to-risk conversion factor for hereditary effects of 1.3E-04. Additionally, information presented in the National Council on Radiation Protection Report Number 116 (NCRP 1993) suggests that genetic effects might be greater than indicated by previous human and animal studies. Nevertheless, because the results of this assessment are intended to support comparison of the alternatives rather than to serve as a determination of absolute risk, it is considered sufficient to measure health impacts solely in terms of lifetime cancer risk. For this reason, potential genetic effects have not been calculated and are not considered further in this analysis.

Radionuclide Unit Risk Factor Calculation

The average daily intake and lifetime radiation doses (see Equation [1], Section D.2.1.3.1) were used to estimate the URFs for the health impact measure appropriate to the contaminant. The URFs for radionuclides were evaluated as follows for inhalation exposure pathways:

$$URF_{ih} = (Intake_{ih})\ (SF_{ih})$$

The following equation was used to evaluate URFs for the ingestion exposure pathways:

$$URF_{ig} = (Intake_{ig})\ (SF_{ig})$$

Where:

URF_{ih} = Unit risk factor for an inhalation pathway for radionuclide i (risk per unit medium concentration)

URF_{ig} = Unit risk factor for an ingestion pathway for radionuclide i (risk per unit medium concentration)

$Intake_{ih}$ = Inhalation intake for radionuclide i for the inhalation pathway of interest (pCi)

$Intake_{ig}$ = Ingestion intake for radionuclide i for the ingestion pathway of interest (pCi)

SF_{ih} = Inhalation slope factor for radionuclide i (risk/pCi)

SF_{ig} = Ingestion slope factor for radionuclide i (risk/pCi)

For exposure pathways involving external radiation exposure, the URFs were evaluated as follows:

$$URF_{ix} = (Exposure_{ix})\ (SF_{ix})$$

Where:

URF_{ix} = Unit risk factor for an external radiation exposure pathway for radionuclide i (risk per unit medium concentration)

$Exposure_{ix}$ = Exposure time for radionuclide i for the external radiation exposure pathway of interest (hour)

SF_{ix} = External exposure slope factor for radionuclide i (risk/hour per pCi/unit medium quantity)

The external slope factors provided in HEAST (EPA 1993b) are for use with contaminated soil (pCi/g soil). For external exposure to air and water, slope factors were generated from radiation dose factors and the health effects conversion factor of 6.2E-04 risk per rem. Cancer incidence (fatal and nonfatal) is used to be consistent with EPA slope factors. The air-immersion external slope factor was evaluated as follows:

$$SF_{ia} = (6.2E\text{-}04)\ (DF_{ia})$$

Where:

SF_{ia} = Air immersion slope factor for radionuclide i (risk/hr per pCi/m^3)

DF_{ia} = Air immersion dose rate factor for radionuclide i (rem/hr per pCi/m^3)

6.2E-04 = Cancer incidence conversion factor (risk/rem)

For dermal exposure pathways, slope factors were generated from radiation dose factors and the health effects conversion factor of 6.2E-04 risk per rem. The dermal slope factor was evaluated as follows:

$$SF_{id} = (6.2E\text{-}04)\ (DF_{id})$$

Where:

SF_{id} = Dermal slope factor for radionuclide i (risk/hr per pCi)

DF_{id} = Dose rate factor for radionuclide i (rem/hr per pCi)

The water immersion slope factor was evaluated as follows:

$$SF_{iw} = (6.2E\text{-}04)\ (DF_{iw})$$

Where:

SF_{iw} = Water immersion slope factor for radionuclide i (risk/hr per pCi/L)

DF_{iw} = Water immersion dose rate factor for radionuclide i (rem/hr per pCi/L)

Chemical Unit Risk Factor Calculation

The intake parameter for chemical exposures was the average daily intake for a chemical by either ingestion or inhalation. For carcinogenic chemicals, the intake was the average over the lifetime of the individual (70 years), and for noncarcinogenic chemicals, it was the average over the exposure duration (20 years for the industrial scenario and 30 years for other scenarios).

The lifetime risk of cancer incidence from chemical-ingestion exposures was evaluated as follows:

$$URF_{ig} = (Intake_{ig})\ (Sfig)$$

Where:

URF_{ig} = Unit risk factor for chemical carcinogen i from an ingestion exposure pathway g (risk/unit medium concentration)

$Intake_{ig}$ = Average daily intake of chemical i from ingestion pathway g (mg/kg/day)

SF_{ig} = Ingestion slope factor for chemical i (risk per mg/kg/day).

The lifetime cancer incidence risk for inhalation was evaluated in a similar manner as follows:

$$URF_{ih} = (Intake_{ih})\ (SF_{ih})$$

Where:

URF_{ih} = Unit risk factor for chemical carcinogen i from an inhalation exposure pathway h (risk/unit medium concentration)

$Intake_{ih}$ = Average daily intake of chemical i from inhalation pathway h (mg/kg/day)

SF_{ih} = Inhalation slope factor for chemical i (risk per mg/kg/day)

The health impact parameter for noncarcinogenic chemicals, the HI, was evaluated as follows for ingestion pathways:

$$URF_{ig} = Intake_{ig} / RfD_{ig}$$

Where:

URF_{ig} = Unit risk factor for the noncarcinogenic chemical from an ingestion exposure pathway g (HI/unit medium concentration)

$Intake_{ig}$ = Average daily intake of chemical i from ingestion pathway g (mg/kg/day)

RfD_{ig} = Ingestion reference dose for chemical i (mg/kg/day)

The HI for inhalation was evaluated in a similar manner as follows:

$$URF_{ih} = Intake_{ih} / RfD_{ih}$$

Where:

URF_{ih} = Unit risk factor for the noncarcinogenic chemical from an inhalation exposure pathway h (HI/unit medium concentration).

$Intake_{ih}$ = Average daily intake of chemical i from inhalation pathway h (mg/kg/day).

RfD_{ih} = Inhalation reference dose for chemical i (mg/kg/day).

Dermal exposures were evaluated as equivalent to ingestion exposures with a correction for the fractional absorption of the chemical in the gastrointestinal tract. This correction is discussed in Section D.2.1.3.2 in the definition of the contaminant-specific factors.

Results of the URF calculations are summarized in Tables D.2.1.15 to D.2.1. 26 for the Native American, residential farmer, industrial, and recreational user (shoreline and land) scenarios . The URFs are provided for each scenario and for each of the three contaminant types: NC, CC, and RA. These summary tables present the URF values for each scenario, medium, and contaminant, summed over exposure pathways. The units for the URFs are health impacts normalized to unit medium contaminant concentration. The complete set of URFs for specific exposure pathways is provided in Strenge-Chamberlain (Strenge-Chamberlain 1994).

D.2.1.4 Risk Module

Once the point concentration has been identified within each grid cell (based on either the current or post-remediation source), this value is multiplied by the URF. The resultant value is the risk to a receptor within this grid cell. The risk module tabulates risk for each receptor scenario across all cells.

The equations for point concentrations and total risk for each scenario are as follows:

Where:

C = Point concentration

S = Source inventory

TUC = Transported unit concentration

R = Total risk

URF = Unit risk factor

The subscripts s, h, t, and m in Equation (3) represent the scenario, hazardous material, time, and media, respectively. The summation in Equation (3) represents addition of contributions from all exposure pathways associated with a particular scenario. The URF values presented in the tables of this report include the summation over the exposure pathways defined previously for each exposure scenario.

Table D.2.1.15 Native American Scenario Noncarcinogenic Chemical Unit Risk Factors

Table D.2.1.16 Native American Scenario Carcinogenic Chemical Unit Risk Factors

Table D.2.1.17 Native American Scenario Radionuclide Unit Risk Factors

Table D.2.1.18 Residential Farmer Scenario Noncarcinogenic Chemical Unit Risk Factors

Table D.2.1.19 Residential Farmer Scenario Carcinogenic Chemical Unit Risk Factors

Table D.2.1.20 Residential Farmer Scenario Radionuclide Unit Risk Factors

Table D.2.1.21 Industrial Scenario Noncarcinogenic Chemical Unit Risk Factors

Table D.2.1.22 Industrial Scenario Carcinogenic Chemical Unit Risk Factors

Table D.2.1.23 Industrial Scenario Radionuclide Unit Risk Factors

Table D.2.1.24 Recreational Shoreline User and Land User Scenario Noncarcinogenic Chemical Unit Risk Factors

Table D.2.1.25 Recreational Shoreline User and Land User Scenario Carcinogenic Chemical Unit Risk Factors

Table D.2.1.26 Recreational Shoreline User and Land User Scenario Radionuclide Unit Risk Factors

To provide a visual display of the total risk, contour plots showing risk distribution across the Hanford Site were generated from the values in the risk module with the help of GIS software. Each contour line represents a discrete value of risk. Risk for these purposes is defined as the increased probability that an individual at any location along such a contour line would develop cancer (in the case of exposure to radionuclides and carcinogenic chemicals) or suffer an adverse effect (in the case of exposure to noncarcinogenic chemicals) under the particular exposure scenario. There is no universal agreement on what level of risk is considered acceptable. For purposes of this analysis, a risk of less than 1.00E-06 (one in a million) is considered low and a risk greater than 1.00E-04 (one in ten thousand) is considered high. An HI greater than 1.0 is indicative of adverse health effects. Conversely, a HI less than 1.0 suggests that no adverse health effects would be expected. The risk contour plots for each alternative are displayed in Section D.5.0. Risk from radionuclides and carcinogenic chemicals is combined and presented on one set of maps. HIs from noncarcinogenic chemicals are presented separately.

D.2.1.5 Example Calculations

This example analysis considers the groundwater exposure pathway, the residential farmer, and the point concentration of iodine-129 (I-129) for a single source location (575000E, 137000N) at 300 years from the present resulting from a hypothetical release. The method for estimating exposure to this receptor is summarized as follows. Also presented is a description of the URF and the risk calculations.

Exposure

Exposure is calculated based on the SIF value from HSRAM (DOE 1995c). The SIF is independent of the contaminant. The SIF is multiplied by contaminant-specific parameters and the initial media concentration. The equation is as follows:

$$\text{Intake or Exposure} = C_{iym}\, PF_{mix}\, SIF_{smyx}$$

Where:

Intake = Average daily intake of contaminants (Ci/kg day) (Ci/L day)

Exposure = Total intake or exposure received over the exposure duration (pCi or hr)

C_{iym} = Concentration of contaminant i, of type y, in medium m (mg or pCi per unit quantity of medium in L, kg, m^3, or m^2)

Pf_{mix} = Contaminant-specific factor for medium m, contaminant i, and exposure pathway x (units specific to analysis)

SIF_{smyx} = Summary intake factor for scenario s, medium m, contaminant type y, and exposure pathway x (units specific to analysis)

The exposure is calculated from the SIF values based on the following assumptions: Media of concern (m) is groundwater; C_{iym} for groundwater is one unit; and C_{iym} for all other media is zero.

Table D.2.1.21 presents the exposure pathways, SIF values, contaminant concentrations, and the exposure or intake for the residential farmer scenario for groundwater.

Unit Risk Factor Calculation

The average daily intake and lifetime radiation doses are used to estimate the URFs for the health impact measure appropriate to the contaminant. Table D.2.1. 27 shows the URF calculations for the groundwater exposure pathway for I-129. The URFs for radionuclides are evaluated as follows for inhalation exposure pathways:

$$URF_{ih} = Intake_{ih}\, SF_{ih}$$

Table D.2.1.27 Exposure Parameters and Calculations for I-129 for the Residential Farmer

The following equation is used to evaluate URFs for the ingestion exposure pathways:

$$URF_{ig} = Intake_{ig}\, SF_{ig}$$

Where:

URF_{ih} = Unit risk factor for an inhalation pathway for radionuclide i (risk per unit medium concentration)

URF_{ig} = Unit risk factor for an ingestion pathway for radionuclide i (risk per unit medium concentration)

$Intake_{ih}$ = Inhalation intake for radionuclide i for the inhalation pathway of interest (pCi)

$Intake_{ig}$ = Ingestion intake for radionuclide i for the ingestion pathway of interest (pCi)

Sfih = Inhalation slope factor for radionuclide i (risk/pCi)

Sfig = Ingestion slope factor for radionuclide i (risk/pCi).

For exposure pathways involving external radiation exposure, the URFs are evaluated as follows:

$$URF_{ix} = Exposure_{ix}\ SF_{ix}$$

Where:

URF_{ix} = Unit risk factor for an external radiation exposure pathway for radionuclide i (risk per unit medium concentration)

Exposure $_{ix}$ = Exposure time for radionuclide i for the external radiation exposure pathway of interest (hr)

Sfix = External exposure slope factor for radionuclide i (risk/hr per pCi/unit medium quantify).

The external slope factors provided in HEAST (EPA 1993b) are for use with contaminated soil (pCi/g soil). For external exposure to air and water, slope factors are generated from radiation dose factors and the default health effects conversion factor of 6.2E-04 risk per rem. For example, the air-immersion effective slope factor is evaluated as follows:

$$SF_{ia} = 6.2E\text{-}04\ DF_{ia}$$

Where:

Sfia = Air immersion slope factor for radionuclide i (risk/hr per pCi/m^3)

DF_{ia} = Air immersion dose rate factor for radionuclide i (rem/hr per pCi/m^3)

6.2E-04 = Cancer incidence conversion factor (risk/rem).

Risk

Once the point concentration has been identified within each grid cell (based on either the current or post-remediation source), this value is multiplied by the URF. The resultant value is the risk to a receptor within this grid cell. The risk module tabulates risk for each receptor scenario across all cells on the Hanford Site. Equation (3) represents total risk for each scenario.

For I-129, the concentration is 1.37E-04 g/m^3 of water because the concentration was given in g/m^3; therefore a conversion is needed to convert to Ci/mL. To convert, multiply the concentration by the specific activity of I-129 to convert to Ci/m^3. Next, multiply by the conversion factor 1.0E+12 to convert Ci to pCi. Then, multiply by the conversion factor 1.0E-03 to convert m^3 to L, assuming a density of 1. Now that the concentration units match the URF units, multiply the two numbers, which results in a risk of 3.11E-04. The calculations are as follows:

Concentration (g/m^3)		1.37E-04
Specific activity (Ci/g)	·	1.76E-04
Concentration (Ci/m^3)		2.41E-08
Conversion (Ci to pCi)	·	1.00E+12
Concentration (pCi/m^3)		2.41E+04
Conversion (m^3 to L)	·	1.00E-03

Concentration (pCi/L)	2.41E+01
URF ·	1.29E-05
RISK	3.11E-04

D.2.2 REMEDIATION RISK METHODOLOGY

Remediation risk is the potential risk from exposure to toxic and radiological contaminants and direct exposure to radiation during the construction and routine operational phases of the TWRS project.

Remediation risk is expressed as the increase in probability that an individual exposed to radioactive or hazardous materials over the duration of the proposed project would contract a fatal cancer from that exposure. In the case of an exposed population, remediation risk represents the expected increase in cancer fatalities in the population at risk.

The risk endpoint for the baseline and post-remediation analyses is cancer incidence, rather than fatal cancers (see Section D.2.1.3.3.). The methodology used for those analyses employs cancer slope factors provided by the EPA (for both chemicals and radionuclides). Because those slope factors are specific to cancer incidence, it was not possible to generate estimates of cancer fatalities from them. However, the difference in cancer incidence rates versus cancer fatality rates for radionuclides is small as indicated by health effect conversion factors presented in ICRP Publication 60 (ICRP 1991). For example, the cancer fatality conversion factor for the general public is 5.0E-04 fatal cancers per rem and the corresponding cancer incidence (fatal and nonfatal cancers) conversion factor is 6.0E-04 cancers per rem. The EPA radiation slope factors give similar results for many radionuclides (e.g., Cs-137 and cobalt-60 [Co-60]) but give lower cancer incidence estimates for others (e.g., plutonium [Pu] isotopes) compared to estimates obtained by multiplying the radiation dose factor times the health effects conversion factor.

Remediation risk calculations evaluate health risk to the TWRS workers, noninvolved workers at the Hanford Site, and the general public. Potential risk to the workers would be from direct exposure to radiation and exposure to chemical emissions from remediation operations during the work day. Potential risk to the noninvolved workers would be from inhaling radioactive, toxic, and/or hazardous atmospheric emissions from tanks, process stacks, and vents. Potential risk to the general public includes both inhaling contaminants and ingesting food and water contaminated by airborne deposition.

D.2.2.1 Source Term

The source is an estimation of the amount of a contaminant available for dispersion into the environment or the radiation field to which a receptor is directly exposed. The source term is the respirable fraction of the source released into the environment.

The source of risk for the workers is from inhalation of radiological and chemical emissions from operations and from direct exposure to radiation fields.

The source of risk for the noninvolved worker is the contaminants that could potentially reach them through dispersion of atmospheric emissions released to the environment. The atmospheric emissions could be radioactive gaseous effluents, chemical emissions, or particulates dispersed in the air. It is assumed that the emissions would be present throughout the workplace and inhaled by the noninvolved worker during the course of a normal workday. It is assumed the noninvolved worker would not ingest food products grown onsite or groundwater from nearby wells.

For the general public, the source of risk is the contaminants that could potentially reach them through atmospheric emissions released to the environment and transported offsite. Members of the general public potentially would inhale gaseous and particulate emissions; ingest vegetation, meat, and milk products contaminated by airborne deposition; and receive external exposures from submersion in a contaminated plume. Modeling codes estimate these doses based on estimates of atmospheric emissions.

D.2.2.2 Transport

Transport refers to the movement of contaminants in the environment from the source location to the receptor. The transport analysis temporally and spatially redistributed the airborne contaminants. Transport was modeled within the site boundary and within an 80-km (50-mi) radius centered at the release point for atmospheric emissions. Transport assumptions for atmospheric emissions are described as follows for each receptor.

Workers

Transport was not evaluated for the worker because fixed dose values were assumed to be similar to the values previously measured for similar activities at the Hanford Site.

Noninvolved Workers

The noninvolved workers are assumed to be located at least 100 m (330 ft) away from the release point or area, out to the Hanford Site boundary. The computer code GENII (Napier et al. 1988) was used to calculate the atmospheric dispersion coefficient, Chi/Q, and corresponding dose for the noninvolved worker. GENII has been used routinely to support Hanford Site operations and risk assessments to calculate dose from the interaction of receptors and airborne radioactivity (DOE 1995c). GENII uses an environmental transport module linked to a human exposure/dose module. The transport module generates atmospheric dispersion coefficients (Chi/Q), which relate the concentrations released at the source to the concentrations at a receptor location. The exposure module then uses the output from the transport module to calculate the dose to a receptor under a specified exposure scenario.

The air transport model in GENII uses a Gaussian diffusion plume method to model atmospheric transport of radiological contaminants from release points or areas to receptors. GENII allows the source to be released either at ground level or at a different elevation. Hanford Site meteorological conditions are used in the analysis involving GENII.

Two types of releases were modeled for this assessment. The first type is the ground release from the tank farms. Modeling for the ground release used the 9-year average (1983 to 1991) wind data measured at a height of 10 m (33 ft) above the Hanford Meteorological Station in the 200 Areas. Table D.2.2.1 displays the meteorological data (i.e., joint frequency distribution of wind speed, wind direction, and stability category) for all stability categories (Pasquill A-G). Figure D.2.2.1 illustrates the data in Table D.2.2.1 and shows a summary of wind direction frequencies. The second release type is the elevated release, which is a release emitted from a processing plant stack. Modeling for the elevated release used the 9-year average (1983 to 1991) wind data measured at a height of 61 m (200 ft) above the Hanford Meteorological Station for stacks taller than 10 m (33 ft). Table D.2.2.2 displays the meteorological data for all stability categories (Pasquill A-G). Figure D.2.2.2 illustrates the data in Table D.2.2.2 and provides a summary of wind direction frequencies.

Figure D.2.2.1 Percent Wind Frequency for All Wind Speeds, Directions, and Pasquill Categories Measured at Height of 10 m (33 ft), Hanford Meteorological Station

Figure D.2.2.2 Percent Wind Frequency for All Wind Speeds, Directions, and Pasquill Categories Measured at Height of 61 m (200 ft), Hanford Meteorological Station

Table D.2.2.2 Joint Frequency Data Collected at 61 m (200 ft) (1983 to 1991)

General Public

For the general public, the atmospheric transport and dispersion modeling was the same as applied for the noninvolved workers, but the distance from the release was changed to extend from the Site boundary to a distance of 80 km (50 mi).

Air Dispersion Isopleths

As discussed earlier, the air dispersion modeling for routine remediation was performed for two release categories: ground and elevated releases. Contour plots showing Chi/Q isopleths for these two cases are presented in Figures D.2.2.3 and D.2.2.4. These plots can be used to calculate the dose and risk to receptors at locations other than the maximally-exposed individual (MEI) locations presented in this assessment. The Chi/Q values shown were computed by GXQ Version 4 (Hey 1993 and 1994). Although the Chi/Q values used in the assessment were computed by GENII, GXQ was used for purposes of generating the contour plots because it requires less processor time than GENII. The computational methods used by GXQ are identical to those used by GENII.

Figure D.2.2.3 Chi/Q Isopleths for Ground Releases s/m^3

Figure D.2.2.4 Chi/Q Isopleths for Elevated Releases in s/m^3

D.2.2.3 Exposure

Exposure to the receptors for this analysis is from airborne contaminants and/or from direct exposure from gamma radiation fields. The radiological dose to a receptor would depend on the location of the receptor relative to the point of release of the radioactive material, or the shielding and distance of the receptor from the radiation field. Doses for the MEI and population were computed for each receptor class. The MEI worker is an individual that receives the highest annual exposure. The receptors are identified as follows.

- Worker population and MEI worker - These are individuals directly involved in the proposed remedial activities. They would receive exposure from inhalation and from direct exposure to gamma radiation fields during routine operation of TWRS facilities.
- Noninvolved worker population and MEI noninvolved worker - This was based on the current Hanford Site employment and assumed to be located from 100 m (330 ft) out to the Hanford Site boundary. Exposure would be by the inhalation pathway and by direct exposure from submersion in a radioactive cloud from routine air emissions during operation of TWRS facilities. The noninvolved worker population would receive a dose based on an annual average. The MEI noninvolved worker would receive the highest annual exposure.
- General public population and MEI general public - The general public population includes people located within 80-km (50-mi) of the Hanford Site boundary. They would be exposed through air dispersion of the plume, which could result in inhalation, external exposure, and exposure from ingestion of contaminated meat, dairy products, and vegetables. The MEI general public is assumed to be an individual located at the Hanford Site boundary who receives the highest annual exposure. The Site boundary is considered to be an adjusted Hanford Site boundary that excludes areas likely to be released by DOE in the near future. The Site boundary for the EIS was defined as follows:
  - N. Columbia River - 0.4 km (0.25 mi) south of the south river bank;
  - E. Columbia River - 0.4 km (0.25 mi) west of the west river bank;
  - S. A line running west from the Columbia River, just north of the Washington Public Power Supply System leased area, through the Wye Barricade to State Route 240; and
  - W. State Route 240 and State Route 24.

Potential exposure and subsequent carcinogenic risk and noncarcinogenic health hazards from chemical emissions were evaluated for the MEI worker, MEI noninvolved worker, and MEI general public receptors as described in more detail in the following text.

Radionuclide exposure estimates for the TWRS workers did not require using a computer model because fixed dose values were assumed to be similar to the values previously measured for similar activities at the Hanford Site. For exposure to nonradioactive chemical emissions, the MEI worker was evaluated using a "box" model. This model assumed that the MEI worker was located within a box 100 m long, 100 m wide, and 3 m high (330 ft long, 330 ft wide, and 10 ft high). Average wind velocity perpendicular to the side of the box was assumed to be 3.6 m/sec. Then, the Chi/Q (atmospheric dispersion coefficient) for the MEI worker was estimated using GENII as follows.

$$\text{Chi/Q} = 1 / (L)\,(H)\,(W)$$

Where:

Chi/Q = Sec/m^3

L = Downwind length of the box, m

H = Height of the box, m

W = Average wind velocity, m/sec

The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

For the noninvolved worker and general public, exposure was estimated through the use of the computer GENII model (Napier et al. 1988 and DOE 1995c). GENII was used to calculate doses corresponding to the Chi/Q values generated through air transport modeling. The GENII calculations were performed assuming that source term release and receptor intake end after 1 year (i.e., 8,760 hours). Doses calculated by GENII were multiplied by the duration (in years) of a particular activity to produce the total dose for that activity. The dose calculation ends after 70 years (i.e., a 70-year life expectancy is assumed).

The GENII computer program allows calculation of radiation doses to individuals or the population from airborne and waterborne radionuclide releases of radionuclides to the environment. Exposure pathways (i.e., ingestion, inhalation, and external exposure routes) are included. For the present analysis, exposure pathways are included in the dose analysis for inhalation or airborne activity, external exposure to airborne and deposited activity, and ingestion of agricultural products grown in soil contaminated from atmospheric deposition. Parameter values used in the analysis were as defined by Schreckhise et al. (Schreckhise et al. 1993) for dose analyses performed for Hanford Site activities. The parameters used for the individual and population dose analyses generally are more conservative than those used for the baseline and post-remediation analyses. The dose estimates generated by GENII were converted to risk as described in Section D.2.2.4.

The assumptions for estimating exposures to the receptors listed previously are described in the following sections.

Workers

The worker exposure is a combination of exposure from inhalation and direct radiation and would depend on the activity. The historical average dose for a Hanford Site tank farm worker has been 14 millirems per year (mrem/year) (WHC 1995g and Jacobs 1996). This same average is assumed for radiation workers during construction of the transfer lines, retrieval system tie-ins, and the tank farm confinement facilities. This same dose of 14 mrem/year is also assumed for monitoring, maintenance, and closure activities. A dose of 200 mrem/year is assumed for personnel operating the evaporators, retrieval facilities, separation and treatment facilities (both in situ and ex situ), and for processing the capsules. This was based on a dose of 200 mrem/year, average whole body deep exposure to operational personnel, at the Plutonium-Uranium Extraction (PUREX) Plant during 1986 (WHC 1995g and Jacobs 1996). A dose of 200 mrem/year was assumed for capsule alternatives. The MEI dose (one worker that receives the maximum exposure permissible) was based on a current site administrative control level of 500 mrem/year per worker for each year of operation.

For nonradiological chemicals, the chemical intake (dose) was estimated for the MEI worker according to the following equation:

$$Intake_i = \frac{(Ca_i)\ (IR)\ (EF)\ (ED)}{(BW)\ (AT)}$$

Where:

$Intake_i$ = Inhalation intake of the ith chemical, mg/kg-day

Ca_i = Estimated air concentration of the ith chemical, mg/m^3

IR = Worker inhalation rate, 20 m^3/day

EF = Worker exposure frequency, 250 days/year

ED = Worker exposure duration, 30 years

BW = Worker body weight, 70 kg

AT = Averaging time, days

= (ED)(365 days/year) for noncarcinogens

= (70 years)(365 days/year) for carcinogens, (25,550 days)

Noninvolved Workers

During the workday, the noninvolved workers would be exposed to contamination from atmospheric emissions released during implementation of TWRS remedial activities. The noninvolved workers are assumed to occupy an area extending from 100 m (330 ft) out to the Hanford Site boundary. To calculate the noninvolved worker population dose, Hanford Site-specific population data were obtained from the Hanford Site phone directory and increased by 10 percent to account for uncertainties. The Hanford Site worker populations are presented in Table D.2.2.3.

Table D.2.2.3 Onsite Population

The principal assumption for calculations of dose is the breathing rate, which is assumed to be 3.30E-04 m^3 /sec (4.30E-04 yd^3 /sec). The dose from ingesting contaminated food was not included because it was assumed that ingestion of food grown onsite would not be allowed. The duration of exposure would vary depending on the schedule for each of the TWRS alternatives being considered.

The noninvolved MEI worker was assumed to be exposed from inhalation and external radiation from the plume continuously throughout the year and from deposited activity for half of the year (4,380 hr/yr). Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI workers. The noninvolved worker population was assumed to be exposed from inhalation and external radiation from the plume continuously throughout the year and from deposited activity for one-third of the year (2,920 hr/yr). The dose from inhalation of resuspended activity was evaluated using the mass loading approach with a particulate air concentration of 100 mg/m^3 for both the maximum individual and population analyses.

General Public

The exposure pathways for the general public are inhalation, external exposure from submersion in a cloud, and consumption of fruits, vegetables, meat, and milk. The general public is assumed to occupy an area extending from the Hanford Site boundary to 80 km (50 mi) from the release site. Population data obtained from the 1990 Census (Beck et al. 1991) are used to calculate exposure and dose for the average member of the general public. Table D.2.2.4 displays the general public population within 80 km (50 mi) of the Hanford Site.

Table D.2.2.4 Offsite Population

For radiological emissions, the assumptions for the general public (MEI and population) were the same as for the noninvolved workers, but also included ingestion of contaminated farm products. The general public MEI was assumed to ingest the following foods: leafy vegetables (82 g/day), root vegetables (600 g/day), fruit (900 g/day), grain (220 g/day), beef (220 g/day), poultry (50 g/day), milk (740 g/day), and eggs (82 g/day). The individuals in the general population each were assumed to ingest the following foods: leafy vegetables (41 g/day), root vegetables (383 g/day), fruit (175 g/day), grain (197 g/day), beef (192 g/day), poultry (23 g/day), milk (630 g/day), and eggs (55 g/day). The maximum individual exposure is based on intake assumptions that have been used historically at the Hanford Site for risk analysis intended to show protection to the public.

For nonradiological chemicals, the chemical intake (dose) was estimated for the MEI general public receptor using a lifetime average daily dose (LADD). The LADD was the combined intake over 6 years for a child and over 24 years for an adult, resulting in a residential exposure duration of 30 years. The residential or general public intake was calculated according to the following equation:

$$Intake_i = \frac{(Ca_i)\ (IR)\ (EF)\ (ED)}{(BW)\ (AT)}$$

Where:

$Intake_i$ = Inhalation intake of the ith chemical, mg/kg-day

Ca_i = Estimated air concentration of the ith chemical, mg/m^3

IR = Residential inhalation rate, m^3/day

= 20 m^3/day for an adult

= 10 m^3/day for a child

EF = Residential exposure frequency, 365 days/year

ED = Residential exposure duration, years

= 24 years for an adult

= 6 years for a child

BW = Residential body weight, kg

= 70 kg for an adult

= 16 kg for a child

AT = Averaging time, days

= (ED)(365 days/year) for noncarcinogens

= (70 years)(365 days/year) for carcinogens, (25,550 days)

Noncarcinogenic health effects were evaluated for a child intake because this scenario results in a larger exposure per body weight and would be more health protective for potential sensitive members of the general population. Carcinogenic effects were evaluated using the combined LADD. Potential impacts from deposition of suspended particulate and subsequent uptake from home-grown food products are based on the magnitude of the emissions and inhalation risks/hazards for residential receptors.

D.2.2.4 Risk

Routine risk for radionuclides is expressed in terms of latent cancer fatalities (LCFs). To estimate the number of cancer deaths that would result from exposure to low dose rates of ionizing radiation, dose-to-risk conversion factors are used to convert the calculated dose (from GENII) to a value for risk. Specific conversion factors were used that are accepted by agencies responsible for protection of human health and the environment, such as the Nuclear Regulatory Commission (NRC) (NRC 1991) and (EPA 1993a).

For radiological risk, two different conversion factors were used: one for workers and noninvolved workers and another for the general public, as recommended by the DOE Office of National Environmental Policy Act (NEPA) Oversight (DOE 1993d). The accepted dose-to-risk conversion factor for the worker is 4.0E-04 LCFs per person-rem effective dose equivalent (400 cancer deaths per million person-rem). The accepted conversion factor for the public is 5.0E-04 LCFs per person-rem effective dose equivalent (500 cancer deaths per million person-rem) (NRC 1991, ICRP 1991). The value for the public is higher because the public includes children, and children are more sensitive to radiation exposure. Assumptions for risk calculations are described in the following text.

In order to estimate the potential noncarcinogenic effects from exposure to multiple chemicals, the HI approach was used. The HI is defined as the summation of the hazard quotients (calculated dose divided by the reference dose [RfD]) for each chemical, for each route of exposure, and is represented by the following equation:

$$HI = \frac{\text{Calculated Dose}_a}{RfD_a} + \frac{\text{Calculated Dose}_b}{RfD_b} + \ldots + \frac{\text{Calculated Dose}_i}{RfD_i}$$

A total HI less than or equal to 1.0 (unity) is indicative of acceptable levels of exposure. To be truly additive in effect, chemicals must affect the same target organ system or result in the same critical toxic endpoint. Therefore, the approach listed previously is conservative and health protective in assuming that all chemical emissions are additive, and the approach provides a screening-level evaluation to potential noncarcinogenic effects.

Quantitative estimates of upper-bound incremental cancer risk (i.e., the excess cancer risk from fatal and nonfatal cancers) due to site-related chemicals were evaluated according to the following equation:

$$R_i = (q_i)\ (E_i)$$

Where:

R_i = Estimated incremental risk of cancer associated with the chemical;

q_i = Cancer slope factor for the chemical, $(mg/kg\text{-}day)^{-1}$

E_i = Exposure dose for the chemical, mg/kg-day

Carcinogenic risk was assumed to be additive and was estimated by summing the upper-bound incremental cancer risk for all carcinogenic chemical emissions.

Workers

Worker risk was evaluated in terms of a maximum individual and collective radiation dose to the workforce. The worker risk was calculated both for each unit process and for each alternative or subalternative as a whole. The method of calculation was as follows:

R = (DR) (W) (risk factor of 4.0E-04 cancer fatality/person-rem) (1.0E-03 rem/mrem)

Where:

R = the number of incremental LCFs due to routine exposure

DR = is the exposure value previously discussed (i.e., 500 mrem/year for the MEI, 200 mrem/year per person, and 14 mrem/year per person)

W = the number of remediation workers exposed during processing for each alternative

For the MEI worker, the exposure assumed for the purposes of the EIS results in an annual risk of 2.0E-04 LCF (0.5 rem/year 4.0E-04 LCF/rem). The risk for an entire alternative would be the product of this annual risk and the alternative's duration in years. For the worker population exposure, the exposure and resulting risk would vary by alternative and are presented in Section D.4.0.

Noninvolved Workers

Risk was calculated for the MEI noninvolved worker and total population of noninvolved workers. The MEI noninvolved worker is located where the dose and risk are highest. This location would change as release conditions change. The dose and risk were calculated for the Site's total noninvolved worker population of approximately 10,900.

General Public

The MEI member of the general public is located where the dose and risk are highest. This location would change as release locations change with the various alternatives. The population dose and risk to the general public would be the total dose and risk to the general population of approximately 376,000 within an 80-km (50-mi) radius from the release point.

D.2.2.5 Transportation Risk

Transportation risk for routine remediation is the integrated risk from direct radiation exposure from onsite truck or rail transport of waste to and from TWRS processing facilities only. Offsite rail transport of waste to the proposed national high-level waste (HLW) repository is discussed in Volume Four, Section E.16.0.

Transportation risk has been estimated by Green (Green 1995) using the RADTRAN 4 computer code (Neuhauser and Kanipe 1986). A key variable in the code is the dose rate from the vehicle package. The radioactive shipments in this analysis were assumed to be the regulatory maximum dose rate of about 10 mrem per hour at 1 m (3.3 ft). It is likely that many of the shipments would have lower values.

For the onsite shipments, the average population density of the 200 East Area (DOE 1994) was assumed to be 264.4 persons/km^2 (684.7 person/mi^2). All onsite travel was assumed to be in a zone with this population density.

The population dose was multiplied by a dose-to-risk conversion factor to estimate the LCF. The worker conversion factor used was 4.0E-04 (400 cancer deaths per million person-rem effective dose equivalent). For the public, the conversion factor was 5.0E-04 (500 cancer deaths per million person-rem effective dose equivalent).

D.3.0 BASELINE RISK

The baseline risk is the existing risk at any location at different times in the future in the absence of remedial activities. It would be represented by the risk from the 177 tanks , 40 inactive MUSTs, and Cs and Sr capsules at the Hanford Site if no further actions were conducted to stabilize the waste. For NEPA purposes, the baseline risk is risk from the No Action alternative.

The No Action alternative was used to approximate the baseline. The No Action alternative would involve several activities including the following.

- The SSTs would be saltwell pumped.
- Monitoring and routine maintenance would be performed.

Section s D.4.1 and D.4.11 discuss the short-term risk for the tank waste No Action alternative and capsules No Action alternative, respectively. Sections D.5.1 and D.5.11 discuss the long-term risk for the tank waste No Action alternative and the capsules No Action alternative, respectively. Section D.7.0 discusses the risk from human intrusion into the tank waste and capsules under the No Action alternatives .

D.4.0 REMEDIATION RISK

This section presents the results of the assessment for radiological and toxicological risk during remediation to remediation workers, noninvolved workers, and the general public for each of the TWRS alternatives. The risk presented in this section was evaluated using the methodology described in Section D.2.0. Using this methodology, remediation risk to the MEIs are expressed as the probability that the individual would contract a fatal cancer as a result of exposure to a radioactive substance and/or carcinogenic chemicals during the duration of the proposed project. In the case of an exposed population, remediation risk represents the expected increase in LCFs in the population at risk of potential exposure. The toxic effects resulting from chemical exposure also are analyzed.

D.4.1 NO ACTION ALTERNATIVE (TANK WASTE)

This section presents the anticipated remediation risk associated with the No Action alternative for tank waste, as outlined in Volume Two, Appendix B.

The radiological and toxicological risk for this alternative were based on the air emissions and direct exposure from continued operations (including tank farm and evaporator operations). There would be no construction, retrieval, pretreatment, treatment, storage, disposal, or waste transportation activities associated with this alternative; therefore, there would be no risk from these components.

D.4.1.1 Radiological Risk

The LCF risk to the worker, noninvolved worker, and general public receptors could result from atmospheric emissions from the evaporator and tank farms. The risk was determined by analyzing the radiological source term, transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.1.1.1 Source Term

Operating air emissions shown in Table D.4.1.1 are the evaporator and tank farm source term for the noninvolved workers and the general public (WHC 1995g and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure to radiation fields associated with the evaporator and tank farm operations.

Table D.4.1.1 Atmospheric Radiological Emissions for the No Action Alternative (Tank Waste)

D.4.1.1.2 Transport

The atmospheric transport parameters for the No Action alternative are presented in Table D.4.1.2. The tank farm atmospheric radiological operating emissions were modeled as a ground release and the evaporator was modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data presented in Table D.2.2.1 and Figure D.2.2.1.

Table D.4.1.2 Atmospheric Transport Parameters for the No Action Alternative (Tank Waste)

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.00E-04 sec/m^3 for the noninvolved worker MEI and 6.60E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.90E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction). The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for 10 years of evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.00E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.60E-03 sec/m^3.

D.4.1.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.1.3. The table shows the exposure each receptor would receive from every component. The sum of the components is shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed but is represented by the component with the highest MEI dose.

Table D.4.1.3 Summary of Anticipated Radiological Exposure for the No Action Alternative (Tank Waste)

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. These data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995g and Jacobs 1996). The calculations for the worker exposures from continued operations are as follows:

Tank farms = (5.00E+04 person-yr) · (1.40E-02 rem/person-yr) = 7.00E+02 person-rem
Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr) = 1.28E+02 person-rem
Total = 8.28E+02 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved worker and general public receptor exposures to the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q from Table D.4.1.2. The dose for each receptor from tank farm and evaporator operations is presented in Table D.4.1.3.

D.4.1.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from the evaporator and tank farms, shown in the combined dose column in Table D.4.1.4, was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk. The LCF risk for each receptor is presented in Table D.4.1.4.

Table D.4.1.4 Summary of Anticipated Risk for the No Action Alternative (Tank Waste)

D.4.1.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm and the evaporator for the worker, noninvolved worker, and general public. Potential carcinogenic risks and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.1.2.1 Source Term

Operating air emissions from the tank farm area and the evaporator are presented in Table D.4.1.5 (WHC 1995g and Jacobs 1996). The noninvolved worker and general public would be exposed to combined emissions from the tank farm area and the evaporator. The worker would be exposed only to emissions (ground-level release) from the tank farm area because emissions from the evaporator occur through a stack-release and would not impact the onsite worker.

Table D.4.1.5 Chemical Emissions for the No Action Alternative (Tank Waste)

D.4.1.2.2 Transport

The tank farm chemical operating emissions were modeled as a ground release. Chemical operating emissions from the evaporator would occur from the evaporator stack and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and MEI general public are identical to the radiological parameters presented in Table D.4.1.2.

The MEI worker was evaluated using a "box" model presented in detail in Section D.2.2.3. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.1.2.3 Exposure

Worker

As discussed previously in Section D.2.2.3, the MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions from the tank farm area (mg/m^3) were estimated by multiplying the cumulative tank farm emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3). Exposure point concentrations for each volatile chemical emitted from the tank farm area are summarized in Table D.4.1.6.

Table D.4.1.6 No Action Alternative Tank Farm Emissions

Estimated operating chemical emission intakes for the MEI worker were calculated according to the equation presented in Section D.2.2.3 and are presented in Table D.4.1.6.

Noninvolved Worker

The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area and the evaporator were estimated by multiplying the cumulative tank farm and evaporator emission rates (mg/sec) by the MEI noninvolved worker Chi/Q values (4.0E-04 sec/m^3 for the tank farm and 2.50E-06 sec/m^3 for the evaporator, respectively). Exposure point concentrations for each volatile chemical emitted from the tank farm area and evaporator are summarized in Table D.4.1.7 and D.4.1.8, respectively.

Table D.4.1.7 No Action Alternative Tank Farm Emissions

Table D.4.1.8 No Action Alternative (Tank Waste) Evaporator Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4.1.7 and D.4.1.8 for the tank farm area and evaporator emissions, respectively.

General Public

The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area and the evaporator were estimated by multiplying the cumulative tank farm and evaporator emission rates (mg/sec) by the MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm and 3.90E-08 sec/m^3 for the evaporator), respectively. Exposure point concentrations for each volatile chemical emitted from the tank farm area and evaporator are summarized in Table D.4.1.9 and D.4.1.10, respectively.

Table D.4.1.9 No Action Alternative Tank Farm Emissions

Table D.4.1.10 No Action Alternative (Tank Waste) Evaporator Emissions

D.4.1.2.4 Toxicity Assessment

Toxicity assessment characterizes the relationship between the exposure to a chemical and the incidence of adverse health effects in exposed populations. In a quantitative carcinogenic risk assessment, the dose-response relationship of a carcinogen is expressed in terms of a slope factor (oral) or unit risk (inhalation), which are used to estimate the probability of risk of cancer associated with a given exposure pathway. Cancer slope factors and URFs as published by EPA (IRIS and HEAST) were used in this operating chemical emission evaluation.

For noncarcinogenic effects, toxicity data developed from animal or human studies typically are used to develop noncancer acceptable levels, or RfDs. A chronic RfD is defined as an estimate of a daily exposure for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of deleterious effects. Chronic RfDs, as published in IRIS or HEAST, were used in this chemical evaluation. Table D.4.1.11 summarizes the cancer slope factors, RfDs, and data sources for each volatile operating chemical emission.

Table D.4.1.11 Toxicity Criteria for Operations Chemical Emissions

D.4.1.2.5 Risk Characterization

MEI Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm are summarized in Table D.4.1.6. The total HI and cancer risk from routine tank farm emissions are 7.70E-02 and 7.05E-07, respectively.

MEI Noninvolved Worker

The noncarcinogenic hazards and carcinogenic risks for chemical emissions from the tank farm and evaporator are summarized in Tables D.4.1.7 and D.4.1.8, respectively. The total HI and cancer risk from combined tank farm and evaporator emissions are 3.33E-02 and 3.05E-07, respectively.

MEI General Public

The noncarcinogenic hazards and carcinogenic risks for chemical emissions from the tank farm and evaporator are summarized in Tables D.4.1.9 and D.4.1.10, respectively. The total HI and cancer risk from combined tank farm and evaporator emissions is 1.82E-05 and 9.08E-11, respectively.

D.4.2 LONG-TERM MANAGEMENT ALTERNATIVE

This section presents the anticipated remediation risk associated with the Long-Term Management alternative for tank waste, as outlined in Volume Two, Appendix B.

The radiological and toxicological risk for this alternative were based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), and retrieval operations. There would be no pretreatment, treatment, storage, disposal, or waste transportation activities associated with this alternative; therefore, there would be no risk from these components.

D.4.2.1 Radiological Risk

The LCF risk to the worker, noninvolved worker, and the general public could result from direct exposure and atmospheric emissions from the evaporators and tank farms. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.2.1.1 Source Term

Operating air emissions shown in Table D.4.2.1 are the evaporator and tank farm source terms for the noninvolved workers and the general public (WHC 1995g and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure to radiation fields associated with the evaporator and tank farm operations.

Table D.4.2.1 Atmospheric Radiological Emissions for the Long-Term Management Alternative

D.4.2.1.2 Transport

The atmospheric transport parameters of the Long-Term Management alternative are presented in Table D.4.2.2. The tank farm and retrieval atmospheric radiological operating emissions were modeled as a ground release and the evaporator emissions were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.2.2 Atmospheric Transport Parameters for the Long-Term Management Alternative

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.0E-04 sec/m^3 for the noninvolved worker MEI and 6.0E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.6E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.9E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction). The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary from the 200 East Area in an east-southeast direction).

The calculated Chi/Q values for 20 years of evaporator operations were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.0E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.6E-03 sec/m^3.

D.4.2.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.2.3. The table shows the exposure each receptor would receive from every component. The sum of the components is shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed but is represented by the component with the highest MEI dose.

Table D.4.2.3 Summary of Anticipated Radiological Exposure for the Long-Term Management Alternative

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. These data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995g and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, and retrieval are as follows:

- Construction = (7.17E+02 person-yr) (1.4E-02 rem/person-yr) = 1.0E+01 person-rem
- Continued Operations -
  Tank farms = (5.00E+04 person-yr) (1.40E-02 rem/person-yr) = 7.0E+02 person-rem
  Evaporator = (7.86E+02 person-yr) (2.00E-01 rem/person-yr) = 1.6E+02 person-rem
  Total = 8.6E+02 person-rem
- Retrieval = (1.82E+03 person-yr) (2.00E-01 rem/person-yr) = 3.6E+02 rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved worker and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.2.1.4 Risk

The LCFs are calculated as the product of the estimated dose multiplied by the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, and retrieval, for each receptor shown in the combined dose column in Table D.4.2.4 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.2.4 Summary of Anticipated Risk for the Long-Term Management Alternative

D.4.2.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, tank waste retrieval, and evaporators for the worker, noninvolved worker, and general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.2.2.1 Source Term

Operating air emissions from the tank farm area, tank waste retrieval, and the evaporators are presented in Table D.4.2.5 (WHC 1995g and Jacobs 1996). The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, tank waste retrieval operations, and the evaporators. The worker would be exposed only to emissions (ground-level release) from the tank farm area and retrieval operations because emissions from the evaporators occur through a stack-release and would not impact the onsite worker.

Table D.4.2.5 Chemical Emissions for the Long-Term Management Alternative

D.4.2.2.2 Transport

The tank farm chemical operating emissions (routine emissions from the tank farm and emissions during retrieval) were modeled as a ground release. Chemical operating emissions from the evaporators would occur from the evaporator stacks and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and MEI general public are identical to the radiological parameters presented in Table D.4.2.2.

The MEI worker was evaluated using a "box" model, as presented in detail in Section D.2.2.3. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.2.2.3 Exposure

Worker

As discussed previously in Section D.4.1.2.2, the MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area and retrieval operations were estimated by multiplying the cumulative tank farm emission rate (mg/sec) and retrieval operation emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3), respectively. Exposure point concentrations for each volatile chemical emitted from the tank farm area and during retrieval are summarized in Tables D.4.2.6 and D.4.2.7, respectively.

Table D.4.2.6 Long-Term Management Tank Farm Emissions

Table D.4.2.7 Long-Term Management Retrieval Emissions

Chemical intake (dose) was estimated for the MEI worker using the same equation and exposure parameters defined in Section D.2.2.3. Estimated intakes of chemical emissions from the tank farm and retrieval operations for the MEI worker are presented in Tables D.4.2.6 and D.4.2.7, respectively.

Noninvolved Worker

The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, retrieval operations, and the evaporators were estimated by multiplying the cumulative tank farm, retrieval, and evaporator emission rates (mg/sec) by their respective MEI noninvolved worker Chi/Q values (4.0E-04 sec/m^3 for the tank farm, 4.0E-04 sec/m^3 for retrieval, 3

2.5E-06 sec/m for the two evaporators). Exposure point concentrations for each volatile chemical emitted from the tank farm area, retrieval operations, and the evaporators are summarized in Tables D.4.2.8, and D.4.2.9, D.4.2.10, and D.4.2.11, respectively.

Table D.4.2.8 Long-Term Management Tank Farm Emissions

Table D.4.2.9 Long-Term Management Retrieval Emissions

Table D.4.2.10 Long-Term Management Evaporator-1 Emissions

Table D.4.2.11 Long-Term Management Evaporator-2 Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4.2.8, D.4.2.9, D.4.2.10, and D.4.2.11 for the tank farm area, retrieval, evaporator-1 , and evaporator-2 emissions, respectively.

General Public

The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area, retrieval operations, evaporator-1 , and evaporator-2 were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 6.60E-08 sec/m^3 for retrieval operations, 6.00E-08 sec/m^3 for evaporator-1 , and 3.90E-08 sec/m^3 for evaporator-2). Exposure point concentrations for each volatile chemical emitted from the tank farm area, retrieval operations, evaporator-1 , and evaporator-2 are summarized in Tables D.4.2.12, D.4.2.13, D.4.2.14, and D.4.2.15, respectively.

Table D.4.2.12 Long-Term Management Tank Farm Emissions

Table D.4.2.13 Long-Term Management Retrieval Emissions

Table D.4.2.14 Long-Term Management Evaporator-1 Emissions

Table D.4.2.15 Long-Term Management Evaporator-2 Emissions

The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4.2.12, D.4.2.13, D.4.2.14, and D.4.2.15 for the tank farm area, retrieval, evaporator-1 , and evaporator-2 , respectively.

D.4.2.2.4 Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

D.4.2.2.5 Risk Characterization

MEI Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm and retrieval operations are summarized in Tables D.4.2.6 and D.4.2.7, respectively. The total HI and cancer risk from routine tank farm emissions and retrieval emissions are 1.12E-01 and 9.84E-07, respectively.

MEI Noninvolved Worker

The noncarcinogenic hazards and carcinogenic risks for chemical emissions from the tank farm, retrieval operations, evaporator-1 , and evaporator-2 are summarized in Tables D.4.2.8, D.4.2.9, D.4.2.10, and D.4.2.11, respectively. The total HI and cancer risk from combined tank farm, retrieval, and evaporator emissions are 4.85E-02 and 4.26E-07, respectively.

MEI General Public

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, retrieval operations, evaporator-1 , and evaporator-2 are summarized in Tables D.4.2.12, D.4.2.13, D.4.2.14, and D.4.2.15, respectively. The total HI and cancer risk from combined tank farm, retrieval, and evaporator emissions are 3.51E-05 and 1.27E-10, respectively.

D.4.3 IN SITU FILL AND CAP ALTERNATIVE

This section presents the anticipated remediation risk associated with the In Situ Fill and Cap alternative for tank waste, as outlined in Volume Two, Appendix B.

The radiological and toxicological risk for this alternative were based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), treatment (including evaporator and gravel fill operations), and closure and monitoring. There would be no retrieval, pretreatment, storage, or waste transportation activities associated with this alternative; therefore, there would be no risk from these components.

D.4.3.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, transport mechanism, exposure, and risk associated with the exposure as discussed in the following subsections.

D.4.3.1.1 Source Term

Source terms used for the noninvolved worker and general public are the atmospheric radiological emissions presented in Table D.4.3.1 (WHC 1995f and Jacobs 1996). The worker would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.3.1 Atmospheric Radiological Emissions for the In Situ Fill and Cap Alternative

D.4.3.1.2 Transport

The atmospheric transport parameters of the In Situ Fill and Cap alternative are presented in Table D.4.3.2. The tank farm and gravel fill atmospheric radiological operating emissions were modeled as a ground release, and the evaporators were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.3.2 Atmospheric Transport Parameters for the In Situ Fill and Cap Alternative

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.0E-04 sec/m^3 for the noninvolved worker MEI and 6.6E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.6E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.9E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction). The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.0E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.6E-03 sec/m^3.

D.4.3.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.3.3. The table shows the exposure each receptor would receive from every component. The sum of the components is shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed, but is represented by the component with the highest MEI dose.

Table D.4.3.3 Summary of Anticipated Radiological Exposure for the In Situ Fill and Cap Alternative

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. These data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995f and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, treatment, and closure are as follows:

Construction = (1.37E+02 person-yr) · (1.4E-02 rem/person-yr) = 1.9E+00 person-rem

Continued Operations -

Tank farms = (1.21E+04 person-yr) · (1.40E-02 rem/person-yr) = 1.7E+02 person-rem

Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr) = 1.3E+02 person-rem

Total = 3.0E+02 person-rem

Treatment Operations -

Evaporator = (7.30E+01 person-yr) · (2.00E-01 rem/person-yr) = 1.5E+01 person-rem

Gravel fill = (1.04E+03 person-yr) · (2.00E-01 rem/person-yr) = 2.1E+02 person-rem

Total = 2.3E+02 person-rem

Closure -

Closure = (1.83E+02 person-yr) · (1.4E-02E-01 rem/person-yr) = 2.56E+00 person-rem

Monitoring = (6.25E+02 person-yr) · (1.4E-02 rem/person-yr) = 8.75E+00 person-rem

Total = 1.13E+01 person- rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.3.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, treatment, and closure, for each receptor shown in the combined dose column in Table D.4.3.4 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.3.4 Summary of Anticipated Risk for the In Situ Fill and Cap Alternative

D.4.3.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, the evaporators, and tank filling (gravel filling) operations for the worker, noninvolved worker, and general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.3.2.1 Source Term

Operating air emissions from the tank farm area and the evaporators and filling the tanks with gravel are presented in Table D.4.3.5 (WHC 1995f and Jacobs 1996). The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, the evaporators, and filling the tanks with gravel. The worker would be exposed only to emissions (ground-level release) from the tank farm area and filling the tanks with gravel because emissions from the evaporators occur through a stack-release and would not impact the onsite worker.

Table D.4.3.5 Chemical Emissions for the In Situ Fill and Cap Alternative

D.4.3.2.2 Transport

The tank farm chemical operating emissions (routine emissions from the tank farm and emissions during filling the tanks with gravel) were modeled as a ground release. Chemical operating emissions from the evaporators would occur from the evaporator stacks and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and general public are identical to the radiological parameters presented in Table D.4.3.2.

The MEI worker was evaluated using a "box" model, as presented in detail in Section D.2.2.3. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.3.2.3 Exposure

Worker

The MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area and filling the tanks with gravel were estimated by multiplying the cumulative tank farm emission rate (mg/sec) and tank-filling emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3), respectively. Exposure point concentrations for each volatile chemical emitted from the tank farm area and during retrieval are summarized in Tables D.4.3.6 and D.4.3.7, respectively.

Table D.4.3.6 In Situ Fill and Cap Tank Farm Emissions

Table D.4.3.7 In Situ Fill and Cap Gravel Fill Emissions

Chemical intake (dose) was estimated for the MEI worker using the same equation and exposure parameters defined in Section D.2.2.3. Estimated intakes of chemical emissions from the tank farm and tank filling operations for the MEI worker are presented in Tables D.4.3.6 and D.4.3.7, respectively.

Noninvolved Worker

The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, filling the tanks with gravel, and the evaporators were estimated by multiplying the cumulative tank farm, tank-filling, and evaporator emission rates (mg/sec) by their respective MEI noninvolved worker Chi/Q values (4.0E-04 sec/m^3 for the tank farm, 4.0E-04 sec/m^3 for tank-filling, 2.50E-06 sec/m^3 for the evaporators).

Exposure point concentrations for each volatile chemical emitted from the tank farm area, tank-filling operations, and the evaporators are summarized in Tables D.4.3.8 and D.4.3.9, D.4.3.10, and D.4.3.11, respectively.

Table D.4.3.8 In Situ Fill and Cap Tank Farm Emissions

Table D.4.3.9 In Situ Fill and Cap Gravel Fill Emissions

Table D.4.3.10 In Situ Fill and Cap Evaporator-1 Emissions

Table D.4.3.11 In Situ Fill and Cap Evaporator-2 Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4.3.8, D.4.3.9, D.4.3.10, and D.4.3.11 for the tank farm area, tank-filling, evaporator-1 , and evaporator-2 emissions, respectively.

General Public

The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area, tank-filling operations, the evaporator, and the DST evaporator were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 6.60E-08 sec/m^3 for tank-filling operations, and 3.90E-08 sec/m^3 for the evaporators). Exposure point concentrations for each volatile chemical emitted from the tank farm area, tank-filling operations, evaporator-1 , and evaporator-2 are summarized in Tables D.4.3.12, D.4.3.13, D.4.3.14, and D.4.3.15, respectively.

Table D.4.3.12 In Situ Fill and Cap Tank Farm Emissions

Table D.4.3.13 In Situ Fill and Cap Gravel Fill Emissions

Table D.4.3.14 In Situ Fill and Cap Evaporator-1 Emissions

Table D.4.3.15 In Situ Fill and Cap Evaporator-2 Emissions

The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4.3.12, D.4.3.13, D.4.3.14, and D.4.3.15 for the tank farm area, tank-filling operations, evaporator-1 , and evaporator-2 , respectively.

D.4.3.2.4 Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

D.4.3.2.5 Risk Characterization

MEI Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm and tank filling operations are summarized in Tables D.4.3.6 and D.4.3.7, respectively. The total HI and cancer risk from routine tank farm emissions and tank filing emissions are 7.89E-02 and 4.50E-07, respectively.

MEI Noninvolved Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, tank filling operations, evaporator-1 , and evaporator-2 are summarized in Tables D.4.3.8, D.4.3.9, D.4.3.10, and D.4.3.11, respectively. The total HI and cancer risk from combined tank farm, tank filling, and evaporator emissions are 3.42E-02 and 1.95E-07, respectively.

MEI General Public

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, tank filling operations, the evaporator, and the DST evaporator are summarized in Tables D.4.3.12, D.4.3.13, D.4.3.14, and D.4.3.15, respectively. The total HI and cancer risk from combined tank farm, tank filling, and evaporator emissions are 2.75E-05 and 5.80E-11, respectively.

D.4.4 IN SITU VITRIFICATION ALTERNATIVE

This section presents the anticipated remediation risk associated with the In Situ Vitrification alternative for tank waste as outlined in Volume Two, Appendix B.

The radiological and toxicological risk for this alternative was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), treatment (including evaporator and in situ vitrification operations), and closure and monitoring. There would be no retrieval, pretreatment, storage, or waste transportation activities associated with this alternative; therefore, there would be no risk from these components.

D.4.4.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.4.1.1 Source Term

Source terms used for the noninvolved worker and general public are the atmospheric radiological emissions presented in Table D.4.4.1 (WHC 1995f and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.4.1 Atmospheric Radiological Emissions for the In Situ Vitrification Alternative

D.4.4.1.2 Transport

The atmospheric transport parameters of the In Situ Vitrification alternative are presented in Table D.4.4.2. The tank farm atmospheric radiological operating emissions were modeled as a ground release, and the evaporators and in situ vitrification were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Figure D.2.2.1 and Table D.2.2.1.

Table D.4.4.2 Atmospheric Transport Parameters for the In Situ Vitrification Alternative

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.0E-04 sec/m^3 for the noninvolved worker MEI and 6.6E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.6E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.9E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction) for the evaporators and 300 m (980 ft) for vitrification. The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.0E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.6E-03 sec/m^3. For the vitrification operation, the Chi/Q values were 2.30E-07 sec/m^3 for the noninvolved worker MEI, 2.4E-08 sec/m^3 for the general public MEI, 2.00E-04 sec/m^3 for the noninvolved worker population, and 1.10E-03 sec/m^3 for the general public population.

D.4.4.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.4.3. The table shows the exposure each receptor would receive from every component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed, but is represented by the component with the highest MEI dose.

Table D.4.4.3 Summary of Anticipated Radiological Exposure for the In Situ Vitrification Alternative

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. These data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995f and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, treatment, and closure are as follows:

Construction = (5.73E+03 person-yr) · (1.4E-02 rem/person-yr) = 8.02E+01 person-rem

Continued Operations -

Tank farms = (1.06E+04 person-yr) · (1.40E-02 rem/person-yr) = 1.48E+02 person-rem

Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr) = 1.28E+02 person-rem

Total = 2.76E+02 person-rem

Treatment Operations -

Evaporator = (7.30E+01 person-yr) · (2.00E-01 rem/person-yr) = 1.46E+01 person-rem

Vitrification = (5.89E+03 person-yr) · (2.00E-01 rem/person-yr) = 1.18E+03 person-rem

Total = 1.19E+03 person-rem

Closure -

Closure = (1.82E+02 person-yr) · (1.40E-02 rem/person-yr) = 2.55E+00 person-rem

Monitoring = (5.00E+02 person-yr) · (1.40E-02 rem/person-yr) = 7.00E+00 person-rem

Total = 9.55E+00 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved worker and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.4.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, treatment, and closure for each receptor shown in the combined dose column in Table D.4.4.4 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.4.4 Summary of Anticipated Risk for the In Situ Vitrification Alternative

D.4.4.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, the evaporators, tank filling (sand filling) operations, and vitrification of the tank contents for the worker, noninvolved worker, and general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.4.2.1 Source Term

Operating air emissions from the tank farm area, filling the tanks with sand, the evaporators, and vitrification of the tank contents are presented in Table D.4.4.5 (WHC 1995f and Jacobs 1996). The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, the evaporators, filling the tanks with sand, and vitrification. The worker would be exposed only to emissions (ground-level release) from the tank farm area filling the tanks with sand because emissions from the evaporators and vitrification occur through a stack-release and would not impact the onsite worker.

Table D.4.4.5 In Situ Vitrification Source Emissions

D.4.4.2.2 Transport

The tank farm chemical operating emissions (routine emissions from the tank farm and emissions during filling the tanks with gravel) were modeled as a ground release. Chemical operating emissions from the evaporators and vitrification operations would occur from stacks and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and general public are identical to the radiological parameters presented in Table D.4.4.2.

The MEI worker was evaluated using a "box" model, as presented in detail in Section D.2.2.3. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.4.2.3 Exposure

Worker

The MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area and filling the tanks with sand were estimated by multiplying the cumulative tank farm emission rate (mg/sec) and tank-filling emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3), respectively. Exposure point concentrations for each volatile chemical emitted from the tank farm area and during retrieval are summarized in Tables D.4.4.6 and D.4.4.7, respectively.

Table D.4.4.6 In Situ Vitrification Tank Farm Emissions

Table D.4.4.7 In Situ Vitrification Sand Fill Emissions

Chemical intake (dose) was estimated for the MEI worker using the same equation and exposure parameters defined in Section D.2.2.3. Estimated intakes of chemical emissions from the tank farm and tank filling operations for the MEI worker are presented in Tables D.4.4.6 and D.4.4.7, respectively.

Noninvolved Worker

The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, filling the tanks with sand, the evaporators, and vitrification operations were estimated by multiplying the cumulative tank farm, tank-filling, evaporator, and vitrification emission rates (mg/sec) by their respective MEI noninvolved worker Chi/Q values (4.0E-04 sec/m^3 for the tank farm, 4.0E-04 sec/m^3 for tank-filling, 2.5E-06 sec/m^3 for the evaporators, and 2.30E-07 sec/m^3 for vitrification). Exposure point concentrations for each volatile chemical emitted from the tank farm area, tank-filling operations, evaporators, and vitrification are summarized in Tables D.4.4.8 and D.4.4.9, D.4.4.10, D.4.4.11, and D.4.4.12, respectively.

Table D.4.4.8 In Situ Vitrification Tank Farm Emissions

Table D.4.4.9 In Situ Vitrification Sand Fill Emissions

Table D.4.4.10 In Situ Vitrification Evaporator -1 Emissions

Table D.4.4.11 In Situ Vitrification Evaporator -2 Emissions

Table D.4.4.12 In Situ Vitrification Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4.4.8, D.4.4.9, D.4.4.10, D.4.4.11, and D.4.4.12 for the tank farm area, tank-filling, evaporator-1 , evaporator-2 , and vitrification emissions, respectively.

General Public

The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area, tank-filling operations, evaporator-1 , evaporator-2 , and vitrification were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 6.60E-08 sec/m^3 for tank-filling operations, 3.90E-08 sec/m^3 for the evaporators, and 2.40E-08 sec/m^3 for vitrification). Exposure point concentrations for each volatile chemical emitted from the tank farm area, tank-filling operations, evaporator-1 , evaporator-2 , and vitrification are summarized in Tables D.4.4.13, D.4.4.14, D.4.4.15, D.4.4.16, and D.4.4.17, respectively.

Table D.4.4.13 In Situ Vitrification Tank Farm Emissions

Table D.4.4.14 In Situ Vitrification Sand Fill Emissions

Table D.4.4.15 In Situ Vitrification Evaporator-1 Emissions

Table D.4.4.16 In Situ Vitrification Evaporator-2 Emissions

Table D.4.4.17 In Situ Vitrification Emissions

The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4.4.13, D.4.4.14, D.4.4.15, D.4.4.16, and D.4.4.17 for the tank farm area, tank-filling operations, evaporator-1 , evaporator-2 , and vitrification, respectively.

D.4.4.2.4 Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

D.4.4.2.5 Risk Characterization

MEI Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm and tank filling operations are summarized in Tables D.4.4.6 and D.4.4.7, respectively. The total HI and cancer risk from routine tank farm emissions and tank filling emissions are 7.89E-02 and 4.51E-07, respectively.

MEI Noninvolved Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, tank filling operations, evaporator-1 , evaporator-2 , and vitrification are summarized in Tables D.4.4.8, D.4.4.9, D.4.4.10, D.4.4.11, and D.4.4.12, respectively. The total HI and cancer risk from combined tank farm, tank filling, evaporator, and vitrification emissions are 3.48E-02 and 1.95E-07, respectively.

MEI General Public

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, tank filling operations, evaporator-1 , evaporator-2 , and vitrification are summarized in Tables D.4.4.13, D.4.4.14, D.4.4.15, D.4.4.16, and

D.4.4.17, respectively. The total HI and cancer risk from combined tank farm, tank filling, evaporator, and vitrification emissions are 2.04E-04 and 5.81E-11, respectively.

D.4.5 EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE

This section presents the anticipated remediation risk associated with the Ex Situ Intermediate Separations alternative for tank waste, as outlined in Volume Two, Appendix B.

The radiological and toxicological risk for this alternative was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), retrieval, separations and treatment, storage and disposal, onsite transportation of waste, monitoring and maintenance, and closure and monitoring.

D.4.5.1 Radiological Risk

The LCF risk to the worker, noninvolved worker, and the general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.5.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4.5.1 (WHC 1995j and Jacobs 1996). They also would receive a direct exposure dose from the vitrified HLW as it is being transported onsite . The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.5.1 Atmospheric Radiological Emissions for the Ex Situ Intermediate Separations Alternative

D.4.5.1.2 Transport

The atmospheric transport parameters of the Ex Situ Intermediate Separations alternative are presented in Table D.4.5.2. The tank farm and retrieval atmospheric radiological operating emissions were modeled as a ground release, and the evaporator and the separations and vitrification were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.5.2 Atmospheric Transport Parameters for the Ex Situ Intermediate Separations Alternative

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.0E-04 sec/m^3 for the noninvolved worker MEI and 6.6E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.6E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.9E-03 sec/m .

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction) for the evaporator and 800 m (2,600 ft) for separations and vitrification. The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.0E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.6E-03 sec/m^3. For the separations and vitrification operation, the Chi/Q values were 2.9E-08 sec/m^3 for the noninvolved worker MEI, 7.70E-09 sec/m^3 for the general public MEI, 5.00E-05 sec/m^3 for the noninvolved worker population, and 5.00E-04 sec/m^3 for the general public population.

D.4.5.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.5.3. The table shows the exposure each receptor would receive from every component. The sum of the components is shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed but is represented by the component with the highest MEI dose.

Table D.4.5.3 Summary of Anticipated Radiological Exposure for the Ex Situ Intermediate Separations Alternative

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995j and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, retrieval, separations and treatment, monitoring and maintenance, and closure are as follows:

Construction = (8.02E+02 person-yr) · (1.4E-02 rem/person-yr)	= 1.12E+01 person-rem
Continued Operations -	
Tank farms = (1.90E+04 person-yr) · (1.40E-02 rem/person-yr)	= 2.66E+02 person-rem
Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr)	= 1.28E+02 person-rem
Total	= 3.94E+02 person-rem
Retrieval = (2.21E+04 person-yr) · (2.00E-01 rem/person-yr)	= 4.42E+03 person-rem
Separation/Treatment = (1.49E+04 person-yr) · (2.0E-01 rem/person-yr)	= 2.98E+03 person-rem
Monitoring/Maintenance = (6.00E+01 person-yr) · (1.4E-02 rem/person-yr)	= 8.40E-01 person-rem
Closure -	
Closure = (2.77E+02 person-yr) · (1.40E-02 rem/person-yr)	= 3.88E+00 person-rem
Monitoring = (6.77E+02 person-yr) · (1.40E-02 rem/person-yr)	= 9.48E+00 person-rem
Total	= 1.34E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.5.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, retrieval, treatment, storage and disposal, monitoring and maintenance, and closure for each receptor shown in the combined dose column in Table D.4.5.4 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.5.4 Summary of Anticipated Risk for the Ex Situ Intermediate Separations Alternative

D.4.5.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, tank waste retrieval, the evaporator, and exposure to particulate emissions from the separation and vitrification of HLW and low-activity waste (LAW) for the worker, noninvolved worker, and the general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.5.2.1 Source Term

Operating air emissions from the tank farm area, tank waste retrieval, the evaporator, and vitrification facilities are presented in Table D.4.5.5 (WHC 1995j and Jacobs 1996). The emission rates from the HLW and LAW vitrification facilities were combined and treated as a single-source emission. The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, tank waste retrieval operations, evaporator, and vitrification facilities. The worker would be exposed only to emissions (ground-level release) from the tank farm area and retrieval operations because emissions from the evaporator and vitrification facilities occur through a stack-release and would not impact the onsite worker.

Table D.4.5.5 Chemical Emissions for the Ex Situ Intermediate Separations

D.4.5.2.2 Transport

The tank farm chemical operating emissions (routine emissions from the tank farm and emissions during retrieval) were modeled as a ground release. Chemical operating emissions from the evaporator and vitrification facilities would occur from stack releases and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and general public are identical to the radiological parameters presented in Table D.4.5.2.

The MEI worker (onsite worker) was evaluated using a simplified "box" model, as presented in detail in Section D.4.1.2.2. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.5.2.3 Exposure

Worker

The MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area and retrieval operations were estimated by multiplying the cumulative tank farm emission rate (mg/sec) and retrieval operation emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3), respectively.

Exposure point concentrations for each volatile chemical emitted from the tank farm area and during retrieval are summarized in Tables D.4.5.6 and D.4.5.7, respectively.

Table D.4.5.6 Ex Situ Intermediate Separations Tank Farm Emissions

Table D.4.5.7 Ex Situ Intermediate Separations Retrieval Emissions

Chemical intake (dose) was estimated for the MEI worker using the same equation and exposure parameters defined in Section D.2.2.3. Estimated intakes of chemical emissions from the tank farm and retrieval operations for the MEI worker are presented in Tables D.4.5.6 and D.4.5.7, respectively.

Noninvolved Worker

The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, retrieval operations, evaporator, and vitrification facilities were estimated by multiplying the cumulative tank farm, retrieval, evaporator, and plant emission rates (mg/sec) by their respective MEI noninvolved worker Chi/Q values (4.0E-04 sec/m^3 for the tank farm, 2.50E-06 sec/m^3 for the evaporator, 4.0E-04 sec/m^3 for retrieval, and 2.90E-08 sec/m^3 for the vitrification plant). Exposure point concentrations for each volatile chemical emitted from the tank farm area, the evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.5.8, D.4.5.9, D.4.5.10, and D.4.5.11, respectively.

Table D.4.5.8 Ex Situ Intermediate Separations Tank Farm Emissions

Table D.4.5.9 Ex Situ Intermediate Separations Evaporator Emissions

Table D.4.5.10 Ex Situ Intermediate Separations Retrieval Emissions

Table D.4.5.11 Ex Situ Intermediate Separations Plant Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4.5.8, D.4.5.9, D.4.5.10, and D.4.5.11 for the tank farm area, the evaporator, retrieval operations, and the vitrification facility emissions, respectively.

General Public

The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area, the evaporator, retrieval operations, and the vitrification facility were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 6.60E-08 sec/m^3 for the evaporator, 6.60E-08 sec/m^3 for retrieval operations, and 7.70E-09 sec/m^3 for the vitrification facility). Exposure point concentrations for each volatile chemical emitted from the tank farm area, the evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.5.12, D.4.5.13, D.4.5.14, and D.4.5.15, respectively.

Table D.4.5.12 Ex Situ Intermediate Separations Tank Farm Emissions

Table D.4.5.13 Ex Situ Intermediate Separations Evaporator Emissions

Table D.4.5.14 Ex Situ Intermediate Separations Retrieval Emissions

Table D.4.5.15 Ex Situ Intermediate Separations Plant Emissions

The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4.5.12, D.4.5.13, D.4.5.14, and D.4.5.15 for the tank farm area, the evaporator, retrieval operations, and the vitrification plant, respectively.

D.4.5.2.4 Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

D.4.5.2.5 Risk Characterization

MEI Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm and retrieval operations are summarized in Tables D.4.5.6 and D.4.5.7, respectively. The total HI and cancer risk from routine tank farm emissions and retrieval emissions are 3.08E-01 and 2.51E-06, respectively.

MEI Noninvolved Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, the evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.5.8, D.4.5.9, D.4.5.10, and D.4.5.11, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval, and plant emissions are 1.33E-01 and 1.09E-06, respectively.

MEI General Public

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, the evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.5.12, D.4.5.13, D.4.5.14, and D.4.5.15, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval, and plant emissions are 7.29E-05 and 5.43E-10, respectively.

D.4.6 EX SITU NO SEPARATIONS ALTERNATIVE

This section presents the anticipated remediation risk associated with the Ex Situ No Separations alternative for tank waste, as outlined in Volume Two, Appendix B.

The radiological and toxicological risk for this alternative was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), retrieval, treatment (vitrification or calcination), storage and disposal, onsite transportation of waste, monitoring and maintenance, and closure and monitoring. There would be no pretreatment and therefore, no associated risk.

D.4.6.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.6.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4.6.1 (WHC 1995c and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.6.1 Atmospheric Radiological Emissions for the Ex Situ No Separations Alternative

D.4.6.1.2 Transport

The atmospheric transport parameters of the Ex Situ No Separations alternative are presented in Table D.4.6.2. The tank farm and retrieval atmospheric radiological operating emissions were modeled as a ground release, and the evaporator and vitrification or calcination emissions were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Tables D.2.2.1 and D.2.2.2 and Figures D.2.2.1 and D.2.2.2.

Table D.4.6.2 Atmospheric Transport Parameters for the Ex Situ No Separations Alternative

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.0E-04 sec/m^3 for the noninvolved worker MEI and 6.6E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q was 1.6E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q was 2.9E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction) for the evaporator and 800 m (2,625 ft) for treatment (vitrification or calcination). The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.0E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the treatment (vitrification or calcination) operation, the Chi/Q values were 2.90E-08 sec/m^3 for the noninvolved worker MEI, 7.70E-09 sec/m^3 for the general public MEI, 5.00E-05 sec/m^3 for the noninvolved worker population, and 5.00E-04 sec/m^3 for the general public population.

D.4.6.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.6.3. The table shows the exposure each receptor would receive from every component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed but is represented by the component with the highest MEI dose.

Table D.4.6.3 Summary of Anticipated Radiological Exposure for the Ex Situ No Separations Alternative (Vitrification)

The worker population dose is dependent on the number of people in the population and the anticipated individual dose. These data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995c and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, retrieval, separations and treatment, monitoring and maintenance, and closure are as follows:

Construction = (8.02E+02 person-yr) · (1.4E-02 rem/person-yr)	= 1.12E+01 person-rem
Continued Operations -	
Tank farms = (1.09E+04 person-yr) · (1.40E-02 rem/person-yr)	= 1.53E+02 person-rem
Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr)	= 1.28E+02 person-rem
	Total = 2.81E+02 person-rem
Retrieval = (2.10E+04 person-yr) · (2.00E-01 rem/person-yr)	= 4.20E+03 person-rem
Treatment = (1.89E+03 person-yr) · (2.00E-01 rem/person-yr)	= 3.78E+02 person-rem
Monitoring/Maintenance = (5.40E+02 person-yr) · (1.4E-02 rem/person-yr)	= 7.56E+00 person-rem
Closure -	
Closure = (2.15E+02 person-yr) · (1.40E-02 rem/person-yr)	= 3.01E+00 person-rem
Monitoring = (5.93E+02 person-yr) · (1.40E-02 rem/person-yr)	= 8.30E+00 person-rem
	Total = 1.13E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.6.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, treatment, and closure, for each receptor shown in the combined dose column in Table D.4.6.4, was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.6.4 Summary of Anticipated Risk for the Ex Situ No Separations (Vitrification) Alternative

D.4.6.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, tank waste retrieval, and the evaporator, and exposure to particulate emissions from the separation and vitrification of HLW and LAW for the worker, noninvolved worker, and the general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.6.2.1 Source Term

Operating air emissions from the tank farm area, tank waste retrieval, evaporator, and vitrification facility are presented in Table D.4.6.5. The emission rates from the HLW and LAW vitrification facilities were combined and treated as a single-source emission. The noninvolved worker and the general public would be exposed to combined emissions from the tank farm area, tank waste retrieval operations, evaporator, and vitrification facilities. The worker would only be exposed to emissions (ground-level release) from the tank farm area and retrieval operations because emissions from the evaporator and vitrification facilities occur through a stack-release and would not impact the onsite worker.

Table D.4.6.5 Chemical Emissions for the Ex Situ No Separation

D.4.6.2.2 Transport

The tank farm chemical operating emissions (routine emissions from the tank farm and emissions during retrieval) were modeled as a ground release. Chemical operating emissions from the evaporator and vitrification facilities would occur from stack releases and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and general public are identical to the radiological parameters presented in Table D.4.6.2.

The MEI worker was evaluated using a simplified "box" model, as presented in detail in Section D.2.2.3. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.6.2.3 Exposure

Worker

The MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area and retrieval operations were estimated by multiplying the cumulative tank farm emission rate (mg/sec) and retrieval operation emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3), respectively. Exposure point concentrations for each volatile chemical emitted from the tank farm area and during retrieval are summarized in Tables D.4.6.6 and D.4.6.7, respectively.

Table D.4.6.6 Ex Situ No Separations Tank Farm Emissions

Table D.4.6.7 Ex Situ No Separations Retrieval Emissions

Chemical intake (dose) was estimated for the MEI worker using the same equation and exposure parameters defined in Section D.2.2.3. Estimated intakes of chemical emissions from the tank farm and retrieval operations for the MEI worker are presented in Tables D.4.6.6 and D.4.6.7, respectively.

Noninvolved Worker

The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, retrieval operations, evaporator, and vitrification facilities were estimated by multiplying the cumulative tank farm, retrieval, evaporator, and plant emission rates (mg/sec) by their respective MEI noninvolved worker Chi/Q values (4.00E-04 sec/m^3 for the tank farm, 2.50E-06 sec/m^3 for the evaporator, 4.00E-04 sec/m^3 for retrieval, and 2.90E-08 sec/m^3 for the vitrification facility). Exposure point concentrations for each volatile chemical emitted from the tank farm area, the evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.6.8, D.4.6.9, D.4.6.10, and D.4.6.11, respectively.

Table D.4.6.8 Ex Situ No Separations Tank Farm Emissions

Table D.4.6.9 Ex Situ No Separations Evaporator Emissions

Table D.4.6.10 Ex Situ No Separations Retrieval Emissions

Table D.4.6.11 Ex Situ No Separations Plant Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4.6.8, D.4.6.9, D.4.6.10 and D.4.6.11 for the tank farm area, the evaporator, retrieval operations and the vitrification facility emissions, respectively.

General Public

The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area, the evaporator, retrieval operations, and the vitrification facility were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 3.90E-08 sec/m^3 for the evaporator, 6.60E-08 sec/m^3 for retrieval operations, and 7.70E-09 sec/m^3 for the vitrification facility). Exposure point concentrations for each volatile chemical emitted from the tank farm area, the evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.6.12, D.4.6.13, D.4.6.14 and D.4.6.15, respectively.

Table D.4.6.12 Ex Situ No Separations Tank Farm Emissions

Table D.4.6.13 Ex Situ No Separations Evaporator Emissions

Table D.4.6.14 Ex Situ No Separations Retrieval Emissions

Table D.4.6.15 Ex Situ No Separations Plant Emissions

The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4.6.12, D.4.6.13, D.4.6.14, and D.4.6.15 for the tank farm area, the evaporator, retrieval operations and the vitrification facility, respectively.

D.4.6.2.4 Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

D.4.6.2.5 Risk Characterization

MEI Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm and retrieval operations are summarized in Tables D.4.6.6 and D.4.5.7, respectively. The total HI and cancer risk from routine tank farm emissions and retrieval emissions are 3.08E-01 and 1.90E-06, respectively.

MEI Noninvolved Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, the evaporator, retrieval operation, and the vitrification facility are summarized in Tables D.4.6.8, D.4.6.9, D.4.6.10 and D.4.6.11, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval, and plant emissions are 1.33E-01 and 8.22E-07, respectively.

MEI General Public

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.6.12, D.4.6.13, D.4.6.14 and D.4.6.15, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval, and plant emissions are 7.34E-05 and 4.29E-10, respectively.

D.4.6.3 Calcination Subalternative

Calcining the tank waste rather than vitrifying it is a subalternative to the Ex Situ No Separations alternative as out lined in Volume Two, Appendix B of the EIS.

The radiological and toxicological risk for this subalternative was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), retrieval, treatment (vitrification or calcination), storage and disposal, onsite transportation of waste, monitoring and maintenance, and closure and monitoring. There would be no pretreatment (separations) ; therefore, there would be no risk from pretreatment.

D.4.6.3.1 Radiological Risk

The LCF risk to workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4.6.1 (WHC 1995c and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Transport

The atmospheric transport parameters are presented in Table D.4.6.2.

Exposure

The radiological exposure for the Ex Situ No Separations (Calcination) alternative is presented in Table D.4.6.16. The table shows the exposure each receptor would receive from every component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed, but is represented by the component with the highest MEI dose.

Table D.4.6.16 Summary of Anticipated Radiological Exposure for the No Separations (Calcination) Alternative

Exposure to the worker population and MEI worker was previously calculated in Section D.4.6.1.3. The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, treatment, and closure, for each receptor shown in the combined dose column in Table D.4.6.17, was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.6.17 Summary of Anticipated Risk for the Ex Situ No Separations Alternative (Calcination)

D.4.7 EX SITU EXTENSIVE SEPARATIONS ALTERNATIVE

This section presents the anticipated remediation risk associated with the Ex Situ Extensive Separations alternative for tank waste, as outlined in Volume Two, Appendix B of the EIS.

The radiological and toxicological risk for this alternative was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), retrieval, separations and treatment, onsite transportation of waste, monitoring and maintenance, and closure and monitoring.

D.4.7.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.7.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4.7.1 (WHC 1995e and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.7.1 Atmospheric Radiological Emissions for the Ex Situ Extensive Separations Alternative

D.4.7.1.2 Transport

The atmospheric transport parameters of the Ex Situ Extensive Separations alternative are presented in Table D.4.7.2. The tank farm and retrieval atmospheric radiological operating emissions were modeled as a ground release and the evaporator and the separations and vitrification were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.7.2 Atmospheric Transport Parameters for the Ex Situ Extensive Separations Alternative

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.0E-04 sec/m^3 for the noninvolved worker MEI and 6.60E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.90E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction) for the evaporator and 800 m (2,600 ft) for separations and vitrification. The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.0E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the separations and vitrification operation, the Chi/Q values were 2.90E-08 sec/m^3 for the noninvolved worker MEI, 7.70E-09 sec/m^3 for the general public MEI, 5.00E-05 sec/m^3 for the noninvolved worker population, and 5.00E-04 sec/m^3 for the general public population.

D.4.7.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.7.3. The table shows the exposure each receptor would receive from every component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed but is represented by the component with the highest MEI dose.

Table D.4.7.3 Summary of Anticipated Radiological Exposure for the Ex Situ Extensive Separations Alternative

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. These data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995e and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, retrieval, separations and treatment, monitoring and maintenance, and closure are as follows:

Construction = (8.02E+02 person-yr) · (1.40E-02 rem/person-yr)	= 1.12E+01 person-rem
Continued Operations -	
Tank farms = (1.24E+04 person-yr) · (1.40E-02 rem/person-yr)	= 1.74E+02 person-rem
Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr)	= 1.28E+02 person-rem
Total	= 3.02E+02 person-rem
Retrieval = (2.21E+04 person-yr) · (2.00E-01 rem/person-yr)	= 4.42E+03 person-rem
Separation/Treatment = (1.63E+04 person-yr) · (2.00E-01 rem/person-yr)	= 3.26E+03 person-rem
Monitoring/Maintenance = (6.00E+01 person-yr) · (1.40E-02 rem/person-yr)	= 8.40E-01 person-rem
Closure -	
Closure = (2.81E+02 person-yr) · (1.40E-02 rem/person-yr)	= 3.93E+00 person-rem
Monitoring = (8.20E+02 person-yr) · (1.40E-02 rem/person-yr)	= 1.15E+01 person-rem
Total	= 1.54E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.7.1.4 Risk

Latent cancer fatalities are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, treatment, and closure, for each receptor shown in the combined dose column in Table D.4.7.4, was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.7.4 Summary of Anticipated Risk for the Ex Situ Extensive Separations Alternative

D.4.7.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, tank waste retrieval, and the evaporator, and exposure to particulate emissions from the separation and vitrification of HLW and LAW for the worker, noninvolved worker, and general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.7.2.1 Source Term

Operating air emissions from the tank farm area, tank waste retrieval, the evaporator and vitrification facilities are presented in Table D.4.7.5 (WHC 1995e and Jacobs 1996). The emission rates from the HLW and LAW vitrification facilities were combined and treated as a single-source emission. The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, tank waste retrieval operations, evaporator, and vitrification facilities. The worker would only be exposed to emissions (ground-level release) from the tank farm area and retrieval Operations because emissions from the evaporator and vitrification facilities occur through a stack-release and would not impact the onsite worker.

Table D.4.7.5 Chemical Emissions for the Ex Situ Extensive Separations Alternative

D.4.7.2.2 Transport

The tank farm chemical operating emissions (routine emissions from the tank farm and emissions during retrieval) were modeled as a ground release. Chemical operating emissions from the evaporator and vitrification facilities would occur from stack releases and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and general public are identical to the radiological parameters presented in Table D.4.7.2.

The MEI worker was evaluated using a simplified "box" model, as presented in detail in Section D.2.2.3. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.7.2.3 Exposure

Worker

The MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area and retrieval operations were estimated by multiplying the cumulative tank farm emission rate (mg/sec) and retrieval operation emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3), respectively. Exposure point concentrations for each volatile chemical emitted from the tank farm area and during retrieval are summarized in Tables D.4.7.6 and D.4.7.7, respectively.

Table D.4.7.6 Ex Situ Extensive Separations Tank Farm Emissions

Table D.4.7.7 Ex Situ Extensive Separations Retrieval Emissions

Chemical intake (dose) was estimated for the MEI Worker using the same equation and exposure parameters defined in Section D.2.2.3.1. Estimated intakes of chemical emissions from the tank farm and retrieval operations for the MEI worker are presented in Tables D.4.7.6 and D.4.7.7, respectively.

Noninvolved Worker

The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, retrieval operations, evaporator, and vitrification facilities were estimated by multiplying the cumulative tank farm, retrieval, evaporator and plant emission rates (mg/sec) by their respective MEI noninvolved worker Chi/Q values (4.0E-04 sec/m^3 for the tank farm, 2.50E-06 sec/m^3 for the evaporator, 4.0E-04 sec/m^3 for retrieval, and 2.90E-08 sec/m^3 for the vitrification facility). Exposure point concentrations for each chemical emitted from the tank farm area, the evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.7.8, D.4.7.9, D.4.7.10 and D.4.7.11, respectively.

Table D.4.7.8 Ex Situ Extensive Separations Tank Farm Emissions

Table D.4.7.9 Ex Situ Extensive Separations Evaporator Emissions

Table D.4.7.10 Ex Situ Extensive Separations Retrieval Emissions

Table D.4.7.11 Ex Situ Extensive Separations Plant Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4.7.8, D.4.7.9, D.4.7.10 and D.4.7.11 for the tank farm area, the evaporator, retrieval operations, and the vitrification facility emissions, respectively.

General Public

The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area, evaporator, retrieval operations, and the vitrification facility were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 3.90E-08 sec/m^3 for evaporator, 6.60E-08 sec/m^3 for retrieval operations, and 7.70E-09 sec/m^3 for the vitrification facility). Exposure point concentrations for each chemical emitted from the tank farm area, the evaporator, retrieval operations and the vitrification facility are summarized in Tables D.4.7.12, D.4.7.13, D.4.7.14 and D.4.7.15, respectively.

Table D.4.7.12 Ex Situ Extensive Separations Tank Farm Emissions

Table D.4.7.13 Ex Situ Extensive Separations Evaporator Emissions

Table D.4.7.14 Ex Situ Extensive Separations Retrieval Emissions

Table D.4.7.15 Ex Situ Extensive Separations Plant Emissions

The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4.7.12, D.4.7.13, D.4.7.14, and D.4.7.15 for the tank farm area, the evaporator, retrieval operations and the vitrification facility, respectively.

D.4.7.2.4 Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

D.4.7.2.5 Risk Characterization

MEI Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm and retrieval operations are summarized in Tables D.4.7.6 and D.4.7.7, respectively. The total HI and cancer risk from routine tank farm emissions and retrieval emissions are 3.08E-01 and 2.33E-06, respectively.

MEI Noninvolved Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.7.8, D.4.7.9, D.4.7.10 and D.4.7.11, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval, and plant emissions are 1.33E-01 and 1.01E-06, respectively.

MEI General Public

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4.7.12, D.4.7.13, D.4.7.14 and D.4.7.15, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval and plant emissions are 7.28E-05 and 4.92E-10, respectively.

D.4.8 EX SITU/IN SITU COMBINATION 1 ALTERNATIVE

This section presents the anticipated remediation risk associated with the Ex Situ/In Situ Combination 1 alternative for tank waste, as outlined in Volume Two, Appendix B of the EIS.

The radiological and toxicological risk for this alternative was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), retrieval, separations and treatment (including vitrification, evaporator, and gravel fill operations), onsite transportation of waste , storage and disposal, monitoring and maintenance, and closure and monitoring.

D.4.8.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.8.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4.8.1 (WHC 1995f, 1995j, and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.8.1 Atmospheric Radiological Emissions for the Ex Situ/In Situ Combination 1 Alternative

D.4.8.1.2 Transport

The atmospheric transport parameters of the Ex Situ/In Situ Combination 1 alternative are presented in Table D.4.8.2. The tank farm and retrieval atmospheric radiological operating emissions were modeled as a ground release; the evaporator and the separations and vitrification were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.8.2 Atmospheric Transport Parameters for Ex Situ/In Situ Combination 1 Alternative

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.00E-04 sec/m^3 for the noninvolved worker MEI and 6.60E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.90E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction) for the evaporator and 800 m (2,600 ft) for separations and vitrification. The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.0E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the separations and vitrification operation, the Chi/Q value was 2.90E-08 sec/m^3 for the noninvolved worker MEI, 7.70E-09 sec/m^3 for the general public MEI, 5.00E-05 sec/m^3 for the noninvolved worker population, and 5.00E-04 sec/m^3 for the general public population.

D.4.8.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.8.3. The table shows the exposure each receptor would receive from every component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed, but is represented by the component with the highest MEI dose.

Table D.4.8.3 Summary of Anticipated Radiological Exposure for the Ex Situ/In Situ Combination 1 Alternative

The worker population dose is dependent on the number of people in the population and the anticipated individual dose. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995f, j and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, retrieval, separations and treatment, monitoring and maintenance, and closure are as follows:

Construction = (5.36E+02 person-yr) · (1.4E-02 rem/person-yr)	= 7.50E+00 person-rem
Continued Operations -	
Tank farms = (1.90E+04 person-yr) · (1.40E-02 rem/person-yr)	= 2.66E+02 person-rem
Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr)	= 1.28E+02 person-rem
Total	= 3.94E+02 person-rem
Retrieval = (1.32E+04 person-yr) · (2.00E-01 rem/person-yr)	= 2. 64 E+03 person-rem
Separation/Treatment = (9.98E+03 person-yr) · (2.00E-01 rem/person-yr)	= 2.00E+03 person-rem

Monitoring/Maintenance = (6.00E+01 person-yr) · (1.40E-02 rem/person-yr) = 8.40E-01 person rem

Closure -

Closure = (2.44E+02 person-yr) · (1.40E-02 rem/person-yr)	= 3.41E+00 person-rem
Monitoring = (6.77E+02 person-yr) · (1.40E-02 rem/person-yr)	= 9.48E+00 person-rem
Total	= 1.29E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.8.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, treatment, and closure, for each receptor shown in the combined dose column in Table D.4.8.4, was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.8.4 Summary of Anticipated Risk for the Ex Situ/In Situ Combination 1 Alternative

D.4.8.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, the evaporators, tank filling (sand filling) operations, retrieval operations, and particulate emissions from vitrification of tank waste for the worker, noninvolved worker, and general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.8.2.1 Source Term

Operating air emissions from the tank farm area, the evaporators, filling the tanks with sand, retrieval of the tank waste, and vitrification of tank waste are presented in Table D.4.8.5 (WHC 1995f, j and Jacobs 1996). The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, the evaporators, filling the tanks with sand, retrieval operations and vitrification, while the worker would only be exposed to emissions (ground-level release) from the tank farm area, filling the tanks with sand and retrieval, because emissions from the evaporators and vitrification facility occur through a stack-release and would not impact the onsite worker.

Table D.4.8.5 Chemical Emissions for the Ex Situ/In Situ Combination 1 Alternative

D.4.8.2.2 Transport

Chemical operating emissions from the tank farm, filling of the tanks and retrieval of tank waste were modeled as a ground release. Chemical operating emissions from the evaporators and vitrification facility would occur from the evaporator stacks and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and general public are identical to the radiological parameters presented in Table D.4.8.2.

The MEI worker was evaluated using a simplified "box" model, as presented in detail in Section D.4.1.2.2. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.8.2.3 Exposure

Worker

The MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area, filling the tanks with sand and retrieval of tank waste were estimated by multiplying each cumulative source emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3). Exposure point concentrations for each volatile chemical emitted from the tank farm area, retrieval operations, and filling of the tanks are summarized in Tables D.4.8.6, D.4.8.7 and D.4.8.8, respectively.

Table D.4.8.6 Ex Situ/In Situ Combination 1 Tank Farm Emissions

Table D.4.8.7 Ex Situ/In Situ Combination 1 Retrieval Emissions

Table D.4.8.8 Ex Situ/In Situ Combination 1 Gravel Fill Emissions

Chemical intake (dose) was estimated for the MEI worker using the same equation and exposure parameters defined in Section D.2.2.3. Estimated intakes of chemical emissions from the tank farm, retrieval operations and tank filling operations for the MEI worker are presented in Tables D.4.8.6, D.4.8.7, and D.4.8.8, respectively.

Noninvolved Worker

The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, evaporators, retrieval operations, tank-filling, and vitrification were estimated by multiplying each cumulative source emission rate (mg/sec) by its respective MEI noninvolved worker Chi/Q value (4.00E-04 sec/m^3 for the tank farm, 4.00E-04 sec/m^3 for tank-filling, 2.50E-06 sec/m^3 for the evaporator, 4.00E-04 sec/m^3 for retrieval, and 2.90E-08 sec/m^3 for vitrification). Exposure point concentrations for each volatile chemical emitted from the tank farm area, evaporators, retrieval, tank-filling and vitrification are summarized in Tables D.4.8.9, D.4.8.10, D.4.8.11, D.4.8.12, D.4.8.13 and D.4.8.14, respectively.

Table D.4.8.9 Ex Situ/In Situ Combination 1 Tank Farm Emissions

Table D.4.8.10 Ex Situ/In Situ Combination 1 Evaporator-1 Emissions

Table D.4.8.11 Ex Situ/In Situ Combination 1 Evaporator-2 Emissions

Table D.4.8.12 Ex Situ/In Situ Combination 1 Retrieval Emissions

Table D.4.8.13 Ex Situ/In Situ Combination 1 Gravel Emissions

Table D.4.8.14 Ex Situ/In Situ Combination 1 Plant Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4.8.9, D.4.8.10, D.4.8.11, D.4.8.12, D.4.8.13 and D.4.8.14 for the tank farm area, evaporator-1, evaporator-2 , retrieval operations, tank-filling, and vitrification, respectively.

General Public

The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from each source were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 6.60E-08 sec/m^3 for tank-filling operations, 3.90E-08 sec/m^3 for the evaporators, 6.60E-08 sec/m^3 for retrieval, and 7.70E-09 sec/m^3 for vitrification). Exposure point concentrations for each chemical emitted from the tank farm area, evaporator-1, evaporator-2 , retrieval, tank-filling, and vitrification are summarized in Tables D.4.8.15, D.4.8.16, D.4.8.17, D.4.8.18, D.4.8.19 and D.4.8.20, respectively. The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4.8.15, D.4.8.16, D.4.8.17, D.4.8.18, D.4.8.19, and D.4.8.20 for the tank farm area, evaporator-1, evaporator-2 , retrieval, tank-filling, and vitrification, respectively.

Table D.4.8.15 Ex Situ/In Situ Combination 1 Tank Farm Emissions

Table D.4.8.16 Ex Situ/In Situ Combination 1 Evaporator-1 Emissions

Table D.4.8.17 Ex Situ/In Situ Combination 1 Evaporator-2 Emissions

Table D.4.8.18 Ex Situ/In Situ Combination 1 Retrieval Emissions

Table D.4.8.19 Ex Situ/In Situ Combination 1 Gravel Fill Emissions

Table D.4.8.20 Ex Situ/In Situ Combination 1 Plant Emissions

D.4.8.2.4 Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

D.4.8.2.5 Risk Characterization

MEI Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, retrieval and tank filling operations are summarized in Tables D.4.8.6, D.4.8.7 and D.4.8.8, respectively. The total HI and cancer risk are 3.10E-01 and 2.52E-06, respectively.

MEI Noninvolved Worker

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, evaporator-1, evaporator-2 , retrieval, tank-filling, and vitrification are summarized in Tables D.4.8.9, D.4.8.10, D.4.8.11, D.4.8.12, D.4.8.13 and D.4.8.14, respectively. The total HI and cancer risk are 1.34E-01 and 1.09E-06, respectively.

MEI General Public

The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, evaporator-1, evaporator-2 , retrieval, tank-filling, and vitrification are summarized in Tables D.4.8.15, D.4.8.16, D.4.8.17, D.4.8.18, D.4.8.19 and D.4.8.20, respectively. The total HI and cancer risk are and 5.44E-10, respectively.

D.4.9 EX SITU/IN SITU COMBINATION 2 ALTERNATIVE

This section presents the anticipated remediation risk associated with the Ex Situ/In Situ Combination 2 alternative for tank waste, as outlined in Volume Two, Appendix B of the EIS.

The radiological and toxicological risk for this alternative was based on the same factors discussed for the Ex Situ/In Situ Combination 1 alternative (Section D.4.8).

D.4.9.1 Radiological Risk

Latent cancer fatality risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.9.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4.9.1 (WHC 1995f,1995j and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.9.1 Atmospheric Radiological Emissions for the Ex Situ/In Situ Combination 2 Alternative

D.4.9.1.2 Transport

The atmospheric transport parameters of the Ex Situ/In Situ Combination 2 alternative are identical to those presented in Table D.4.8.2 for the Ex Situ/In Situ Combination 1 alternative. The modeling assumptions and calculated Chi/Q values for the Ex Situ/In Situ Combination 2 alternative are also identical to those discussed in Section D.4.8.1.2 for the Ex Situ/In Situ Combination 1 alternative.

D.4.9.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.9.2. The table shows the exposure each receptor would receive from every component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed, but is represented by the component with the highest MEI dose.

Table D.4.9.2 Summary of Anticipated Radiological Exposure for the Ex Situ/In Situ Combination 2 Alternative

The worker population dose is dependent on the number of people in the population and the anticipated individual dose. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995f, j and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, retrieval, separations and treatment, monitoring and maintenance, and closure are as follows:

Construction = (5.36E+02 person-yr) · (1.4E-02 rem/person-yr)	= 7.50E+00 person-rem
Continued Operations -	
Tank farms = (1.90E+04 person-yr) · (1.40E-02 rem/person-yr)	= 2.66E+02 person-rem
Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr)	= 1.28E+02 person-rem
	Total = 3.94E+02 person-rem
Retrieval = (1.32E+04 person-yr) · (2.00E-01 rem/person-yr)	= 2.64E+03 person-rem
Separation/Treatment = (9.98E+03 person-yr) · (2.00E-01 rem/person-yr)	= 2.00E+03 person-rem
Monitoring/Maintenance = (6.00E+01 person-yr) · (1.40E-02 rem/person-yr)	= 8.40E-01 person rem
Closure -	
Closure = (2.44E+02 person-yr) · (1.40E-02 rem/person-yr)	= 3.41E+00 person-rem
Monitoring = (6.77E+02 person-yr) · (1.40E-02 rem/person-yr)	= 9.48E+00 person-rem
	Total = 1.29E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.9.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, treatment, and closure for each receptor shown in the combined dose column in Table D.4.9.3 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.9.3 Summary of Anticipated Risk for the Ex Situ/In Situ Combination 2 Alternative

D.4.9.2 Chemical Exposure

The potential carcinogenic risk and noncarcinogenic health hazards resulting from implementing the Ex Situ/In Situ Combination 2 may result from exposure to volatile emissions from the tank farm, the evaporators, tank filling (sand filling) operations, retrieval operations, and particulate emissions from vitrification of tank waste for the worker, noninvolved worker, and general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

D.4.9.2.1 Source Term

The source emissions for the Ex Situ/In Situ Combination 2 alternative are approximately the same as those of the Ex Situ/In Situ Combination 1 alternative. This is a conservative assumption based on reviewing and comparing the waste types, volumes, and activities that would take place during the operating period of the Ex Situ/In Situ Combination 2 alternative. The chemical concentration of many contaminants would be higher for the waste retrieved for the Ex Situ/In Situ Combination 2 compared to Ex Situ/In Situ Combination 1 alternative. However, the volume of waste that would be retrieved for the Ex Situ/In Situ Combination 2 alternative would be approximately 30 percent of the Ex Situ/In Situ Combination 1 alternative. The volume of vitrified waste produced would be approximately 60 percent of the Ex Situ/In Situ Combination 1 alternative. Volatile emissions from the waste treatment facilities stacks would be lower for the Ex Situ/In Situ Combination 2 alternative based on smaller treatment facilities and smaller contaminant inventories. Chemical emissions from the waste treatment facilities would be the largest component of the operating emissions. Volatile emissions from the fill and cap portion of the Ex Situ/In Situ Combination 2 alternative would be higher than those from the Ex Situ/In Situ Combination 1 alternative because more tanks would be treated in situ. The combination of these factors resulted in assessing the chemical risk using the same emissions rates for both combination alternatives.

Therefore, operating air emissions from the tank farm area, the evaporators, filling the tanks with sand, retrieval of the tank waste, and vitrification of tank waste are presented in Table D.4.8.5 (WHC 1995f, j and Jacobs 1996). The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, the evaporators, filling the tanks with sand, retrieval operations and vitrification, while the worker would only be exposed to emissions (ground-level release) from the tank farm area, filling the tanks with sand and retrieval, because emissions from the evaporators and vitrification facility occur through a stack-release and would not impact the onsite worker.

D.4.9.2.2 Transport

Chemical transport modeling assumptions and parameters for the Ex Situ/In Situ Combination 2 alternative are identical to those presented in Table D.4.8.2 for the Ex Situ/In Situ Combination 1 alternative. The MEI worker was evaluated using a simplified "box" model, as presented in detail in Section D.4.1.2.2. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

D.4.9.2.3 Exposure

The chemical exposure to each MEI receptor (i.e., worker, noninvolved worker, and general public) from volatile chemicals emitted as a result of implementing the Ex Situ/In Situ Combination 2 alternative is approximately equal to that of Ex Situ/In Situ Combination 1 alternative.

Therefore, chemical intake (dose) for each MEI receptor are presented in Section D.4.8.2.3.

D.4.9.2.4 Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

D.4.9.2.5 Risk Characterization

The noncarcinogenic hazard, and carcinogenic risk to each MEI receptor (i.e., worker, noninvolved worker, and general public) resulting from implementing the Ex Situ/In Situ Combination 2 alternative are approximately equal to that of the Ex Situ/In Situ Combination 1 alternative.

The total HI and cancer risk to each MEI receptor for each scenario is presented in Section D.4.8.2.5.

D.4. 10 PHASED IMPLEMENTATION ALTERNATIVE

The Phased Implementation alternative includes remediating the tank waste in a two-phase process. The first phase would be a commercial demonstration of the separations and immobilization processes for selected tank waste. The second step would involve scaling-up the demonstration processes to treat the remaining tank waste and construction of larger treatment facilities.

D.4.10.1 Phase 1

This section presents the anticipated remediation risk associated with Phase 1, as outlined in Volume Two, Appendix B of the EIS.

The radiological and toxicological risk for this alternative was based on the air emissions and direct exposure from construction (including construction, decontamination and decommissioning), continued operations (including tank farm and evaporator operations), retrieval, separations and treatment (including the LAW vitrification facility and the LAW/HLW vitrification facility), storage and disposal, and monitoring and maintenance.

D.4.10.1.1 Radiological Risk

Th LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4. 10 .1. The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the workplace.

Table D.4.10 .1 Atmospheric Radiological Emissions for Phase 1

Transport

The atmospheric transport parameters for Phase 1 are presented in Table D.4.10 .2. The tank farm atmospheric radiological operating emissions were modeled as a ground release and the evaporator and the separations and vitrification were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.10 .2 Atmospheric Transport Parameters for Phase 1

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.00E-04 sec/m^3 for the noninvolved worker MEI and 6.60E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.9E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction) for the evaporator and 400 m (1,300 ft) for separations and vitrification. The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 4.00E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q values were 1.60E-03 sec/m^3. For the separations and vitrification operation, the Chi/Q values were 9.40E-08 sec/m^3 for the noninvolved worker MEI, 1.50E-08 sec/m^3 for the general public MEI, 1.20E-04 sec/m^3 for the noninvolved worker population, and 8.00E-04 sec/m^3 for the general public population.

Exposure

The radiological exposure for the alternative is presented in Table D.4.10 .3. The table shows the exposure each receptor would receive from every component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed but is represented by the component with the highest MEI dose.

Table D.4.10 .3 Summary of Anticipated Radiological Exposure for Phase 1

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995a and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, retrieval, separations and treatment, monitoring and maintenance, and closure are as follows:

Construction = (5.00E-01 person-yr) (1.40E-02 rem/person-yr)	= 7.00E-03 person-rem
Continued Operations -	
Tank farms = (5.00E+03 person-yr) · (1.40E-02 rem/person-yr)	= 7.00E+01 person-rem
Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr)	= 1.28E+02 person-rem
Total	= 1.98E+02 person-rem
Retrieval = (1.00E+02 person-yr) · (2.00E-01 rem/person-yr)	= 2.00E+01 person-rem
Separation/Treatment = (3.36E+03 person-yr) · (2.00E-01 rem/person-yr)	= 6.72E+02 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, treatment, and closure, for each receptor shown in the combined dose column in Table D.4. 10 .4, was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.10 .4 Summary of Anticipated Risk for Phase 1

D.4.10.1.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, tank waste retrieval, and the evaporator, and exposure to particulate emissions from the separation and vitrification of HLW and LAW for the worker, noninvolved worker, and general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

Source Term

Operating air emissions from the tank farm area, tank waste retrieval, evaporator and vitrification facilities are presented in Table D.4.10 .5 (Jacobs 1996). The emission rates from the full-scale HLW and LAW vitrification facilities were combined and treated as a single-source emission, as discussed in Section D.4.5.2.1 for the Ex Situ Intermediate Separations alternative. This assumption is conservative and health protective as the pilot separation/vitrification facilities are scaled-down versions and would emit a fraction of the particulates emitted in this scenario. The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, tank waste retrieval operations, evaporator, and vitrification facilities. The worker would only be exposed to emissions (ground-level release) from the tank farm area and retrieval operations because emissions from the evaporator and vitrification facilities occur through a stack-release and would not impact the onsite worker.

Table D.4.10 .5 Chemical Emissions for Phase 1

Transport

The tank farm chemical operating emissions (routine emissions from the tank farm and emissions during retrieval) were modeled as a ground release. Chemical operating emissions from the evaporator and vitrification facilities would occur from stack releases and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and general public, are identical to the radiological parameters presented in Table D.4. 10 .2.

The MEI worker was evaluated using a simplified "box" model, as presented in detail in Section D.2.2.3. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

Exposure

Worker

The MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area and retrieval operations were estimated by multiplying the cumulative tank farm emission rate (mg/sec) and retrieval operation emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3), respectively. Exposure point concentrations for each volatile chemical emitted from the tank farm area and during retrieval are summarized in Tables D.4.10 .6 and D.4. 10 .7, respectively.

Table D.4.10 .6 Phase 1 Tank Farm Emissions

Table D.4.10 .7 Phase 1 Retrieval Emissions

Chemical intake (dose) was estimated for the MEI worker using the same equation and exposure parameters defined in Section D.2.2.3. Estimated intakes of chemical emissions from the tank farm and retrieval operations for the MEI worker are presented in Tables D.4. 10 .6 and D.4.10 .7, respectively.

Noninvolved Worker - The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm, and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, retrieval operations, evaporator, and vitrification facilities were estimated by multiplying the cumulative tank farm, retrieval, evaporator, and plant emission rates (mg/sec) by their respective MEI noninvolved worker Chi/Q values (4.00E-04 sec/m^3 for the tank farm, 2.50E-06 sec/m^3 for the evaporator, 4.00E-04 sec/m^3 for retrieval, and 2.90E-08 sec/m^3 for the vitrification facility). Exposure point concentrations for each chemical emitted from the tank farm area, the evaporator, retrieval operations and the vitrification facility are summarized in Tables D.4.10 .8, D.4. 10 .9, D.4.10 .10 and D.4. 10 .11, respectively.

Table D.4.10 .8 Phase 1 Tank Farm Emissions

Table D.4.10 .9 Phase 1 Evaporator Emissions

Table D.4.10 .10 Phase 1 Retrieval Emissions

Table D.4.10 .11 Phase 1 Plant Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4. 10 .8, D.4.10 .9, D.4. 10 .10, and D.4.10 .11 for the tank farm area, the evaporator, retrieval operations, and the vitrification facility emissions, respectively.

General Public - The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area, the evaporator, retrieval operations, and the vitrification facility were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 3.90E-08 sec/m^3 for evaporator,
3 3

6.60E-08 sec/m for retrieval operations, and 7.70E-09 sec/m for the vitrification facility). Exposure point concentrations for each volatile chemical emitted from the tank farm area, evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4. 10 .12, D.4. 10 .13, D.4. 10 .14 and D.4. 10 .15, respectively.

Table D.4.10 .12 Phase 1 Tank Farm Emissions

Table D.4.10 .13 Phase 1 Evaporator Emissions

Table D.4.10 .14 Phase 1 Retrieval Emissions

Table D.4.10 .15 Phase 1 Plant Emissions Phase 1 Plant Emissions

The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4. 10 .12, D.4. 10 .13, D.4. 1 .14, and D.4. 10 .15 for the tank farm area, the evaporator, retrieval operations and the vitrification facility, respectively.

Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

Risk Characterization

MEI Worker - The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm and retrieval operations are summarized in Tables D.4. 10 .6 and D.4.10 .7, respectively. The total HI and cancer risk from routine tank farm emissions and retrieval emissions are 1.12E-01 and 5.14E-07, respectively.

MEI Noninvolved Worker - The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4. 10 .8, D.4. 10 .9, D.4. 10 .10 and D.4. 10 .11, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval and plant emissions are 4.84E-02 and 2.23E-07, respectively.

MEI General Public - The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, evaporator, retrieval operations, and the vitrification facility are summarized in Tables D.4. 10 .12, D.4. 10 .13, D.4. 10 .14 and D.4. 10 .15, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval and plant emissions are 2.82E-05 and 1.58E-10, respectively.

D.4.10.2 Total Alternative

This section presents the anticipated remediation risk associated with the Total alternative for tank waste, as outlined in Volume Two, Appendix B of the EIS.

The radiological and toxicological risk for this alternative was based on the air emissions and direct exposure from construction, continued operations (including tank farm and evaporator operations), retrieval, separations and treatment (including Phase 1 and Phase 2), storage and disposal, onsite transportation of waste, monitoring and maintenance, and closure and monitoring.

D.4.10.2.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

Source Term - The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4. 10 .16 (WHC 1995j and Jacobs 1996). They would also receive a direct exposure dose from the vitrified HLW as it is being transported to a national HLW repository. The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.10 .16 Atmospheric Radiological Emissions for the Total Alternative

Transport - The atmospheric transport parameters of the Total alternative are presented in Table D.4. 10 .17. The tank farm and retrieval atmospheric radiological operating emissions were modeled as a ground release, and the evaporator and the separations and vitrification were modeled as elevated releases. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.10 .17 Atmospheric Transport Parameters for the Total Alternative

For ground releases, dispersion in the atmosphere would cause contaminant air concentrations and exposures to decrease with increasing distance from the source. Maximum individual exposures therefore would occur at the inner boundaries (i.e., closest distance to the source) of the defined receptor occupancy zones. For the noninvolved worker, the maximum exposure would occur 100 m (330 ft) from the source (in an east-southeast direction). For the general public, the maximum exposure would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the center of the 200 East Area).

The calculated Chi/Q values for ground releases from the tank farms were calculated by the GENII computer code to be 4.00E-04 sec/m^3 for the noninvolved worker MEI and 6.60E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 1.60E-03 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 2.90E-03 sec/m^3.

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction) for the evaporator and 800 m (2,600 ft) for separations and vitrification. The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values for the evaporator operation were 2.50E-06 sec/m^3 for the noninvolved worker MEI and 3.90E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q values were 4.00E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q values were 1.60E-03 sec/m^3. For Phase 1 separations and vitrification operation, the Chi/Q values were 9.40E-08 sec/m^3 for the noninvolved worker MEI, 1.50E-08 sec/m^3 for the general public MEI, 1.20E-04 sec/m^3 for the noninvolved worker population, and 8.00E-04 sec/m^3 for the general public population. For Phase 2 separations and vitrification operation, the Chi/Q values were 2.90E-08 sec/m^3 for the noninvolved worker MEI, 7.70E-09 sec/m^3 for the general public MEI, 5.00E-05 sec/m^3 for the noninvolved worker population, and 5.00E-04 sec/m^3 for the general public population.

Exposure - The radiological exposure for the alternative is presented in Table D.4. 10 .18. The table shows the exposure each receptor would receive from each component. The sum of the components are shown in the last column for each population and MEI receptor except for the MEI worker. The MEI worker is not summed but is represented by the component with the highest MEI dose.

Table D.4.10 .18 Summary of Anticipated Radiological Exposure for the Total Alternative

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995j and Jacobs 1996). The calculations for the worker exposures from construction, continued operations, retrieval, separations and treatment, monitoring and maintenance, and closure are as follows:

Construction

Phase 1 = (5.00E-01 person-yr) · (1.40E-02 rem/person-yr) = 7.00E-03 person-rem

Phase 2 = (5.36E+02 person-yr) · (1.40E-02 rem/person-yr) = 7.50E+00 person-rem

Total = 7.51E+00 person-rem

Continued Operations - Phase 1 and Phase 2

Tank farms = (1.90E+04 person-yr) · (1.40E-02 rem/person-yr) = 2.66E+02 person-rem

Evaporator = (6.40E+02 person-yr) · (2.00E-01 rem/person-yr) = 1.28E+02 person-rem

Total = 3.94E+02 person-rem

Retrieval

Phase 1 and 2 = (2.21E+04 person-yr) · (2.00E-01 rem/person-yr) = 4.42E+03 person-rem

Separation/Treatment

Phase 1= (6.72E+03 person-yr) · (2.0E-01 rem/person-yr) = 1.34E+03 person-rem

Phase 2= (9.98E+03 person-yr) · (2.0E-01 rem/person-yr) = 2.00E+03 person-rem

Total = 3.34E+03 person-rem

Monitoring and Maintenance.

Phase 1 and 2 = (6.00E+01 person-yr) · (1.40E-02 rem/person-yr) = 8.40E-01 person-rem

Closure - Phase 1 and Phase 2

Closure = (2.77E+02 person-yr) · (1.40E-02 rem/person-yr) = 3.88E+00 person-rem

Monitoring = (6.77E+02 person-yr) · (1.40E-02 rem/person-yr) = 9.48E+00 person-rem

Total = 1.34E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a maximum of 30 years.

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q value.

Risk - The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The sum of the radiological dose from construction, continued operations, retrieval, treatment, storage and disposal, monitoring and maintenance, and closure for each receptor shown in the combined dose column in Table D.4.10 .19, was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.10 .19 Summary of Anticipated Risk for the Total Alternative

D.4.10.2.2 Chemical Exposure

Potential carcinogenic risk and noncarcinogenic health hazards may result from exposure to volatile emissions from the tank farm, tank waste retrieval, the evaporator, and exposure to particulate emissions from the separation and vitrification of HLW and LAW for the worker, noninvolved worker, and general public. Potential carcinogenic risk and noncarcinogenic health hazards were estimated using the chemical source term, transport mechanism, exposure, and toxicological criteria as discussed in the following subsections.

Source Term - Operating air emissions from the tank farm area, tank waste retrieval, evaporator, and vitrification facilities are presented in Table D.4. 10 .20 (WHC 1995j and Jacobs 1996). The emission rates from the HLW and LAW vitrification facilities were combined and treated as a single-source emission for both Phase 1 and Phase 2. The noninvolved worker and general public would be exposed to combined emissions from the tank farm area, tank waste retrieval operations, evaporator, and Phase 1 and Phase 2 vitrification facilities. The worker only would be exposed to emissions (ground-level release) from the tank farm area and retrieval operations because emissions from the evaporator and vitrification facilities occur through a stack-release and would not impact the onsite worker.

Table D.4.10 .20 Chemical Emissions for the Total Alternative

Transport - The tank farm chemical operating emissions (routine emissions from the tank farm and emissions during retrieval) were modeled as a ground release. Chemical operating emissions from the evaporator and vitrification facilities would occur from stack releases and were modeled as elevated releases. Transport parameters, location of the MEI noninvolved worker and MEI general public, and Chi/Q values for the MEI noninvolved worker and general public are identical to the radiological parameters presented in Table D.4. 10 .17.

The MEI worker (onsite worker) was evaluated using a simplified box model, as presented in detail in Section D.4.1.2.2. The estimated Chi/Q value for the MEI worker was 9.26E-04 sec/m^3.

Exposure

Worker - The MEI worker was assumed to be located within a box placed directly over the tank farm area. Exposure point concentrations of chemical emissions (mg/m^3) from the tank farm area and retrieval operations were estimated by multiplying the cumulative tank farm emission rate (mg/sec) and retrieval operation emission rate (mg/sec) by the MEI worker Chi/Q value (9.26E-04 sec/m^3), respectively. Exposure point concentrations for each volatile chemical emitted from the tank farm area and during retrieval are summarized in Tables D.4. 10 .21 and D.4.10 .22 respectively.

Table D.4.10 .21 Total Alternative Tank Farm Emissions

Table D.4.10 .22 Total Alternative Retrieval Emissions

Chemical intake (dose) was estimated for the MEI worker using the same equation and exposure parameters defined in Section D.2.2.3. Estimated intakes of chemical emissions from the tank farm and retrieval operations for the MEI worker are presented in Tables D.4. 10 .21 and D.4.10 .22, respectively.

Noninvolved Worker - The MEI noninvolved worker was assumed to be located at the point where maximum downwind air concentrations were calculated (100 m [330 ft] from the tank farm and 200 m [660 ft] from the evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm, retrieval operations, evaporator, and vitrification facilities were estimated by multiplying the cumulative tank farm, retrieval, evaporator, and plant emission rates (mg/sec) by their respective MEI noninvolved worker Chi/Q values (4.00E-04 sec/m^3 for the tank farm, 2.50E-06 sec/m^3 for the evaporator, 4.00E-04 sec/m^3 for retrieval, 9.40E-08 sec/m^3 for Phase 1 vitrification, and 2.90E-08 sec/m^3 for Phase 2 vitrification). Exposure point concentrations for each volatile chemical emitted from the tank farm area, the evaporator, retrieval operations, and the Phase 1 and Phase 2 vitrification facility are summarized in Tables D.4.10 .23, D.4. 10 .24, D.4.10 .25, D.4. 10 .26, and D.4.10 .27 respectively.

Table D.4.10 .23 Total Alternative Tank Farm Emissions

Table D.4.10 .24 Total Alternative Evaporator Emissions

Table D.4.10 .25 Total Alternative Retrieval Emissions

Table D.4.10 .26 Total Alternative Phase 1 Plant Emissions

Table D.4.10 .27 Total Alternative Phase 2 Plant Emissions

Chemical intake (dose) was estimated for the MEI noninvolved worker according to the same equation and exposure parameters used for the MEI worker. Estimated operating chemical emission intakes for the MEI noninvolved worker are presented in Tables D.4. 10 .23, D.4.10 .24, D.4. 10 .25, D.4.10 .26, and D.4. 10 .27 for the tank farm area, evaporator, retrieval operations, and the Phase 1 and Phase 2 vitrification facilities emissions, respectively.

General Public - The MEI general public receptor was assumed to be located at the point where maximum air concentrations were calculated (approximately 22 km [14 mi] from both the tank farm area and evaporator). Exposure point concentrations (mg/m^3) of chemical emissions from the tank farm area, the evaporator, retrieval operations, and the vitrification facilities were estimated by multiplying the cumulative emission rates (mg/sec) of each source by their respective MEI general public Chi/Q values (6.60E-08 sec/m^3 for the tank farm, 6.60E-08 sec/m^3 for the evaporator, 6.60E-08 sec/m^3 for retrieval operations, 1.50E-08 sec/m^3 for Phase 1 vitrification, and 7.70E-09 sec/m^3 for Phase 2 vitrification). Exposure point concentrations for each volatile chemical emitted from the tank farm area, evaporator, retrieval operations, and the Phase 1 and Phase 2 vitrification facilities are summarized in Tables D.4.10 .28, D.4. 10 .29, D.4.10 .30, D.4. 10 .31, and D.4.10 .32, respectively.

Table D.4.10 .28 Total Alternative Tank Farm Emissions

Table D.4.10 .29 Total Alternative Evaporator Emissions

Table D.4.10 .30 Total Alternative Retrieval Emissions

Table D.4.10 .31 Total Alternative Phase 1 Plant Emissions

Table D.4.10 .32 Total Alternative Phase 2 Plant Emissions

The residential or general public intake was calculated according to the equation and exposure parameters presented in Section D.2.2.3. Estimated chemical emission intakes for the MEI general public are presented in Tables D.4. 10 .28, D.4. 10 .29, D.4. 10 .30, D.4. 10 .31, and D.4. 10 .32 for the tank farm area, the evaporator, retrieval operations, and the Phase 1 and Phase 2 vitrification facilities, respectively.

Toxicity Assessment

Toxicity assessment was previously discussed in detail in Section D.4.1.2.4. Cancer slope factors, RfDs, and data sources for each volatile operating chemical emission are summarized in Table D.4.1.11.

Risk Characterization

MEI Worker - The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm and retrieval operations are summarized in Tables D.4. 10 .21 and D.4. 10 .22, respectively. The total HI and cancer risk from routine tank farm emissions and retrieval emissions combined are 3.08E-01 and 2.51E-06, respectively.

MEI Noninvolved Worker - The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farms, the evaporator, retrieval operations, and Phase 1 and 2 vitrification facilities are summarized in Tables D.4. 10 .23, D.4. 10 .24, D.4. 10 .25, D.4. 10 .26, and D.4. 10 .27, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval, and vitrification emissions are 1.33E-01 and 1.09E-06, respectively.

MEI General Public - The noncarcinogenic hazards and carcinogenic risk for chemical emissions from the tank farm, evaporator, retrieval operations, and the Phase 1 and Phase 2 vitrification facilities are summarized in Tables D.4.10 .28, D.4. 10 .29, D.4.10 .30, D.4. 10 .31, and D.4.10 .32, respectively. The total HI and cancer risk from combined tank farm, evaporator, retrieval, and vitrification emissions are 7.50E-05 and 6.35E-10, respectively.

D.4.11 NO ACTION ALTERNATIVE (CAPSULES)

This section presents the anticipated remediation risk associated with the No Action alternative for Cs and Sr capsules, as outlined in Volume Two, Appendix B of the EIS.

The radiological risk for this alternative was based on the air emissions and direct exposure from storage operations at WESF. No nonradiological chemical (toxicological) emissions were associated with the capsules.

D.4.11.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.11.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4. 11 .1 (WHC 1995h and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the workplace.

Table D.4.11 .1 Atmospheric Radiological Emissions for the No Action Alternative (Capsules)

D.4.11.1.2 Transport

The atmospheric transport parameters of the No Action Capsules alternative are presented in Table D.4. 11 .2. The atmospheric radiological operating emissions were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.11 .2 Atmospheric Transport Parameters for the No Action Alternative (Capsules)

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction). The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values were 5.40E-07 sec/m^3 for the noninvolved worker MEI and 3.40E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 3.70E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.70E-03 sec/m^3.

D.4.11.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.11 .3. The table shows the exposure each receptor would receive.

Table D.4.11 .3 Summary of Anticipated Exposure and Risk for the No Action Alternative (Capsules)

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995h and Jacobs 1996). The calculations for the worker exposures from storage operations are as follows:

Storage = (7.61E+02 person-yr) · (2.00E-01 rem/person-yr) = 1.52E+02 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a duration of the alternative (not exceed 30 years).

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q value.

D.4.11.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The dose-to-risk conversion factors used were 4.00E-04 LCFs per person-rem for workers and noninvolved workers and 5.00E-04 LCFs per person-rem for the general public.

The radiological dose for each receptor shown in the dose column in Table D.4. 11 .3 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

D.4.12 ONSITE DISPOSAL ALTERNATIVE

This section presents the anticipated remediation risk associated with the Onsite Disposal alternative for Cs and Sr capsules, as outlined in Volume Two, Appendix B of the EIS.

The radiological risk for this alternative was based on the air emissions and direct exposure from storage and packaging operations at WESF. No nonradiological chemical (toxicological) emissions were associated with the capsules.

D.4.12.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.12.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4. 12 .1 (WHC 1995h and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the workplace.

Table D.4.12 .1 Atmospheric Radiological Emissions for the Onsite Disposal Alternative

D.4.12.1.2 Transport

The atmospheric transport parameters of the Onsite Disposal alternative are presented in Table D.4. 12 .2. The atmospheric radiological operating emissions were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.12 .2 Atmospheric Transport Parameters for the Onsite Disposal Alternative

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction). The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values were 5.40E-07 sec/m^3 for the noninvolved worker MEI and 3.40E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 3.70E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.70E-03 sec/m^3.

D.4.12.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.12 .3. The table shows the exposure each receptor would receive.

Table D.4.12 .3 Summary of Anticipated Radiological Exposure for the On Site Disposal Alternative

The worker population dose is dependent on the number of people in the population and the anticipated dose each individual would receive. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995h and Jacobs 1996). The calculations for the worker exposures from storage and packaging are as follows:

Storage/Packaging = (8.40E+02 person-yr) · (2.00E-01 rem/yr) = 1.68E+02 person-rem

Dry storage monitoring = (4.40E+02 person-yr) · (1.40E-01 rem/yr) = 6.16E+00 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for the duration of the alternative (not exceeding 30 years).

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q value.

D.4.12.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The radiological dose for each receptor shown in the combined dose column in Table D.4.12 .4 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.12 .4 Summary of Anticipated Risk for the Onsite Disposal Alternative

D.4.13 OVERPACK AND SHIP ALTERNATIVE

This section presents the anticipated remediation risk associated with the Overpack and Ship alternative for Cs and Sr capsules, as outlined in Volume Two, Appendix B of the EIS.

The radiological risk for this alternative was based on the air emissions and direct exposure from storage and overpacking at WESF, and transporting capsules onsite . No nonradiological chemical (toxicological) emissions were associated with the capsules.

D.4.13 .1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.13.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4. 13 .1 (WHC 1995h and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the work place.

Table D.4.13 .1 Atmospheric Radiological Emissions for the Overpack and Ship Alternative

D.4.13.1.2 Transport

The atmospheric transport parameters of the Overpack and Ship alternative are presented in Table D.4.13.2. The atmospheric radiological operating emissions were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.13 .2 Atmospheric Transport Parameters for the Overpack and Ship Alternative

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction). The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values were 5.40E-07 sec/m^3 for the noninvolved worker MEI and 3.40E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 3.70E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.70E-03 sec/m^3.

D.4.13.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.13 .3. The table shows the exposure each receptor would receive.

Table D.4.13 .3 Summary of Anticipated Radiological Exposure for the Overpack and Ship Alternative

The worker population dose is dependent on the number of people in the population and the anticipated individual dose. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995h and Jacobs 1996). The calculations for the worker exposures from storage and overpacking operations are as follows:

Storage/Overpacking = (1.48E+02 person-yr) · (2.00E-01 rem/person-yr) = 2.84E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for the duration of the alternative (not exceeding 30 years).

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.13.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The dose-to-risk conversion factors used were 4.00E-04 LCFs per person-rem for workers and noninvolved workers and 5.00E-04 LCFs per person-rem for the general public.

The radiological dose for each receptor shown in the combined dose column in Table D.4.13.4 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.13 .4 Summary of Anticipated Risk for the Overpack and Ship Alternative

D.4.14 VITRIFY WITH TANK WASTE ALTERNATIVE

This section presents the anticipated remediation risk associated with the Vitrify With Tank Waste alternative for Cs and Sr capsules, as outlined in Volume Two, Appendix B of the EIS.

The radiological risk for this alternative was based on the air emissions and direct exposure from storage and overpacking operations in WESF, and transporting the overpacked capsules to the vitrification facility. No nonradiological chemical (toxicological) emissions were associated with the capsules.

D.4.14.1 Radiological Risk

The LCF risk to the workers, noninvolved workers, and general public could result from direct exposure and atmospheric emissions from the components associated with this alternative. The risk was determined by analyzing the radiological source term, the transport mechanism, exposure, and the risk associated with the exposure as discussed in the following subsections.

D.4.14.1.1 Source Term

The source term used for the noninvolved worker and general public was the atmospheric radiological emissions presented in Table D.4. 14 .1 (WHC 1995h and Jacobs 1996). The workers would receive a combined dose from the air emissions and from direct exposure from radiation fields in the workplace.

Table D.4.14 .1 Atmospheric Radiological Emissions for the Vitrify with Tank Waste Alternative

D.4.14.1.2 Transport

The atmospheric transport parameters of the Vitrify with Tank Waste alternative are presented in Table D.4. 14 .2. The atmospheric radiological operating emissions were modeled as an elevated release. For modeling purposes, it was assumed that the source term would be released at a point in the 200 Areas represented by the meteorological conditions at the Hanford Meteorological Station. The analysis used the Hanford Meteorological Station joint frequency data from Table D.2.2.1 and Figure D.2.2.1.

Table D.4.14 .2 Atmospheric Transport Parameters for the Vitrify with Tank Waste Alternative

For elevated releases (stack releases), the maximum exposure would not necessarily occur at the closest distance to the source. Air transport modeling indicates that the maximum exposure for the noninvolved worker would occur 200 m (660 ft) from the source (in an east-southeast direction). The maximum exposure for a member of the general public would occur 22 km (14 mi) from the source (i.e., the distance to the Hanford Site boundary in an east-southeast direction from the 200 East Area).

The calculated Chi/Q values were 5.40E-07 sec/m^3 for the noninvolved worker MEI and 3.40E-08 sec/m^3 for the general public MEI. For the noninvolved worker population of 10,900 occupying an area between 100 m (330 ft) from the source and the Hanford Site boundary, the population-weighted Chi/Q value was 3.70E-04 sec/m^3. For the general public population of 376,000 occupying an area outside the Hanford Site boundary within an 80-km (50-mi) radius centered on the 200 Areas, the population-weighted Chi/Q value was 1.70E-03 sec/m^3.

D.4.14.1.3 Exposure

The radiological exposure for the alternative is presented in Table D.4.14 .3. The table shows the exposure each receptor would receive.

Table D.4.14 .3 Summary of Anticipated Radiological Exposure for the Vitrify with Tank Waste Alternative

The worker population dose is dependent on the number of people in the population and the anticipated individual dose. The data were obtained from the Site maintenance and operations contractor and the TWRS EIS contractor (WHC 1995h and Jacobs 1996). The calculations for the worker exposures from storage and overpacking operations are as follows:

Storage/Overpack = (1.40E+02 person-yr) · (2.00E-01 rem/person-yr) = 2.8E+01 person-rem

The MEI worker was assumed to receive a dose of 500 mrem (5.00E-01 rem) per year for a duration of the alternative (not exceeding 30 years).

The noninvolved workers and general public exposures from inhalation of the atmospheric emissions (source term) were converted to a radiological dose in rem using the GENII computer code and applying the appropriate Chi/Q.

D.4.14.1.4 Risk

The LCFs are calculated as the product of the estimated dose times the dose-to-risk conversion factor (Section D.2.2.4). The dose-to-risk conversion factors used were 4.00E-04 LCFs per person-rem for workers and noninvolved workers and 5.00E-04 LCFs per person-rem for the general public.

The radiological dose for each receptor shown in the combined dose column in Table D.4.13.4 was multiplied by the appropriate dose-to-risk conversion factor to produce the LCF risk.

Table D.4.14 .4 Summary of Anticipated Risk for the Vitrify with Tank Waste Alternative

D.4.15 REMEDIATION RISK SUMMARY

This section summarizes the results of the remediation risk assessment presented in Sections D.4.1 to D.4.14 for each of the alternatives. Separate summaries are presented for radiological risk and chemical risk.

D.4.15.1 Radiological Risk

Table D.4.15.1 summarizes the calculated LCF risk associated with radiological exposures for each alternative. Risks are summarized for the workers, noninvolved workers, and the general public. Risks are also summarized for the MEI from each of these receptor groups. The table presents both remediation risk and total risk for each receptor and alternative. The total risk includes the risk from remediation activities plus the risk from post-closure monitoring.

Table D.4.15.1 Comparison of Radiological Consequences from Remediation Operations Under Normal Conditions

D.4.15.2 Chemical Risk

Tables D.4.15.2 and D.4.15.3 summarize the calculated noncarcinogenic health hazard and carcinogenic risk associated with chemical air emissions for each tank waste alternative. Capsule alternatives are not shown because chemical emissions are not associated with any of these alternatives. Table D.4.15.2 summarizes the nonradiological health hazard (expressed as a HI) for the MEI worker,

Table D.4.15.2 Comparison of Nonradiological Chemical Hazards from Remediation Operations

Table D.4.15.3 Comparison of Nonradiological Chemical Cancer Risks from Remediation Operations

MEI noninvolved worker, and MEI general public for each alternative. Table D.4.15.3 summarizes the nonradiological cancer risk for the MEI worker, MEI noninvolved worker, and MEI general public for each alternative.

D.4.16 UNCERTAINTY

The uncertainties in the risk assessment for tank waste remediation are associated with the source data and source term, transport, exposure pathway, and dose to risk conversion factors. By far the greatest uncertainty is associated with the source data, which are based on the estimated inventory and source terms (e.g., the amount of chemicals and radionuclides released into the environment). The uncertainties associated with the source and source terms are discussed in detail in Volume Five, Appendix K . Other contributors to the routine risk assessment uncertainty are the airborne transport of the released chemicals and radionuclides, accumulation of contaminants in food products, production and distribution of food products, lifestyle and diet of specific individuals or food consumption rates, and dose conversion factors of the contaminants . A detailed discussion of the uncertainties in the remediation risk assessment is presented in Volume Five, Appendix K.

D.5.0 ANTICIPATED POST-REMEDIATION RISK

This section presents the results of the assessment of anticipated post-remediation risk for each of the TWRS EIS alternatives. Post-remediation risk is the risk to a future land user from exposure to residual contamination after the TWRS mission has been completed. Anticipated risk was evaluated for five exposure scenarios: 1) the Native American; 2) the residential farmer; 3) the industrial worker; 4) the recreational shoreline user; and 5) the recreational land user. These scenarios were selected to represent a range of possible land uses that could occur at the Hanford Site in the future.

The risk presented in this section was evaluated using the modular risk assessment methodology described in Section D.2.1. The modular approach separates the four basic components of the risk assessment process (i.e., source, transport, exposure, and risk) into discrete modules that can be assessed independently and then combined.

The following sections discuss the source, transport, exposure, and risk modules developed for each of the TWRS EIS alternatives. Due to their length, the support ing tables and graphs are presented at the end of this section.

D.5.1 NO ACTION ALTERNATIVE (TANK WASTE) (BASELINE RISK ASSESSMENT)

This section presents the anticipated post-remediation risk associated with the No Action alternative for tank waste. Post remediation for this alternative refers to risk remaining after tank farm operational activities and 100 years institutional controls (40 CFR 191) are discontinued.

D.5.1.1 Source

Post-remediation contamination sources under the No Action alternative would consist of the current inventories in the SSTs , DSTs , and MUSTs (Jacobs 1996). Additional discussion of contaminant source inventories is provided in Volume Two, Appendix A.

D.5.1.2 Transport

Post remediation contaminant releases would be from the tanks to the soil. Contaminants released to the soil would migrate to groundwater in proportion to their ionic mobility. Air emissions from all sources were assumed to be zero. Thus, groundwater transport (i.e., transport in the vadose zone and aquifer) was the only transport pathway considered for this assessment. The point concentrations used for the risk calculations (i.e., future concentrations at a given receptor originating from a particular source) were generated through groundwater transport modeling and are discussed briefly in the following text. A detailed discussion of groundwater modeling is provided in Volume Four, Appendix F.

Groundwater modeling predicts that contaminants released from the tanks would be present in groundwater beneath the Hanford Site for all periods of interest [i.e., 300, 500, 2,000, 5,000, and 10,000 years from the present (40 CFR 191)]. Calculated groundwater contaminant concentrations and spatial distributions are discussed in Volume Four, Appendix F.

Example point concentrations for one constituent (I-129) are displayed in Table D.5.1.1. The table shows calculated groundwater concentrations by grid cell for the periods of interest. Similar data have been tabulated for the other constituents calculated to reach groundwater but are not presented here in the interest of brevity.

Table D.5.1.1 Modeled Point Concentrations for Iodine-129 Released from Single- and Double-Shell Tanks, No Action Alternative

Contaminated groundwater would eventually discharge to the Columbia River where it would be rapidly diluted by mixing with the river flow. The contaminant mass entering the river would cause the recreational shoreline user to receive small exposures from surface water activities. To evaluate an upper bound for these exposures, conservative surface water concentrations were calculated for five mobile constituents of concern (C-14, I-129, Tc-99, U-238, and nitrate) by applying a dilution factor to the maximum calculated groundwater concentration given in Volume Four, Appendix F for each constituent in each time period. The resultant river water concentrations were then conservatively assumed to be present uniformly in the surface water used by the recreational shoreline user.

The dilution factor was determined by using results from the surface water impacts analysis described in Section 5.2.2. In that analysis, a mixing calculation indicated that the concentration of nitrate in the Columbia River would reach a maximum of 0.177 mg/L under the Long-Term Management alternative at 300 years from 1995. This concentration (0.177 mg/L) is approximately 0.12 mg/L above the river's 0.05 mg/L background nitrate concentration and resulted from the discharge of groundwater with a maximum calculated nitrate concentration of 1.05E+03 mg/L. Using these results, the ratio of surface water concentration (0.177-0.05=0.127 mg/L) to groundwater concentration (1.05E+03 mg/L) yields a dilution factor for nitrate of 0.127/1.05E+03=1.21E-04. For the risk analysis, the maximum calculated groundwater concentrations for the constituents of concern were multiplied by the dilution factor to produce maximum surface water concentrations. Applying the nitrate dilution factor to the other four constituents is considered appropriate because these constituents have approximately the same groundwater mobility (i.e., the same K_d) as nitrate.

D.5.1.3 Exposure

Exposure is quantified using a URF. A URF is the risk associated with exposure to a unit concentration of a given contaminant under one of five exposure scenarios (i.e., Native American, residential farmer, industrial, recreational shoreline user, and recreational land user). URFs were developed for the appropriate exposure pathway (i.e., ingestion, inhalation, and direct contact) for each applicable exposure scenario. URFs are discussed and presented in Section D.2.1.3.

Exposure would occur as the result of direct or indirect exposure to groundwater and, for the recreational shoreline user, to surface water. The recreational land user scenario assumes no use of groundwater; thus there is no complete exposure pathway. Therefore, there is no risk associated with this scenario and it is not discussed further. Because the Native American, residential farmer, industrial, and recreational shoreline user scenarios included groundwater use, these receptors have complete exposure pathways and receive direct exposure. These receptors would have the potential to receive indirect exposures through the pathways shown in Section D.2.1.3.

D.5.1.4 Risk

The anticipated risk to a receptor within a grid cell was calculated as the product of the point concentration and the URF (Section D.2.1.4). The risk module calculates risk for each exposure scenario, source, and period of interest across all grid cells on the Hanford Site. To visually display the anticipated risk, GIS software was used to generate contour maps illustrating potential risk to a receptor at various locations across the Hanford Site. Each area defined by contour lines represents a zone with a discrete value of risk. Risk from radionuclides and carcinogenic chemicals was combined and presented on one set of maps. HIs from noncarcinogenic chemicals are presented on a separate set of maps.

For radionuclides and carcinogenic chemicals, the risk is defined as the increased probability that an individual at any location along a contour line would develop cancer under the defined conditions of the exposure scenario. Human health risk is defined in terms of the incremental lifetime cancer risk (ILCR). Although there is no universally accepted standard for the level of risk considered acceptable, for purposes of this analysis risk of 1.00E-06 (one in one million) is considered to be low and risk greater than 1.00E-04 (one in ten thousand) is considered high. An ILCR of 1 means that an individual's lifetime probability of developing cancer approaches 100 percent.

For noncarcinogenic chemicals, the HI is the ratio of chemical intake to a reference dose below which no toxic effects are expected. Where the HI is less than 1.0, no toxic effects are expected. Where it is greater than 1, toxic effects are expected. Contour maps for the HI are constructed in the same way as for the cancer risk.

On certain contour maps, white areas with risk values less than the minimum value contoured (i.e., less than 1.0E-06) appear as "holes" in the risk distributions. One such set of "holes" trending in a northwest-to- southeast direction north of the 200 Areas represents areas where basalt occurs above the water table, preventing the influx of contaminated water into these areas. Another such set underlying the 200 West Area represent s conditions of groundwater mounding created by liquid discharges from Hanford Site facilities. The roughness associated with the contour lines is a function of the resolution of the analysis (i.e., 1 by 1 km [0.6 by 0.6 mi] grid size).

The risk calculation for the No Action alternative combines the risk contributed by the SSTs and DSTs into a single risk value for each grid cell. Risk calculations were performed for all five periods of interest. Risk contour maps are presented for all scenarios and time periods except in cases where the maximum combined risk from radionuclides and carcinogenic chemicals is below 1.00E-06, or the maximum hazard from noncarcinogenic chemicals is less than an HI of 1.0. No maps are presented in these latter cases.

Contour maps depicting the risk from radionuclides and carcinogenic chemicals in tank waste are presented in Figures D.5.1.1 to D.5.1.5 for the Native American scenario, Figures D.5.1.6 to D.5.1. 9 for the residential farmer scenario , Figures D.5.1.10 to D.5.1. 13 for the industrial worker scenario , and Figures D.5.1.14 to D.5.1. 16 for the recreational shoreline user scenario. Contour maps depicting the HI from noncarcinogenic chemicals in tank waste are presented in Figures D.5.1.17 to D.5.1.19 for the Native American scenario, Figures D.5.1. 20 to D.5.1. 22 for the residential farmer scenario , and Figure D.5.1. 23 for the industrial worker scenario. No HI maps are presented for the recreational shoreline user scenario because the maximum HI did not exceed 1.0.

Figure D.5.1.1 No Action Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 300 Years from Present

Figure D.5.1.2 No Action Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 500 Years from Present

Figure D.5.1.3 No Action Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 2,500 Years from Present

Figure D.5.1.4 No Action Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.1.5 No Action Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 10,000 Years from Present

Figure D.5.1. 6 No Action Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals at 300 Years from Present

Figure D.5.1. 7 No Action Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals at 500 Years from Present

Figure D.5.1. 8 No Action Alternative, Residential Farmer Scenario Post Remediation Risk from Tank Residuals at 2,500 Years from Present

Figure D.5.1. 9 No Action Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.1. 10 No Action Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals at 300 Years from Present

Figure D.5.1. 11 No Action Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals at 500 Years from Present

Note that the contour maps depicting risk (ILCR) to the recreational shoreline user include a contribution from C-14, I-129, Tc-99, and U-238 in surface water. A summary of the surface water contributions for the recreational shoreline user scenario is shown in Table D.5.1.2 for each alternative and time period. These contributions are quite small and in the case of the residential farmer scenario would be even smaller because the residential farmer scenario involves substantially less surface water activity. For this reason, surface water contributions for the residential farmer scenario are disregarded for this and all other TWRS alternatives. For the Native American scenario, surface water pathways are integrated into the groundwater pathways for all alternatives.

D.5.2 LONG-TERM MANAGEMENT ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the Long-Term Management alternative for tank waste. Post remediation for this alternative refers to the risk remaining after operation of the tank farms (i.e., institutional controls) is discontinued (assumed to be 100 years from 1995 for the purpose of this EIS). Over the 100-year period, the SSTs would continue to be stabilized and isolated to prevent liquid infiltration and the DSTs would undergo two tanking campaigns.

D.5.2.1 Source

Under the Long-Term Management alternative, the post-remediation source for SSTs would consist of the current SST farms. The source for the DSTs would consist of the current DST farms (containing 1 percent residual) and the replacement DST farms (containing the remaining 99 percent of the inventory) (WHC 1995g and Jacobs 1996). Additional discussion of source inventories is provided in Volume Four, Appendix F.

D.5.2.2 Transport

Post-remediation contaminant releases would be to the soil below the tanks. Contaminants released to the soil would migrate to groundwater in proportion to their ionic mobility. Groundwater modeling predicts that contaminants released from the tanks would be present in groundwater beneath the Hanford Site for all periods of interest (i.e. 300, 500, 2,000, 5,000, and 10,000 years from the present). Calculated groundwater contaminant concentrations and distributions are discussed in Volume Four, Appendix F.

To evaluate surface water exposures for the recreational shoreline user scenario, surface water concentrations resulting from groundwater discharge to the Columbia River were conservatively calculated using a dilution factor approach as described for the No Action alternative in Section D.5.1.2.

D.5.2.3 Exposure

Exposure for the Long-Term Management alternative was analyzed using the same URF methods and factors used for the No Action alternative (Section D.5.1.3). URFs are presented in Section D.2.1.3.

D.5.2.4 Risk

Risk for the Long-Term Management alternative is calculated using the same approach used for the No Action alternative (Section D.5.1.4). The risk calculation combines the risk contributed by the SSTs, original DSTs, and the replacement DST groups into a single risk value for each grid cell.

Contour maps depicting the risk from radionuclides and carcinogenic chemicals in tank waste are presented in Figures D.5.2.1 to D.5.2.5 for the Native American scenario, Figures D.5.2.6 to D.5.2. 9 for the residential farmer scenario , Figures D.5.2.10 to D.5.2. 13 for the industrial scenario , and Figures D.5.2.14 to D.5.2. 16 for the recreational shoreline user scenario. Contour maps depicting the HI from noncarcinogenic chemicals in tank waste are presented in Figures D.5.2.17 to D.5.2.19 for the Native American scenario, Figures D.5.2. 20 to D.5.2.22 for the residential farmer scenario, and Figure D.5.2. 23 for the industrial scenario. No HI maps are presented for the recreational shoreline user scenario because the maximum HI did not exceed 1.0.

Figure D.5.2.1 Long-Term Management Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 300 Years from Present

Figure D.5.2.2 Long-Term Management Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 500 Years from Present

Figure D.5.2.3 Long-Term Management Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 2,500 Years from Present

Figure D.5.2.4 Long-Term Management Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.2.5 Long-Term Management Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 10,000 Years from Present

D.5.3 IN SITU FILL AND CAP ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the In Situ Fill and Cap alternative. Implementing this alternative would involve leaving radioactive waste in the existing tanks. DST liquid would be pumped to the evaporator and the concentrated waste returned to the DST Farms. The tanks would then be filled with gravel and capped with Hanford Barriers (WHC 1995f and Jacobs 1996).

D.5.3.1 Source

Post-remediation contamination sources under this alternative would consist of the current tank inventory as described in Volume Four, Appendix F.

D.5.3.2 Transport

Transport for the In Situ Fill and Cap alternative was analyzed using the same approach used for the No Action alternative (Section D.5.1.2) except that under the In Situ Fill and Cap alternative a Hanford Barrier would be placed over the tanks to reduce the infiltration of precipitation. This barrier would slow the process of leaching contaminants from the waste.

Groundwater modeling predicts that contaminants released from the fill and cap residuals would not reach groundwater during the first 500 years. Point concentrations are therefore zero for all constituents for the 300- and 500-year periods. During the latter three periods of interest (i.e., 2,500, 5,000, and 10,000 years from the present), modeling predicts that contaminants released from the in situ fill and cap residuals would be present in groundwater. Predicated groundwater contaminant concentrations and distributions during each time period are discussed in Volume Four, Appendix F.

To evaluate surface water exposures for the recreational shoreline user scenario, surface water concentrations resulting from groundwater discharge to the Columbia River were conservatively calculated using a dilution factor approach as described for the No Action alternative in Section D.5.1.2.

D.5.3.3 Exposure

Exposure for the In Situ Fill and Cap alternative was analyzed using the same URF methods and factors as used for the No Action alternative (Section D.5.1.3). URFs are presented in Section D.2.1.3.

D.5.3.4 Risk

Risk for the In Situ Fill and Cap alternative was calculated using the same approach as used for the No Action alternative (Section D.5.1.4). Because all tank constituents are calculated to have groundwater concentrations of zero within all cells for the 300- and 500-year periods, no risk calculations were performed for those periods.

Contour maps depicting the risk from radionuclides and carcinogenic chemicals for the In Situ Fill and Cap alternative are presented in Figures D.5.3.1 and D.5.3.2 for the Native American scenario; Figures D.5.3. 3 and D.5.3.4 for the residential farmer scenario; Figures D.5.3.5 and D.5.3. 6 for the industrial worker scenario; and Figures D.5.3. 7 and D.5.3. 8 for the recreational shoreline user scenario. Contour maps depicting the HI from noncarcinogenic chemicals are presented in Figures D.5.3.9 and D.5.3.10 for the Native American scenario, and Figures D.5.3. 11 and D.5.3. 12 for the residential farmer scenario. No HI maps are presented for the industrial worker or recreational shoreline user scenario s because the maximum HI from noncarcinogenic chemicals does not exceed 1.0.

Figure D.5.3.1 In Situ Fill and Cap Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.3.2 In Situ Fill and Cap Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 10,000 Years from Present

Figure D.5.3. 3 In Situ Fill and Cap Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank

D.5.4 IN SITU VITRIFICATION ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the In Situ Vitrification alternative. This alternative would involve melting the tank waste and tanks into a glass monolith. Implementing this alternative would involve 1) sending all pumpable liquid from the DSTs to the evaporator for removing excess water; 2) constructing tank farm confinement facilities; 3) filling tank voids with Hanford Site sand; 4) vitrifying, using joule heating, to melt the tank waste and tanks in place into a single block of glass; and 5) installing Hanford Barriers over the vitrified site.

D.5.4.1 Source

Post-remediation contamination sources under the In Situ Vitrification alternative would consist of the current tank inventory (minus volatiles) but in a vitrified form that would release contaminants very slowly (WHC 1995f and Jacobs 1996). Additional discussion of contaminant source inventories is provided in Volume Four, Appendix F.

D.5.4.2 Transport

Post-remediation contaminant releases would be to the soil below the vitrified tanks. Contaminants released to the soil would migrate to groundwater in proportion to their ionic mobility. Groundwater modeling predicts that contaminants released from the vitrified tanks would not reach groundwater during the first 500 years. Point concentrations are therefore zero for all constituents for the first two periods of interest (i.e., 300 and 500 years from the present). During the latter three periods of interest (i.e., 2,500, 5,000, and 10,000 years from the present), modeling predicts that contaminants released would be present in groundwater. Predicated groundwater contaminant concentrations and distributions are discussed in Volume Four, Appendix F.

To evaluate surface water exposures for the recreational shoreline user scenario, surface water concentrations resulting from groundwater discharge to the Columbia River were conservatively calculated using a dilution factor approach as described for the No Action alternative in Section D.5.1.2.

D.5.4.3 Exposure

Exposure for the In Situ Vitrification alternative was analyzed using the same URF methods and factors used for the No Action alternative (Section D.5.1.3). URFs are presented in Section D.2.1.3.

D.5.4.4 Risk

The risk is calculated using the same approach used for the No Action alternative (Section D.5.1.4). Because all constituents in the vitrified tanks are calculated to have groundwater concentrations of zero within all cells for the 300- and 500-year periods, no risk calculations were performed for those periods.

Contour maps depicting the risk from radionuclides and carcinogenic chemicals in the vitrified tanks are presented in Figures D.5.4.1 and D.5.4.2 for the Native American scenario, Figures D.5.4.3 and D.5.4. 4 for the residential farmer scenario , and Figures D.5.4.5 and D.5.4.6 for the industrial worker scenario . The maximum risk (ILCR) from radionuclides and carcinogenic chemicals did not exceed 1.00E-06 for the recreational shoreline user scenario; therefore , no risk contour maps are presented. The maximum HI from noncarcinogenic chemicals did not exceed 1.0 for any scenario or time period; therefore, no maps are presented for the HI.

Figure D.5.4.1 In Situ Vitrification Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.4.2 In Situ Vitrification Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 10,000 Years from Present

Figure D.5.4. 3 In Situ Vitrification Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.4. 4 In Situ Vitrification Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals at 10,000 Years from Present

Figure D.5.4.5 In Situ Vitrification Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.4.6 In Situ Vitrification Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals at 10,000 Years from Present

D.5.5 EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the Ex Situ Intermediate Separations alternative. Implementing this alternative would involve retrieving tank waste, separating the HLW and LAW fractions, treating/immobilizing both fractions by converting them to glass, and disposing of the final glass waste forms. The vitrified LAW would be disposed of in onsite vaults. The vitrified HLW would be shipped to the proposed national HLW repository.

D.5.5.1 Source

Post-remediation contamination sources under the Ex Situ Intermediate Separations alternative would consist of tank residuals and the LAW disposal vaults. Tank waste retrieval efficiency is assumed to be 99 percent (WHC 1995f and Jacobs 1996). The contaminant inventory in tank residuals was therefore assumed to be 1 percent of the current inventory discussed in Volume Two, Appendix A. The LAW vaults would contain the contaminant inventory remaining in the LAW fractions following pretreatment and vitrification. Additional discussion of the inventory for the LAW vaults is presented in Volume Four, Appendix F.

D.5.5.2 Transport

Post-remediation contaminant releases were assumed to be to the soil below the tanks and the LAW vaults. Contaminants released to the soil would migrate to groundwater in proportion to their ionic mobility.

Groundwater modeling predicts that contaminants released from tank residuals would not reach groundwater during the first 500 years. Point concentrations are therefore zero for all constituents at periods of 300 and 500 years. During the latter three periods of interest (i.e., 2,500, 5,000, and 10,000 years from the present), modeling predicts that contaminants released from tank residuals would be present in groundwater beneath the Hanford Site.

Groundwater modeling predicts that contaminants leached from the LAW vaults would not reach groundwater during the first 2,500 years. Point concentrations are therefore zero for all constituents at periods of 300, 500, and 2,500 years. During the latter two periods of interest (i.e., 5,000 and 10,000 years from the present), modeling predicts that contaminants released from the LAW vaults would be present in groundwater beneath the Hanford Site. Calculated groundwater contaminant concentrations and distributions are discussed in Volume Four, Appendix F.

To evaluate surface water exposures for the recreational shoreline user scenario, surface water concentrations resulting from groundwater discharge to the Columbia River were conservatively calculated using a dilution factor approach, as described for the No Action alternative in Section D.5.1.2.

D.5.5.3 Exposure

Exposure for the Ex Situ Intermediate Separations alternative was analyzed using the same URF methods and factors used for the No Action alternative (Section D.5.1.3). URFs are presented in Section D.2.1.3.

D.5.5.4 Risk

Risk for the Ex Situ Intermediate Separations alternative is calculated using the same approach used for the No Action alternative (Section D.5.1.4). Risk calculations were performed separately for the tank residuals, LAW vaults, and residuals and vaults combined.

Contaminants released from tank residuals are calculated to have groundwater concentrations of zero in all cells at periods of 300 and 500 years from the present. Risk calculations were therefore performed only for periods 2,500, 5,000, and 10,000 years from the present. Contour maps depicting the risk from radionuclides and carcinogenic chemicals in tank residuals are presented in Figures D.5.5.1 and D.5.5.2 for the Native American scenario, Figures D.5.5. 3 and D.5.5.4 for the residential farmer scenario, Figures D.5.5. 5 and D.5.5. 6 for the industrial scenario, and Figure D.5.5. 7 for the recreational shoreline user scenario. Maps depicting the HI from noncarcinogenic chemicals in tank residuals are presented in Figures D.5.5.8 for the Native American scenario and Figure D.5.5. 9 for the residential farmer scenario. No HI maps are presented for the industrial or recreational shoreline user scenarios because the maximum HI did not exceed 1.0 for either scenario.

Figure D.5.5.1 Ex Situ Intermediate Separations Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 2,500 Years from Present

Figure D.5.5.2 Ex Situ Intermediate Separations Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.5. 3 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals at 2,500 Years from Present

Figure D.5.5. 4 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post Remediation Risk

Contaminants released from LAW vaults are calculated to have groundwater concentrations of zero in all cells at periods of 300, 500, and 2,500 years from the present. Risk calculations were therefore performed only for periods of 5,000 and 10,000 years from the present. Contour maps depicting the risk from radionuclides and carcinogenic chemicals in LAW vaults are presented in Figures D.5.5.10 and D.5.5.11 for the Native American scenario, Figures D.5.5. 12 and D.5.5.13 for the residential farmer scenario, and in Figure s D.5.5.14 and D.5.5.15 for the industrial scenario. No risk maps are presented for the recreational shoreline user scenario because the maximum risk (ILCR) from radionuclides and carcinogenic chemicals in LAW vaults did not exceed 1.00E-06. No HI maps are presented because the maximum HI from noncarcinogenic chemicals in the LAW vaults did not exceed 1.0 for any scenario.

Risk calculations for the combined tank residuals and LAW vaults were performed only for periods of 2,500, 5,000, and 10,000 years from the present (contaminants would not reach groundwater during the 300- and 500-year periods). Contour maps depicting the combined risk from radionuclides and carcinogenic chemicals in tank residuals and LAW vaults are presented in Figures D.5.5.16 to D.5.5.18 for the Native American scenario, Figures D.5.5. 19 to D.5.5.21 for the residential farmer scenario, Figures D.5.5. 22 to D.5.5. 24 for the industrial scenario, and Figure D.5.5. 25 for the recreational shoreline user scenario. Maps depicting the combined HI from noncarcinogenic chemicals in tank residuals and LAW vaults are presented in Figure D.5.5.26 for the Native American scenario and Figure D.5.5.27 for the residential farmer scenario. No HI maps are presented for the industrial scenario or recreational shoreline user scenario because the maximum combined HI did not exceed 1.0 for either scenario.

D.5.6 EX SITU NO SEPARATIONS ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the Ex Situ No Separations alternative. Under this alternative, tank waste would be retrieved and vitrified or calcined. The retrieved waste would not be separated into HLW and LAW waste streams. Waste from SSTs and DSTs would be blended as necessary and vitrified into a HLW glass or calcined and put into canisters. The HLW glass or the calcined waste would be shipped offsite to the proposed national HLW repository (WHC 1995c and Jacobs 1996).

D.5.6.1 Source

Post-remediation contamination sources under the Ex Situ No Separations alternative would consist of tank residuals. Since tank waste retrieval would be conducted in the same manner as for the Ex Situ Intermediate Separations alternative (i.e., 99 percent retrieval efficiency), the contaminant inventory in the tank residuals would be the same.

D.5.6.2 Transport

Because the contaminant inventory in tank residuals was the same as for the Ex Situ Intermediate Separations alternative, a separate groundwater transport modeling analysis was not required. Modeling results for the Ex Situ No Separations alternative would be the same as the results for the tank residuals for the Ex Situ Intermediate Separations alternative (Section D.5.5.2).

D.5.6.3 Exposure

Because the contaminant inventory in the tank residuals would be the same as for the Ex Situ Intermediate Separations alternative, exposures would be the same.

D.5.6.4 Risk

Risk and HI contours for the tank residuals in the Ex Situ No Separations alternative would be the same as for the tank residuals in the Ex Situ Intermediate Separations alternative (Section D.5.5.4, Figures D.5.5.1 to D.5.5.9).

D.5.7 EX SITU EXTENSIVE SEPARATIONS ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the Ex Situ Extensive Separations alternative. This alternative would involve implementing the same basic operations described for the Ex Situ Intermediate Separations alternative but would involve conducting a more complex waste separation operation. Fifteen processing systems (12 more than for the Ex Situ Intermediate Separations alternative) would be used to reduce the volume of HLW and to reduce the amount of radioactive contaminants in the LAW (WHC 1995e and Jacobs 1996).

D.5.7.1 Source

Post-remediation contamination sources under the Ex Situ Separations alternative would consist of tank residuals and LAW vaults. Because tank waste retrieval would be conducted in the same manner as for the Ex Situ Intermediate Separations alternative (i.e., 99 percent retrieval efficiency), the contaminant inventory in the tank residuals would be the same. As in the Ex Situ Intermediate Separations alternative, the LAW vaults would contain the contaminant inventory remaining in the LAW following separation and treatment. Additional discussion of the inventory for the LAW vaults is presented in Volume Four, Appendix F.

D.5.7.2 Transport

Because the contaminant inventory in tank residuals would be the same as for the Ex Situ Intermediate Separations alternative, a separate groundwater transport modeling analysis was not required. Modeling results for tank residuals for the Ex Situ Intermediate Separations alternative (Section D.5.5.2) apply to the Ex Situ Extensive Separations alternative as well.

Groundwater modeling predicts that contaminants leached from the LAW vaults would not reach groundwater during the first 2,500 years. Point concentrations are therefore zero for all constituents at periods of 300, 500, and 2,500 years. During the latter two periods of interest (i.e., 5,000 and 10,000 years from the present), modeling predicts that contaminants released from the LAW vaults would be present in groundwater beneath the Hanford Site. Calculated groundwater contaminant concentrations and distributions are discussed in Volume Four, Appendix F.

To evaluate surface water exposures for the recreational shoreline user scenario, surface water concentrations resulting from groundwater discharge to the Columbia River were conservatively calculated using a dilution factor approach as described for the No Action alternative in Section D.5.1.2.

D.5.7.3 Exposure

Because the contaminant inventory in tank residuals would be the same as for the Ex Situ Intermediate Separations Alternative, exposure would be the same. Exposures for the LAW vaults were analyzed using the same URF methods and factors used for the No Action alternative (Section D.5.1.3). URFs are presented in Section D.2.1.3.

D.5.7.4 Risk

As in the Ex Situ Intermediate Separations alternative, risk calculations were performed separately for tank residuals, LAW vaults, and residuals and vaults combined.

Risk for the tank residuals in the Ex Situ Extensive Separations alternative would be the same as for the tank residuals in the Ex Situ Intermediate Separations alternative (Section D.5.5.4, Figure D.5.5.1 to D.5.5.9).

Because constituents released from LAW vaults would not reach groundwater for 2,500 years, risk calculations were performed only for periods of 5,000 and 10,000 years. Contour maps depicting the risk from radionuclides and carcinogenic chemicals in LAW vaults are presented in Figures D.5.7.1 and D.5.7.2 for the Native American scenario , Figures D.5.7.3 and D.5.7.4 for the residential farmer scenario , and Figure D.5.7.5 for the industrial scenario. No risk maps are presented for the recreational shoreline user scenario because the maximum risk (ILCR) from radionuclides and carcinogenic chemicals in LAW vaults did not exceed 1.00E-06. No HI maps are presented because the maximum HI from noncarcinogenic chemicals in LAW vaults did not exceed 1.0 for any scenario.

Figure D.5.7.1 Ex Situ Extensive Separations Alternative, Native American Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.7.2 Ex Situ Extensive Separations Alternative, Native American Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Figure D.5.7.3 Ex Situ Extensive Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.7.4 Ex Situ Extensive Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Figure D.5.7.5 Ex Situ Extensive Separations Alternative, Industrial Worker Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Although the risk for tank residuals would be the same as for the Ex Situ Intermediate Separations alternative, the risk for LAW vaults would be different; therefore, the combined risk from residuals and vaults would be different. Risk calculations for the combined tank residuals and LAW vaults were performed only for periods of 2,500, 5,000, and 10,000 years from the present (contaminants would not reach groundwater during the 300- and 500-year periods). Contour maps depicting the combined risk from radionuclides and carcinogenic chemicals in tank residuals and LAW vaults are presented in Figures D.5.7.6 and D.5.7.7 for the Native American scenario, Figures D.5.7. 8 and D.5.7.9 for the residential farmer scenario, Figures D.5.7. 10 and D.5.7. 11 for the industrial scenario, and Figure D.5.7. 12 for the recreational shoreline user scenario. Map s depicting the combined HI from noncarcinogenic chemicals in tank residual s and LAW vaults are presented in Figure D.5.7.13 for the Native American scenario and Figure D.5.7.14 for the residential farmer scenario . No HI maps are presented for the industrial or recreational shoreline user scenarios because the maximum combined HI did not exceed 1.0 for either scenario.

Figure D.5.7.6 Ex Situ Extensive Separations Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.7.7 Ex Situ Extensive Separations Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.7. 8 Ex Situ Extensive Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.7. 9 Ex Situ Extensive Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

D.5.8 EX SITU/IN SITU COMBINATION 1 ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the Ex Situ/In Situ Combination 1 alternative for tank waste. This alternative would involve a combination of the Ex Situ Intermediate Separations alternative (Section D.5.5) and the In Situ Fill and Cap alternative (Section D.5.3). Tanks with the highest content of mobile constituents of concern (i.e., uranium isotopes, Tc-99, I-129, and C-14) would be remediated in accordance with the Ex Situ Intermediate Separations alternative. Tanks with a low content of these constituents would be remediated in accordance with the In Situ Fill and Cap alternative.

This EIS examines a tank selection process based on recovering 90 percent of the constituents that contribute to post-remediation risk. Implementing this process would remove approximately 50 percent of the tank waste by volume and result in ex situ remediation of approximately 70 of the 177 tanks; the remaining tanks (approximately 107) would be remediated as described under the In Situ Fill and Cap alternative. Further details of the tank selection process are provided in Volume Two, Appendix B.

D.5.8.1 Source

For the ex situ portion of this alternative, post-remediation contamination sources would be the same type but of lesser quantity than those described in Section D.5.5.1 for the Ex Situ Intermediate Separations alternative (i.e., tank residuals and LAW disposal vaults). For the in situ portion, post- remediation sources would be the same type but of lesser quantity than those described in Section D.5.3.1 for the In Situ Fill and Cap alternative (i.e., tank residuals). Additional discussion of contaminant source inventories is provided in Volume Four, Appendix F.

D.5.8.2 Transport

Post-remediation contaminant releases would be to the soil below the tanks and LAW vaults. Contaminants released to the soil would migrate to groundwater in proportion to their ionic mobility.

Groundwater modeling predicts that contaminants released from the tank residuals (both ex situ and in situ) would not reach groundwater during the first 500 years. Point concentrations are therefore zero for all constituents at periods of 300 and 500 years. During the latter three periods of interest (i.e., 2,500, 5,000, and 10,000 years from the present) modeling predicts that contaminants released from tank residuals would be present in groundwater beneath the Hanford Site.

Groundwater modeling predicts that contaminants leached from the LAW vaults would not reach groundwater during the first 2,500 years. Point concentrations are therefore zero for all constituents at periods of 300, 500, and 2,500 years. During the latter two periods of interest (i.e., 5,000 and 10,000 years from the present), modeling predicts that contaminants released from the LAW vaults would be present in groundwater beneath the Hanford Site. Calculated groundwater contaminant concentrations and distributions are discussed in Volume Four, Appendix F.

To evaluate surface water exposures for the recreational shoreline user scenario, surface water concentrations resulting from groundwater discharge to the Columbia River were conservatively calculated using a dilution factor approach as described for the No Action alternative in Section D.5.1.2.

D.5.8.3 Exposure

Exposures for the Ex Situ/In Situ Combination 1 alternative were analyzed using the same URF methods and factors as used for the No Action alternative (Section D.5.1.3). URFs are presented in Section D.2.1.3.

D.5.8.4 Risk

Risk for the Ex Situ/In Situ Combination 1 alternative is calculated using the same approach used for the No Action alternative (Section D.5.1.4). Risk calculations were performed separately for the tank residuals (both ex situ and in situ), LAW vaults, and residuals and vaults combined.

Contaminants released from the ex situ tank residuals are calculated to have groundwater concentrations of zero in all cells at periods of 300 and 500 years from the present. Risk calculations were therefore performed only for periods of 2,500, 5,000, and 10,000 years from the present. Contour maps depicting risk from radionuclides and carcinogenic chemicals in ex situ residuals are presented in Figures D.5.8.1 and D.5.8.2 for the Native American scenario, Figures D.5.8. 3 and D.5.8.4 for the residential farmer scenario, and Figures D.5.8. 5 and D.5.8. 6 for the industrial scenario. No risk maps are presented for the recreational shoreline user scenario because the maximum risk (ILCR) did not exceed 1.00E-06. A map depicting the HI from noncarcinogenic chemicals in ex situ tank residuals is presented in Figure D.5.8. 7 for the Native American scenario. No HI maps are presented for the residential farmer, industrial, or recreational shoreline user scenarios because the maximum HI did not exceed 1.0 for these scenario s .

Figure D.5.8.1 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 2,500 Years from Present

Figure D.5.8.2 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8. 3 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 2,500 Years from Present

Figure D.5.8. 4 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8. 5 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 2,500 Years from Present

Figure D.5.8. 6 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8.7 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Hazard Index from Ex Situ Tank Residuals at 5,000 Years from Present

Contaminants released from the in situ tank residuals are calculated to have groundwater concentrations of zero in all cells at periods of 300 and 500 years from the present. Risk calculations were therefore performed only for periods of 2,500, 5,000, and 10,000 years from the present. Contour maps depicting the risk from radionuclides and carcinogenic chemicals in the in situ tank residuals are presented in Figures D.5.8.8 and D.5.8.9 for the Native American scenario, Figures D.5.8. 10 and D.5.8. 11 for the residential farmer scenario, Figures D.5.8. 12 and D.5.8. 13 for the industrial scenario, and Figures D.5.8. 14 and D.5.8. 15 for the recreational shoreline user scenario. Maps depicting the HI from noncarcinogenic chemicals in the in situ tank residuals are presented in Figures D.5.8.16 and D.5.8.17 for the Native American scenario and Figures D.5.8.18 and D.5.8. 19 for the residential farmer scenario. No HI maps are presented for the industrial or recreational shoreline user scenarios because the maximum HI did not exceed 1.0 for either scenario.

Figure D.5.8.8 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8.9 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.8. 10 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8. 11 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.8. 12 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8. 13 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.8. 14 Ex Situ/In Situ Combination 1 Alternative, Recreational River User Scenario, Post Remediation Risk from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8. 15 Ex Situ/In Situ Combination 1 Alternative, Recreational River User Scenario, Post Remediation Risk from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.8.16 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Hazard Index from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8.17 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Hazard Index from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.8. 18 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Hazard Index from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.8. 19 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Hazard Index from In Situ Tank Residuals at 10,000 Years from Present

Contaminants released from LAW vaults are calculated to have groundwater concentrations of zero in all cells at periods of 300, 500, and 2,500 years from the present. Risk calculations were therefore performed only for periods of 5,000 and 10,000 years from the present. Contour maps depicting the risk from radionuclides and carcinogenic chemicals in LAW vaults are presented in Figures D.5.8.20 and D.5.8.21 for the Native American scenario, Figures D.5.8. 22 and D.5.8.23 for the residential farmer scenario, and Figures D.5.8.24 and D.5.8.25 for the industrial scenario . No risk maps are presented for the recreational shoreline user scenario because the maximum risk (ILCR) did not exceed 1.00E-06. No HI maps are presented because the maximum HI from noncarcinogenic chemicals in the LAW vaults did not exceed 1.0 for any scenario.

Figure D.5.8.20 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.8.21 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Figure D.5.8. 22 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.8. 23 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Figure D.5.8.24 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.8.25 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Risk calculations for the tank residuals (ex situ and in situ) in combination with the LAW vaults were performed only for periods of 2,500, 5,000, and 10,000 years from the present (contaminants would not reach groundwater during the 300- and 500-year periods). Contour maps depicting the combined risk from radionuclides and carcinogenic chemicals in tank residuals (ex situ and in situ) and LAW vaults are presented in Figures D.5.8.26 to D.5.8.28 for the Native American scenario, Figures D.5.8.29 to D.5.8. 31 for the residential farmer scenario, Figures D.5.8. 32 to D.5.8. 34 for the industrial scenario, and Figures D.5.8. 35 and D.5.8. 36 for the recreational shoreline user scenario. Maps depicting the combined HI from noncarcinogenic chemicals in tank residuals (ex situ and in situ) and LAW vaults are presented in Figures D.5.8.37 and D.5.8.38 for the Native American scenario and Figures D.5.8. 39 and D.5.8. 40 for the residential farmer scenario. No HI maps are presented for the industrial or recreational shoreline user scenarios because the maximum combined HI did not exceed 1.0 for either scenario.

Figure D.5.8.26 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.8.27 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.8.28 Ex Situ/In Situ Combination 1 Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.8. 29 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.8. 30 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.8. 31 Ex Situ/In Situ Combination 1 Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.8. 32 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.8. 33 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.8. 34 Ex Situ/In Situ Combination 1 Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.8. 35 Ex Situ/In Situ Combination 1 Alternative, Recreational River User Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.8. 36 Ex Situ/In Situ Combination 1 Alternative, Recreational River User Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

D.5.9 EX SITU/IN SITU COMBINATION 2 ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the Ex Situ/In Situ Combination 2 alternative for tank waste. This variation of the Ex Situ/In Situ Combination 1 alternative would use modified tank selection criteria to provide for ex situ treatment of the largest contributors to long-term risk (i.e., uranium isotopes, Tc-99, I-129, and C-14) while limiting the volume of waste to be processed. Under this variation, approximately 25 tanks instead of 70 tanks would be remediated as described for the Ex Situ Intermediate Separations alternative, while the remaining tanks would be remediated as described for the In Situ Fill and Cap alternative. Further details of the tank selection process are provided in Volume Two, Appendix B.

D.5.9.1 Source

Post-remediation contamination sources for the ex situ portion of this alternative would be of the same type as those described for the Ex Situ/In Situ Combination 1 alternative (i.e., tank residuals and LAW vaults). However, under this alternative these sources would contain less contamination because less waste would be retrieved. Post-remediation sources for the in situ portion of this alternative would also be of the same type as those described for the Ex Situ/In Situ Combination 1 alternative (i.e., tank residuals). However, under this alternative these sources would contain more contamination because more waste would be left in place.

D.5.9.2 Transport

Post-remediation contamination releases would be to the soil below the tanks and LAW vaults. Contaminants released to the soil would migrate to groundwater in proportion to their ionic mobility.

Groundwater modeling calculates that contaminants released from the tank residuals (both ex situ and in situ) would not reach groundwater during the first 500 years. Point concentrations are therefore zero for all constituents at periods of 300 and 500 years. During the latter three periods of interest (i.e., 2,500, 5,000, and 10,000 years from the present), modeling calculates that contaminants released from tank residuals would be present in groundwater beneath the Hanford Site.

Groundwater modeling calculates that contaminants leached from the LAW vaults would not reach groundwater during the first 2,500 years. Point concentrations are therefore zero for all constituents at periods of 300, 500, and 2,500 years. During the latter two periods of interest (i.e., 5,000 and 10,000 years from the present), modeling calculates that contaminants released from the LAW vaults would be present in groundwater beneath the Hanford Site. Calculated groundwater contaminant concentrations and distributions are discussed in Volume Four, Appendix F.

To evaluate surface water exposures for the recreational shoreline user scenario, surface water concentrations resulting from groundwater discharge to the Columbia River were conservatively calculated using a dilution factor approach as described for the No Action alternative in Section D.5.1.2.

D.5.9.3 Exposure

Exposures for the Ex Situ/In Situ Combination 2 alternative were analyzed using the same URF methods and factors as used for the No Action alternative (Section D.5.1.3). URFs are presented in Section D.2.1.3.

D.5.9.4 Risk

Risk for the Ex Situ/In Situ Combination 2 alternative is calculated using the same approach used for the No Action alternative (Section D.5.1.4). Risk calculations were performed separately for the tank residuals (both ex situ and in situ), LAW vaults, and residuals and vaults combined.

Contaminants released from the ex situ tank residuals are calculated to have groundwater concentrations of zero in all cells at periods of 300 and 500 years from the present. Risk calculations were therefore performed only for periods of 2,500, 5,000, and 10,000 years from the present. Contour maps depicting risk from radionuclides and carcinogenic chemicals in ex situ residuals are presented in Figures D.5.9.1 and D.5.9.2 for the Native American scenario, Figures D.5.9.3 and D.5.9.4 for the residential farmer scenario, and Figure D.5.9.5 for the industrial scenario. No risk maps are presented for the recreational shoreline user scenario because the maximum risk (ILCR) did not exceed 1.00E-06. No HI maps are presented because the maximum HI did not exceed 1.0 for any scenario.

Figure D.5.9.1 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 2,500 Years from Present

Figure D.5.9.2 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 5,000 Years from Present

Figure D.5.9.3 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 2,500 Years from Present

Figure D.5.9.4 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 5,000 Years from Present

Figure D.5.9.5 Ex Situ/In Situ Combination 2 Alternative, Industrial Worker Scenario, Post Remediation Risk from Ex Situ Tank Residuals at 5,000 Years from Present

Contaminants released from the in situ tank residuals are calculated to have groundwater concentrations of zero in all cells at periods of 300 and 500 years from the present. Risk calculations were therefore performed only for periods of 2,500, 5,000, and 10,000 years from the present. Contour maps depicting risk from radionuclides and carcinogenic chemicals in the in situ residuals are presented in Figures D.5.9.6 and D.5.9.7 for the Native American scenario, Figures D.5.9.8 and D.5.9.9 for the residential farmer scenario, Figures D.5.9.10 and D.5.9.11 for the industrial scenario, and Figures D.5.9.12 and D.5.9.13 for the recreational shoreline user scenario. Maps depicting the HI from noncarcinogenic chemicals in the in situ tank residuals are presented in Figures D.5.9.14 and D.5.9.15 for the Native American scenario and Figures D.5.9.16 and D.5.9.17 for the residential farmer scenario. No HI maps are presented for the industrial or recreational shoreline user scenarios because the maximum HI did not exceed 1.0 for either scenario.

Figure D.5.9.6 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.9.7 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.9.8 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.9.9 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.9.10 Ex Situ/In Situ Combination 2 Alternative, Industrial Worker Scenario, Post Remediation Risk from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.9.11 Ex Situ/In Situ Combination 2 Alternative, Industrial Worker Scenario, Post Remediation Risk from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.9.12 Ex Situ/In Situ Combination 2 Alternative, Recreational River User Scenario, Post Remediation Risk from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.9.13 Ex Situ/In Situ Combination 2 Alternative, Recreational River User Scenario, Post Remediation Risk from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.9.14 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Hazard Index from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.9.15 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Hazard Index from In Situ Tank Residuals at 10,000 Years from Present

Figure D.5.9.16 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Hazard Index from In Situ Tank Residuals at 5,000 Years from Present

Figure D.5.9.17 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Hazard Index from In Situ Tank Residuals at 10,000 Years from Present

Contaminants released from the LAW vaults are calculated to have groundwater concentrations of zero in all cells at periods of 300, 500, and 2,500 years from the present. Risk calculations were therefore performed only for periods of 5,000 and 10,000 years from the present. Contour maps depicting risk from radionuclides and carcinogenic chemicals in LAW vaults are presented in Figures D.5.9.18 and D.5.9.19 for the Native American scenario, Figures D.5.9.20 and D.5.9.21 for the residential farmer scenario, and Figures D.5.9.22 and D.5.9.23 for the industrial scenario. No risk maps are presented for the recreational shoreline user scenarios because the maximum risk (ILCR) did not exceed 1.00E-06. No HI maps are presented because the maximum HI from noncarcinogenic chemicals in the LAW vaults did not exceed 1.0 for any scenario.

Figure D.5.9.18 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.9.19 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Figure D.5.9.20 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.9.21 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Figure D.5.9.22 Ex Situ/In Situ Combination 2 Alternative, Industrial Worker Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.9.23 Ex Situ/In Situ Combination 2 Alternative, Industrial Worker Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Risk calculations for the tank residuals (ex situ and in situ) in combination with the LAW vaults were performed only for periods of 2,500, 5,000, and 10,000 years from the present (contaminants would not reach groundwater during the 300- and 500-year periods). Contour maps depicting the combined risk from radionuclides and carcinogenic chemicals in tank residuals (ex situ and in situ) and LAW vaults are presented in Figures D.5.9.24 to D.5.9.26 for the Native

American scenario, Figures D.5.9.27 to D.5.9.29 for the residential farmer scenario, Figures D.5.9.30 and D.5.9.31 for the industrial scenario, and Figures D.5.9.32 and D.5.9.33 for the recreational shoreline user scenario. Maps depicting the combined HI from noncarcinogenic chemicals in tank residuals (ex situ and in situ) and LAW vaults are presented in Figures D.5.9.34 and D.5.9.35 for the Native American scenario and Figures D.5.9.36 and D.5.9.37 for the residential farmer scenario. No HI maps are presented for the industrial or recreational shoreline user scenarios because the maximum HI did not exceed 1.0 for either scenario.

Figure D.5.9.24 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.9.25 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.9.26 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.9.27 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.9.28 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.9.29 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.9.30 Ex Situ/In Situ Combination 2 Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.9.31 Ex Situ/In Situ Combination 2 Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.9.32 Ex Situ/In Situ Combination 2 Alternative, Recreational River User Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.9.33 Ex Situ/In Situ Combination 2 Alternative, Recreational River User Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.9.34 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Hazard Index from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.9.35 Ex Situ/In Situ Combination 2 Alternative, Native American Scenario, Post Remediation Hazard Index from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.9.36 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Hazard Index from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.9.37 Ex Situ/In Situ Combination 2 Alternative, Residential Farmer Scenario, Post Remediation Hazard Index from Tank Residuals & LAW Vaults at 10,000 Years from Present

D.5. 10 PHASED IMPLEMENTATION ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the Total alternative. Implementing this alternative would involve retrieving tank waste, separating the HLW and LAW fractions, treating/immobilizing both fractions by converting them to glass, and disposing of the final glass waste forms. The vitrified LAW would be disposed of in onsite vaults. The vitrified HLW would be shipped to the proposed national HLW repository.

D.5. 10 .1 Source

Post-remediation contamination sources under the Total alternative would consist of tank residual s and the LAW disposal vaults. Tank waste retrieval efficiency is assumed to be 99 percent (WHC 1995f and Jacobs 1996). The contaminant inventory in tank residuals was therefore assumed to be 1 percent of the current inventory discussed in Volume Two, Appendix A. The LAW vaults would contain the contaminant inventory remaining in the LAW fractions following pretreatment and vitrification. Additional discussion of the inventory for the LAW vaults is presented in Appendix F.

D.5. 10 .2 Transport

Post-remediation contaminant releases were assumed to be to the soil below the tanks and the LAW vaults. Contaminants released to the soil would migrate to groundwater in proportion to their ionic mobility.

Groundwater modeling predicts that contaminants released from tank residuals would not reach groundwater during the first 500 years. Point concentrations are therefore zero for all constituents at periods of 300 and 500 years. During the latter three periods of interest (i.e., 2,500, 5,000, and 10,000 years from the present), modeling predicts that contaminants released from tank residuals would be present in groundwater beneath the Hanford Site.

Groundwater modeling predicts that contaminants leached from the LAW vaults would not reach groundwater during the first 2,500 years. Point concentrations are therefore zero for all constituents at periods of 300, 500, and 2,500 years. During the latter two periods of interest (i.e., 5,000 and 10,000 years from the present), modeling predicts that contaminants released from the LAW vaults would be present in groundwater beneath the Hanford Site.

D.5. 10 .3 Exposure

Exposure for the Total alternative was analyzed using the same URF methods and factors used for the No Action alternative (Section D.5.1.3). URFs are presented in Section D.2.1.3.

D.5. 10 .4 Risk

Risk for the Total alternative is calculated using the same approach used for the No Action alternative (Section D.5.1.4). Risk calculations were performed separately for the tank residuals, LAW vaults , and residuals and vaults combined.

Contaminants released from tank residuals are calculated to have groundwater concentrations of zero in all cells at periods of 300 and 500 years from the present. Risk calculations were therefore performed only for periods 2,500, 5,000, and 10,000 years from the present. Contour maps depicting the risk from radionuclides and carcinogenic chemicals in tank residuals are presented in Figures D.5.10.1 and D.5.10.2 for the Native American scenario, Figures D.5. 10.3 and D.5.10.4 for the residential farmer scenario, Figures D.5. 10.5 and D.5. 10.6 for the industrial scenario, and Figure D.5. 10.7 for the recreational shoreline user scenario. M aps depicting the HI from noncarcinogenic chemicals in tank residuals are presented in Figure D.5.10.8 for the Native American scenario and Figure D.5. 10.9 for the residential farmer scenario. No HI maps are presented for the industrial or recreational shoreline user scenario because the maximum HI did not exceed 1.0 for either scenario.

Figure D.5.10.1 Phased Implementation Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 2,500 Years from Present

Figure D.5.10.2 Phased Implementation Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.10.3 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Risk from

Tank Residuals at 2,500 Years from Present

Figure D.5.10.4 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.10.5 Phased Implementation Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals at 2,500 Years from Present

Figure D.5.10.6 Phased Implementation Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.10.7 Phased Implementation Alternative, Recreational River User Scenario, Post Remediation Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.10.8 Phased Implementation Alternative, Native American Scenario, Post Remediation Hazard Index Risk from Tank Residuals at 5,000 Years from Present

Figure D.5.10.9 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Hazard Index Risk from Tank Residuals at 5,000 Years from Present

Contaminants released from LAW vaults are calculated to have groundwater concentrations of zero in all cells at periods of 300, 500, and 2,500 years from the present. Risk calculations were therefore performed only for periods of 5,000 and 10,000 years from the present. Contour maps depicting the risk from radionuclides and carcinogenic chemicals in LAW vaults are presented in Figures D.5.10.10 and D.5.10.11 for the Native American scenario, Figures D.5. 10.12 and D.5.10.13 for the residential farmer scenario, and Figure s D.5.10.14 and D.5.10.15 for the industrial scenario. No risk maps are presented for the recreational shoreline user scenario because the maximum risk (ILCR) from radionuclides and carcinogenic chemicals in LAW vaults did not exceed 1.00E-06. No HI maps are presented because the maximum HI from noncarcinogenic chemicals in the LAW vaults did not exceed 1.0 for any scenario.

Figure D.5.10.10 Phased Implementation Alternative, Native American Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.10.11 Phased Implementation Alternative, Native American Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Figure D.5.10.12 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.10.13 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Figure D.5.10.14 Phased Implementation Alternative, Industrial Worker Scenario, Post Remediation Risk from LAW Vaults at 5,000 Years from Present

Figure D.5.10.15 Phased Implementation Alternative, Industrial Worker Scenario, Post Remediation Risk from LAW Vaults at 10,000 Years from Present

Risk calculations for the combined tank residuals and LAW vaults were performed only for periods of 2,500, 5,000, and 10,000 years from the present (contaminants would not reach groundwater during the 300- and 500-years periods). Contour maps depicting the combined risk from radionuclides and carcinogenic chemicals in tanks residuals and LAW vaults are presented in Figures D.5.10.16 to D.5.10.18 for the Native American scenario, Figures D.5. 10.19 to D.5.10.21 for the residential farmer scenario, Figures D.5. 10.22 to D.5. 10.24 for the industrial scenario, and Figure D.5. 10.25 for the recreational shoreline user scenario. M aps depicting the combined HI from noncarcinogenic chemicals in tank residuals and LAW vaults are presented in Figure D.5.10.26 for the Native American scenario and Figure D.5. 10.27 for the residential farmer scenario. No HI maps are presented for the industrial scenario or recreational shoreline user because the maximum combined HI did not exceed 1.0 for either scenario.

Figure D.5.10.16 Phased Implementation Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.10.17 Phased Implementation Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.10.18 Phased Implementation Alternative, Native American Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.10.19 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.10.20 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.10.21 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.10.22 Phased Implementation Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 2,500 Years from Present

Figure D.5.10.23 Phased Implementation Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.10.24 Phased Implementation Alternative, Industrial Worker Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 10,000 Years from Present

Figure D.5.10.25 Phased Implementation Alternative, Recreational River User Scenario, Post Remediation Risk from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.10.26 Phased Implementation Alternative, Native American Scenario, Post Remediation Hazard Index from Tank Residuals & LAW Vaults at 5,000 Years from Present

Figure D.5.10.27 Phased Implementation Alternative, Residential Farmer Scenario, Post Remediation Hazard Index from Tank Residuals & LAW Vaults at 5,000 Years from Present

D.5. 11 NO ACTION ALTERNATIVE (CAPSULES)

Post-remediation is not included in this alternative. This alternative does not remediate the waste. After 10 years, a remediation decision would be made (Jacobs 1996).

D.5. 12 CAPSULES ONSITE DISPOSAL ALTERNATIVE

This section presents the anticipated post-remediation risk associated with the Onsite Disposal alternative for the capsules. Implementing this alternative would involve retrieving capsules from WESF, placing capsules in Overpack canisters, and transferring the canisters to an onsite drywell disposal facility where they would be stored indefinitely (WHC 1995h and Jacobs 1996).

D.5. 12 .1 Source

The inventory of cesium and strontium in drywell disposal would be the same as the cesium and strontium inventory given in Section D.2.1.1.2.

D.5. 12 .2 Transport

The radioisotopes Cs-137 and Sr-90 (half lives of 30.2 and 28.6 years, respectively) will eventually decay to their stable progeny (Ba-137 and Zr-90, respectively). Groundwater transport modeling for tank waste indicates that neither Cs-137, Sr-90, nor their progeny would reach groundwater before 1,200 years (Volume Four, Appendix F), and the Cs-137 and Sr-90 would have nearly completely decayed to their stable progeny products within this time period. Therefore, only minute quantities of Cs-137 and Sr-90 would reach the groundwater.

The Cs-137 and Sr-90 daughter products (elements Ba-137 and Zr-90) are not carcinogenic, but are known to cause toxic effects at intakes greater than their respective reference doses. A rigorous groundwater transport analysis would only be needed if the estimated concentration of these stable daughters in groundwater resulted in intakes that exceed the reference doses within the 10,000-year period of interest. The following calculations show that intakes based on estimated future aquifer concentrations would be at least one order of magnitude below the reference doses. In this calculation, it was conservatively assumed that the mass of the stable daughters in the aquifer would be equal to the current mass of the parent radionuclides.

Cs-137 Case

Data

Current Cs-137 inventory	=	5.30E+07 Ci
Cs-137 specific activity	=	8.70E+01 Ci/g
Standard human weight	=	70 kg
Standard human consumption	=	2 L/day
	=	2,000 cm^3/day
Aquifer volume	=	1,000 m · 1,000 m · 10 m
		1.00E+07 m^3
		1.00E+13 cm^3 (assumed)

Calculation

Total mass of Ba-137	=	5.30E+07 Ci ÷ 8.7E+01 Ci/g
	=	6.10E+05 g
Ba-137 concentration in aquifer	=	6.10E+05 g ÷ 1.0E+13 cm^3
	=	6.10E-08 g/cm^3
Intake for standard human	=	2.00E+03 cm^3/day · 6.1E-08 g/cm^3 ÷ 70 kg
	=	1.80E-06 g/kg/day
	=	1.80E-03 mg/kg/day

Conclusion

The reference dose for Ba-137 ingestion from HEAST (EPA 1993) is 3.50E-02 mg/kg/day. Comparing the calculated intake to the reference dose indicates that there would be no expected toxic effects from Ba-137 (i.e., 1.80E-03 mg/kg/day is less than 3.50E-02 mg/kg/day).

Sr-90 Case

Data

Current Sr-90 inventory	=	2.30E+07 Ci
Sr-90 specific activity	=	1.40E+02 Ci/g
Standard human weight	=	70 kg
Standard human consumption	=	2 L/day
	=	2,000 cm^3/day
Aquifer volume	=	1,000 m · 1,000 m · 10 m
		1.00E+07 m^3
		1.00E+13 cm^3 (assumed)

Calculation

Total mass of Z r-90	=	2.30E+07 Ci ÷ 1.4E+02 Ci/g
	=	1.70E+05 grams
Z r-90 concentration in aquifer	=	1.70E+05 grams ÷ 1.0E+13 cm^3
	=	1.70E-08 g/cm^3
Intake for standard human	=	2.00E+03 cm^3/day · 1.7E-08 g/cm^3 ÷ 70 kg
	=	4.80E-07 g/kg/day
	=	4.80E-04 mg/kg/day

Conclusion

The reference dose for Zr-90 ingestion from HEAST (EPA 1993) is 7.00E-02 mg/kg/day. Comparing the calculated intake to the reference dose indicates that there would be no expected toxic effects from Z r-90 (i.e., 4.80E-04 mg/kg/day is less than 7.00E-02 mg/kg/day).

Because there would be no exposure under this alternative, there would be no anticipated risk associated with the Cs and Sr capsules under the Onsite Disposal alternative.

D.5. 13 OVERPACK AND SHIP ALTERNATIVE

Implementing this alternative would involve retrieving capsules from WESF, placing capsules in overpack canisters, and transporting the canisters offsite for disposal in a geologic repository (WHC 1995b and Jacobs 1996). Because all the capsules would be removed from the Hanford Site, there would be no post-remediation risk.

D.5. 14 CAPSULES VITRIFY WITH TANK WASTE ALTERNATIVE

Implementing this alternative would involve 1) retrieving capsules from WESF; 2) decladding the capsules and removing their contents; 3) combining the cesium and strontium with HLW from the SSTs and DSTs; 4) vitrifying the HLW into a glass; 5) placing the HLW glass into onsite interim storage; and 6) transporting the HLW glass offsite for disposal in a geologic repository (WHC 1995h and Jacobs 1996). Because all the capsule contents would be removed from the Hanford Site as part of the HLW glass , there would be no post-remediation risk.

D.5. 15 TOTAL HEALTH IMPACTS

D.5. 15 .1 Total Health Impacts for Hanford Site Users

This section discusses the calculation of the total or integrated post-remediation risk over the 10,000-year period of interest. This risk has been calculated for each alternative and for four types of receptors: the Native American, the residential farmer, the industrial worker, and the recreational shoreline user. The exposure scenarios are described in Section D.2.1.3 and assume a hypothetical post-remediation use scenario under which onsite controls are not maintained.

The total risk is expressed as the total cancer incidence and cancer fatalities over the 10,000-year period for each receptor group. It is calculated by multiplying the ILCR for each receptor group (as presented in Figures D.5.1.1 through D.5. 10.27) by the population for that group. Note that the risk contours shown in Figures D.5.1.1 through D.5. 10.27 give the ILCR for an individual. For example, an isopleth with a value of 1.0E-03 indicates that an individual located along that contour line has a 0.001 chance of developing cancer, or that one person out of 1,000 will develop cancer. By making assumptions regarding populations, individual risks are used to calculate total risks, which indicate the number of individuals in each receptor group that may contract cancer or die from cancer over the 10,000-year period of interest.

The method used to calculate total risk uses the areas described by the individual risk contours shown in Figures D.5.1.1 through D.5.10.27 . These areas were calculated using computer contouring software for periods of 300, 500, 2,500, 5,000, and 10,000 years from the present for each receptor and alternative. The number of individuals exposed in each contour area during each time interval was calculated using assumed values for population density or total population and the duration of active land use for each receptor group. The corresponding cancer incidence and cancer fatalities were obtained by multiplying the number of exposed individuals by the risk value (ILCR) for the given contour area. The total risk for each receptor is the sum of all the cancer incidences and fatalities for each contour area during each time interval.

Assumptions were made for such factors as the duration of exposure, the population affected, and the lifespan or duration of active use for a generation.

For the Native American scenario, the following assumptions were used.

- The duration of each generation is 70 years of continuous occupancy.
- The population density is 1.91 persons/km^2. This value is based on an assumed population of 1,500 individuals occupying 785 km^2 (303 mi^2) of the total area of the Hanford Site. This value is similar to the population density of the Umatilla Indian Reservation, which is 2.08 persons/km^2 based on information presented in the Comprehensive Plan of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR 1995).

Consequently, the number of Native Americans at any given time is 1,500 (1.91 · 785). During a 10,000-year time span, there would be 143 generations (10,000 ÷ 70), or a total of 2.1E+05 (143 · 1,500) receptors for the Native American scenario.

For the residential farmer scenario, the following assumptions were used.

- The d uration of each generation is 70 years of continuous farming.
- The p opulation density is 4.97 persons/km^2 (WSDFM 1994). This population density is similar to the present (1990's) farming area surrounding the Site.
- Farming will occupy 785 km^2 (303 mi^2) of the total area of the Hanford Site.

Consequently, the number of farming individuals at any given time is 3,900 (4.97 · 785). During a 10,000-year time span, there would be 143 generations (10,000 ÷ 70), or a total of 5.6E+05 (143 · 3,900) receptors for the residential farmer scenario.

For the industrial worker scenario, the following assumptions were used.

- A workforce of 2,200 would occupy the Site. Previous estimates have indicated a large industrial complex at the Site would have a workforce of 1,700 (TRIDEC 1993).
- The d uration of each worker's employment would be 30 continuous years; 30 years is assumed to be one generation or occupation period for the industrial worker.
- The c alculated worker population would remain constant as a function of time.
- The worker population would not be uniformly distributed throughout the Site as for the Native American and residential farmer scenarios. Instead, the workers would occupy an industrial complex assumed to be located in the risk contour area with the highest probability of occurrence. Probability of occurrence for this assessment was calculated by dividing the areas for the individual contours by the total area of 785 km^2 (303 mi^2).

During a 10,000-year period, the net result would be 333 generations (10,000 ÷ 30) of industrial workers or a total population of 7.3E+05 receptors (333 · 2,200).

For the recreational shoreline user scenario, the following assumptions were used.

- The duration of active use of the area for recreation is 30 years per person (DOE 1995c), usage is for 14 days per year, and 30 years is assumed to be one recreational generation.
- During the period of interest there would be 40,000 one-day visits to the shoreline (NPS 1994). This would be equivalent to 2,857 visits of 14 days per visit. For use in calculations, it is assumed that 1,950 visits of 14 days each that result in exposure would occur in shoreline areas.

Consequently, during a 10,000-year period there would be 333 generations (10,000 ÷ 30), or a total of 6.5E+05 receptors (333 · 1,950) for the recreational shoreline scenario.

The results of calculating total or integrated risk for the Native American, residential farmer, industrial worker, and recreational shoreline user for all alternatives are shown in Table D.5. 15 .1. This table shows the total calculated cancer incidence and cancer fatalities for each group of receptors and for each alternative over the entire 10,000 years.

Table D.5.15.1 Bounding Case Post-Remediation Total Cancer Incidence and Cancer Fatalities for 10,000 Years from the Present for all Alternatives

Example Calculation for Total Risk

Given a set of risk contours at 500 years, the total risk to the residential farmer based on 2 risk contours with areas of 47 km^2 (18 mi^2) and 64 km^2 (24 mi^2) and ILCR values of 0.05 and 0.001, respectively, is calculated as follows.

The risk contours at 500 years must be used to represent the next 2,000 years of exposure because the next risk contour available is for 2,500 years from the present time. During this 2,000-year period there will be 28.57 generations of residential farmers (2,000 ÷ 70) occupying the land with a population density of 4.97 persons per km^2. The cancer incidence, R(1), over this period for the 47 km^2 area with an ILCR of 0.05 is:

$R(1) = 47 \cdot 4.97 \cdot 28.57 \cdot 0.05 = 333.7$ cancer incidences

The cancer fatalities corresponding to this cancer incidence are 333.7 ÷ 1.2 = 278 fatalities. This conversion is based on the ratio of the dose to risk conversion factors for cancer incidence and cancer fatalities (6.0E-04 ÷ 5.0E-04 = 1.2) given in the ICRP (ICRP 1991).

Using the same method, the cancer incidence, R(2), over this period for the 64 km^2 (24 mi^2) area with an ILCR of

0.001 is:

R(2) = 64 · 4.97 · 28.57 · 0.001 = 9.0 cancer incidences.

The corresponding cancer fatalities are 9.0 ÷ 1.2 = 7.6 fatalities.

The total risk is the sum of R(1) and R(2), that is:

R(total) = R(1) + R(2) = 333.7 + 9.0 = 342.7 = 343 cancer incidences.

The corresponding cancer fatalities are 343 ÷ 1.2 = 285.6 = 286 fatalities.

The above total risk is calculated by assuming that the two isopleths with risk levels of 0.05 and 0.001 have the same risk magnitude for the entire 2,000 year duration of the calculation. In reality, as time increases, the risk level decreases because of radioactive decay and the transport and dilution of contaminants in the aquifer. To make the adjustment for this , it is assumed that one-half of the risk level at the start of the period would be the risk for the entire duration. Therefore, the total cancer incidence would be one-half of 343, or 172, and the total cancer fatalities would be one-half of 286, or 143.

A high degree of uncertainty is associated with calculating cancer incidence and cancer fatalities over 10,000 years. Changes in population density, climate, use restrictions, and many other factors can affect these calculations. Therefore, the total cancer incidence and cancer fatalities should be considered rough approximations only and have been rounded to one significant digit in the text and Summary of this EIS.

D.5. 15 .2 Total Health Impacts Along the Columbia River

Different contaminants will enter the groundwater and reach the Columbia River at varying times in the future. The contaminants time of first arrival at the Columbia River, the time that peak concentration is reached, and the time of final arrival of a contaminant are dependent not only on the transport properties of the contaminant, but also on the alternative under consideration. Transport of contaminants through the groundwater is described in detail in Volume Four, Appendix F. A summary of first arrival times, times of peak concentration, and times of final arrival is shown in Table D.5. 15 .2 for C-14, I-129, Tc-99, U-238, and Np-237. This table also shows the total inventory in curies for each radionuclide, taking into account radioactive decay from the present until the time of peak concentration.

Table D.5.15.2 Estimated Arrival and Curies of Radionuclides that Reach the Columbia River Within a 10,0000-Year Period of Interest

Total cancer fatalities are calculated using factors that relate the number of fatal cancers to the curies of each contaminant that is released to the river. These factors are calculated by using a computer program for calculating population dose integrated over 10,000 years, which estimates the time integral of collective dose over a period of up to 10,000 years for time variant radionuclide releases to surface waters, such as rivers (DOE 1987).

For long-term releases of radionuclides to the Columbia River, estimated downriver population totals are needed. For purposes of the TWRS EIS it is assumed that the potentially affected downriver population is 500,000, a number that has been used previously (DOE 1987).

A summary of the calculation results for total fatalities, population dose in person-rem, and the maximum incremental dose in mrem is shown in Table D.5. 15 .3.

Table D.5.15.3 Estimated Fatality, Population Dose (person-rem), and Maximum Incremental Dose (mrem) for the Columbia River User Over 10,000 Years for all Alternatives

D.5.16 RISK RANGE

The post-remediation risk calculations presented in Section D.5.0 contain a number of conservative assumptions designed to ensure that the results provide an upper bound of the long-term risk associated with the TWRS alternatives. For comparison purposes, a nominal case has also been evaluated. The nominal case is based on most likely rather than conservative assumptions. Evaluation methods for the nominal case were identical to the bounding case. This section presents the risk range for the bounding and nominal cases. Risk range refers to the difference between the risk values for the bounding case and the corresponding values for the nominal case.

D.5.16.1 Maximum Risk Range

Tables D.5.16.1 and D.5.16.2 show the maximum calculated values for ILCR and noncarcinogenic chemical hazard for the bounding case and nominal case, respectively. Values shown on these tables are the highest values calculated for each exposure scenario and time period under each alternative. The risk range can be determined by comparing values on the bounding case table with their corresponding values on the nominal case table. For example, under the bounding case the post-remediation risk to the residential farmer at 300 years for the No Action alternative is calculated to be 4.58E-01 (Table D.5.16.1). Under the nominal case, this risk is calculated to be 1.92E-01. (Table D.5.16.2).

Table D.5.16.1 Summary of Bounding Case Maximum Incremental Lifetime Cancer Risk and Hazard Indicies

Table D.5.16.2 Summary of Nominal Case Maximum Incremental Lifetime Cancer Risk and Hazard Indicies

D.5.16.2 Total Health Impacts Range

Table D.5.16.3 shows the total post-remediation cancer incidence and fatalities calculated over a 10,000-year period for the nominal case. The corresponding values for the bounding case are shown in Table D.5.15.1. The risk range can be determined in the same manner as discussed above for the maximum risk range. For example, under the bounding case for the No Action alternative, the total cancer incidence for the residential farmer over 10,000 years is calculated to be 759 (Table D.5.15.1). Under the nominal case, the corresponding cancer incidence is calculated to be 626 (Table D.5.16.3).

Table D.5.16.3 Nominal Case Post-Remediation Total Cancer Incidence and Cancer Fatalities for 10,000 Years from the Present Time

D.5.17 UNCERTAINTY

The uncertainty analyses for post-remediation risk assessment are based on the HSRAM uncertainty analysis. The carcinogenic and noncarcinogenic risk presented in the post-remediation risk evaluation are estimates given multiple assumptions about exposures, toxicity, and other variables. The uncertainties are inherent (e.g., toxicity values, default exposure parameters) or specific (e.g., data evaluation, contaminant identification) in the risk assessment process. Specific considerations in evaluating uncertainty are Site-specific factors, exposure assessment factors, toxicity assessment factors, and risk characterization factors . A detailed discussion of uncertainty in the post-remediation risk assessment is provided in Volume Five, Appendix K.

D.6.0 ECOLOGICAL RISK ASSESSMENT METHODOLOGY AND RESULTS

D.6.1 INTRODUCTION

This section summarizes the methodology and results of the ecological risk assessment (risks to plants and animals from potential exposure to radioactive and toxic contaminants) for the various TWRS alternatives. Potential ecological risks are evaluated under baseline conditions (i.e., the No Action alternative) with ecological impacts from other alternatives being compared to the baseline impacts. The No Action alternative is a conservative and bounding scenario since it assumes that all of the tank waste would remain in-place and would be available for direct contact and potential migration to groundwater and the Columbia River. Consequently, the No Action alternative represents the greatest potential impacts to ecological receptors (terrestrial and aquatic).

Under baseline conditions, radiological doses and chemical hazards were estimated for potential ecological receptors from 1) direct contact with tank waste; 2) exposure to tank waste contaminants in groundwater that reaches the Columbia River; and 3) exposure to routine contaminant releases to the air. For other alternatives (e.g., in situ and ex situ alternatives described previously), potential ecological risks were estimated from radionuclides and chemicals released to the air during remediation activities.

The ecological risk assessment methodology is conceptually identical to the methodology used to estimate potential human health risks. All chemicals of concern for human health were also considered chemicals of concern for potential ecological receptors. Consequently, the ecological risk assessment used the same source terms and contaminant transport data that were used in the human health risk assessment (Section D.2.0). The URF approach developed for human health risk was followed for terrestrial receptors except that ecological species-specific factors were substituted for the human land use-specific factors and are described in more detail in Section D.6.3.2. Potential radiation doses to aquatic organisms from tank waste contaminants calculated to reach the Columbia River by groundwater migration were evaluated using the CRITRII model (Baker-Soldat 1992).

The ecological risk assessment in this EIS follows the approaches recommended in EPA's Framework for Ecological Risk Assessment (EPA 1992) and the Hanford Site Baseline Risk Assessment Methodology (DOE 1993d). The basic components of this ecological risk assessment are 1) problem formulation; 2) characteriz ation of potential exposures; 3) estimation of potential ecological impacts from radionuclides and toxic chemicals; and 4) summariz ation of the risk assessment results (EPA 1992).

D.6.2 PROBLEM FORMULATION

This section describes the ecosystem potentially at risk, potential ecological effects of the contaminants of concern, endpoints selected for risk assessment, and the conceptual model.

D.6.2.1 Ecosystems Potentially at Risk

The Hanford Site supports a variety of arid terrestrial habitats, a major aquatic habitat in the Columbia River, and a number of threatened, endangered, or candidate species, as described in Volume Five, Appendix I. The primary ecosystems potentially at risk from exposure to tank waste include the shrub-steppe habitat in and immediately adjacent to the Central Plateau; mobile organisms that may enter the area (for example, birds and deer); and aquatic wildlife in the Columbia River.

D.6.2.2 Ecological Effects

To date, no specific ecological effects of exposure to tank waste have been documented. The waste is in tanks buried in the ground (i.e., 4.6 m [15 ft] below the ground surface), which limits potential contact with any leaking waste to deep-rooted plants and burrowing animals. The areas adjacent to the tanks are highly disturbed, kept clear of vegetation, and represent low quality habitat thereby further limiting organisms' access to the waste. No current ecological risk exists since there is no complete exposure pathway for the tank waste. Any potential ecological effects would occur in the future following the loss of institutional controls. Natural succession and potential failures of tanks could increase the likelihood of contact with the waste. The direct ecological effects of concern at this time would be radiation and toxic chemical exposures that could lead to individual mortality, reproductive and developmental effects, and a variety of potential indirect effects on other ecological variables. Examples of potential indirect effects include decreased biodiversity, habitat loss or alteration, and impacts on productivity and nutrient turnover. As described in the following sections, this screening level assessment focuses on radiation doses and chemical intakes in individual indicator organisms.

D.6.2.3 Endpoint Selection

Human health risk assessment typically focuses on two well-defined endpoints associated with the health of individual humans, cancer incidence, and the noncancer effects of hazardous chemicals. However, ecological risk assessment is concerned with many species and attributes of ecosystems other than their species composition, such as nutrient turnover rates, energy flow, and food web complexity. Particular endpoints must therefore be chosen for each new ecological risk assessment.

D.6.2.3.1 Assessment Endpoints

Assessment endpoints are the specific ecological characteristics to be protected (EPA 1992, Suter 1993). For purposes of this EIS, the primary assessment endpoint for the effects of radionuclides and hazardous chemicals is prevention of the adverse effects of these substances on any ecological receptors. A second, more specific, endpoint is prevention of adverse effects on Federal or Washington State species of concern that may occur in the TWRS area. These species, described in Section 4.4 and Volume Five, Appendix I, include Piper's daisy (Erigeron piperianus), the sage sparrow (Amphispiza belli), Swainson's hawk (Buteo swainsoni), and the loggerhead shrike (Lanius ludovicianus).

D.6.2.3.2 Measurement Endpoints

Measurement endpoints are characteristics that are subject to measurement and correspond in some way to the assessment endpoints. The measurement endpoints chosen to correspond to the assessment endpoints are 1) estimated radiation doses to terrestrial organisms compared with the 0.1 rad/day expected to have no adverse effects (IAEA 1992) (this screening radiological value is intended to be protective of chronic reproductive and developmental effects for a wide range of terrestrial species and is not specific for any one species); 2) the ratio of estimated hazardous chemical intake by terrestrial organisms to the intake expected to have no adverse effect (HI value greater than 1.0 indicates a potential for adverse effects); and 3) estimated radiation doses to aquatic organisms compared with the 1.0 rad/day expected to have no adverse effects (NCRP 1991).

D.6.2.4 Conceptual Model

The primary objective of the conceptual model is to develop a series of working hypotheses about how contamination may impact the ecological components of the natural environment (EPA 1992). For purposes of this EIS, these hypotheses center on potential exposures of individual organisms to radiation and hazardous chemicals.

The conceptual model for terrestrial organisms is a flow diagram illustrating potential complete pathways for movement of tank waste or radiation to a selected suite of representative species (Figure D.6.2.1). The representative species included a generic plant, the great basin pocket mouse (Perognathus parvus), the coyote (Canis latrans), the mule deer (Odocoileus hemionus), the red-tailed hawk (Buteo jamaicensus), and the loggerhead shrike (Lanius ludovicianus). The exposure pathways considered were food, soil, and water ingestion; inhalation; and direct radiation.

This model is designed to assess effects at several trophic levels such as the primary producer, herbivore, and mammalian and avian carnivores while being simple enough to efficiently assess potential effects at the waste sites within the scope of this EIS. The species chosen are all known to occur on the Hanford Site, and all of them could potentially be exposed to tank waste constituents at some future time.

Figure D.6.2.1 Conceptual Model of Potential Exposure of Ecological Receptors to Hanford Site Waste

As illustrated in Figure D.6.2.1, the pocket mouse serves as a vector for contaminant movement through the food chain from plants to mammalian and avian carnivores. Because the mouse has no requirement for drinking water and obtains all its water from food, it would be subject to impacts from radiological and nonradiological chemicals in soil and food and to direct radiation while in burrows. Its small home range would cause it to spend all its time within a contaminated area and obtain all its food there (Table D.6.2.1).

Table D.6.2.1 Organism Data Used to Estimate Radiation Doses and Hazard Quotients for Ecological Receptors

The mule deer has a wider home range than the mouse, requires water, and consumes small amounts of soil while grazing, allowing some direct exposure to contaminants unmodified by plant uptake (Table D.6.2.1; Arthur-Alldredge 1979). The fraction of contaminated plants consumed was set equal to the ratio of the grid cell area to the home range (100 hectare [ha]/1,240 ha = 0.008).

The coyote is a mammalian predator, requires water, and was assumed to consume only pocket mice as prey for purposes of this assessment. The fraction of contaminated prey consumed was set equal to the ratio of the grid area to the home range (100 ha/302 ha = 0.33).

The red-tailed hawk is an avian predator with a wide home range, requires water, and is assumed to consume only pocket mice as prey for purposes of this assessment. The fraction of contaminated prey consumed was set equal to the ratio of the grid cell area to the home range (100 ha/218 ha = 0.46). Potential effects on the red-tailed hawk also serve as measurement endpoints for effects on other raptors of concern such as the Swainson's hawk, for which relevant data are not available.

The loggerhead shrike is a passerine (songbird) bird species that is much smaller than the red-tailed hawk and has a smaller home range. The shrike feeds on insects, small mammals, and other birds (Fitzner-Rickard 1975). For purposes of this EIS, the shrike was assumed to consume only pocket mice as prey. Its small home range would cause it to spend all its time within a contaminated area and obtain all its food there (Table D.6.2.1).

The CRITRII model was used to estimate radiation doses to aquatic organisms (Baker-Soldat 1992). That model uses a simple food chain and bioaccumulation factors to estimate internal and external radiation doses to algae, fish, crustaceans, mollusks, and muskrats, raccoons, herons, and ducks feeding on aquatic organisms.

D.6.3 ANALYSIS

The analysis phase of an ecological risk assessment consists of technically evaluating data for potential exposures to and effects of the contaminants (EPA 1992). This section describes how the exposures were estimated for each representative receptor of concern.

D.6.3.1 Source Terms and Direct Exposure

The source terms were the same as those used for the human health risk assessment. Constituent concentrations for direct exposure to tank waste were estimated from waste inventory data and volumes (WHC 1995g and Jacobs 1996), assuming an average density of 1.5 kg/L. Air concentrations for the No Action and remediation alternatives were estimated from average annual routine emissions and the minimum and maximum onsite Chi/Q values. Because ecological receptors would not have access to groundwater unless it reached the surface, water concentrations used were the minimum and maximum calculated (i.e., modeled) concentrations in groundwater reaching the Columbia River at 300, 500, 2,500, 5,000, and 10,000 years. Use of the maximum modeled concentrations provides conservative, upper-bound estimates of exposure point concentrations and potential exposures.

D.6.3.2 Characterization of Exposure

This section describes the general methods used to estimate the intake of hazardous chemicals, the associated HIs, and radiation doses resulting from radionuclide intake by terrestrial organisms. The section first describes the equations used as they are typically presented in the risk assessment literature and then describes how the equations were modified to calculate URFs to simplify computation. Strictly speaking, the "URFs" as applied to ecological receptors are unit dose or HI factors, in that the result is an estimated radiation dose or chemical HI, rather than a probability of some adverse effect. However, the term URF is maintained here for purposes of consistency with the methodology used for the human health risk assessment.

D.6.3.2.1 Estimation of Hazardous Chemical Intake

Uptake of contaminants from soil by a generic plant was estimated by multiplying the soil concentration by the soil-to-plant concentration factors used in the GENII model at the Hanford Site (Table D.6.3.1 and D.6.3.2).

Table D.6.3.1 Transfer Factors Used to Estimate Radiation Doses to Ecological Receptors

Table D.6.3.2 Properties of Chemicals Used to Estimate Hazard Quotients

The equation is:

(1) $C_{vi} = (C_{si})(B_{vi})(0.4)$

Where:

- C_{vi} = Contaminant concentration in plant, mg kg^{-1} wet weight
- C_{si} = Contaminant concentration in soil, mg kg^{-1} dry weight
- B_{vi} = Soil-to-plant concentration factor (unitless) (The factor for grain concentration was used for the pocket mouse, which is assumed to consume seeds. The vegetative portion values were used for the mule deer.)
- 0.4 = Dry weight/wet weight conversion (DOE 1994)

The intake rate of hazardous chemicals for a herbivore via consumption of plants is typically calculated as:

(2) $I_i = (C_{vi})(IR)(FI)/(BW)$

Where:

- I_i = Intake rate of the i_{th} contaminant, mg kg^{-1} day^{-1}
- C_{vi} = Contaminant concentration in plant, mg kg^{-1}
- IR = Ingestion rate of food, kg day^{-1} wet weight
- FI = Fraction ingested from contaminated source, unitless
- BW = Body weight, kg wet weight

Consumption rates by carnivores are calculated similarly, substituting the contaminant concentrations in the herbivore for the concentrations in plants. Contaminant concentrations in herbivore muscle are typically estimated using the equation:

(3) $C_{mi} = (C_{vi})(IR)(FI)(B_{mi})$

Where:

C_{mi} = Contaminant concentration in muscle, mg kg^{-1} wet weight

C_{vi} = Contaminant concentration in plant, mg kg^{-1} wet weight

IR = Ingestion rate of plants by herbivore, kg day^{-1}

FI = Fraction ingested from a contaminated source, unitless

B_{mi} = Plant-to-muscle transfer factor, day kg^{-1}

However, as described in the following text, radionuclide body burdens were estimated from element-specific fractions retained, biological half-lives, and radiological half-lives. Therefore, for purposes of consistency, nonradiological body burdens were estimated in the same way, assuming an infinite radiological half-life. The resulting equation is:

(4) $C_{mi} = [(C_{vi})(IR)(FI)(FR)(B_i)]/BW$

Where:

C_{mi} = Contaminant concentration in muscle, mg kg^{-1} wet weight

C_{vi} = Contaminant concentration in plant, mg kg^{-1} wet weight

IR = Ingestion rate of plants by herbivore, kg day^{-1}

FI = Fraction ingested from a contaminated source, unitless

FR = Fraction retained (Baker-Soldat 1992)

B_i = Effective half-life (days), calculated as described in Baker and Soldat (Baker-Soldat 1992); assuming radiological half-life to be infinite reduces it to the biological half-life.

This equation assumes that the body burden is at steady state following chronic intake by a secondary receptor.

Food ingestion rates and body weights used in estimating exposures for this EIS are listed in Table D.6.2.1. Intakes via inhalation and water ingestion were estimated following procedures recommended in EPA (EPA 1993) when species-specific values were not available (Table D.6.2.1).

D.6.3.2.2 Calculation of Hazard Indices

The HI, the ratio of estimated intake to that expected to have no adverse effect, is typically calculated as:

$HI = I/NOAEL$

Where I is calculated as described in equation (2), and the No Observed Adverse Effect Level (NOAEL) is obtained from the literature as described in the following text. Both are expressed as mg per kg body weight per day.

An HI greater than 1.0 for a given chemical indicates that the estimated intake exceeds the threshold level and adverse health effects may occur. An HI less than 1.0 is indicative of no adverse impacts. For sites with multiple chemicals, the HIs may be summed, making the assumption that the modes of action and target organs of the chemicals are similar. Thus, a site may be said to present a hazard if the sum of the HIs exceeds 1.0, even if the individual chemical HIs are less than 1.0. URFs were estimated to allow calculation of the HIs directly from media concentrations, without the necessity of separate calculations of uptake at each trophic level. This consists of simply combining all the variables except the medium concentration for each constituent of concern for each organism. URFs for food ingestion and water ingestion are summarized in Tables D.6.3.3 and D.6.3.4, respectively.

Table D.6.3.3 Food Ingestion Unit Risk Factors, Chemicals

Tables D.6.3.4 Water Ingestion Unit Risk Factors, Chemicals

NOAELs were obtained from a variety of sources, with Opresko et al. (Opresko et al. 1994) as the primary source (Table D.6.3.5). Wildlife NOAELs for test species other than those of interest here were scaled to the body weight of the organism using the equation:

(5) $NOAEL_y = (NOAEL_x)[(bw_x)/(bw_y)]^{1/3}$

Where:

$NOAEL_y$ = NOAEL for the organism of interest

$NOAEL_x$ = NOAEL for experimental animal available from the literature

bw_y = Body weight of the organism of interest

bw_x = Body weight of experimental animal with the known NOAEL (Table D.6.3.6)

Table D.6.3.5 Ingestion No Observed Adverse Effect Levels Used to Estimate Hazard Quotients

Scaling factors estimated according to Equation (5) are summarized in Table D.6.3.6. NOAELs for plants (Table D.6.3.5) were obtained as benchmark soil concentrations from Will and Suter (Will-Suter 1994), and the vegetation HIs were calculated as the waste unit soil concentration divided by the NOAEL.

Table D.6.3.6 Scaling Factors for Extrapolating No Observed Adverse Effect Levels Between Species

D.6.3.2.3 Estimation of Radiation Doses

Radiation doses to ecological receptors were calculated using URFs analogous to those for chemicals. The basic equation used to estimate radiation dose to the pocket mouse was as follows:

(6) Dose rate (rad d^{-1}) = $[(CS)(PS)(WW)(Q_v)(FI)(EF)(ED)(FR)(B_i)(E_i)(1\ y/365\ d)]/[(BW)(AT)]$

Where:

CS = Radionuclide concentration in soil, Ci/kg

PS = Soil-to-plant transfer factor

WW = Wet-to-dry weight conversion factor, 0.4

Q_v = Ingestion rate, kg/day

FI = Fraction ingested from contaminated source

EF = Exposure frequency, 365 day/year

ED = Exposure duration, 1 year

FR = Fraction retained (Baker-Soldat 1992)

B_i = Effective decay constant of the radionuclide (days), calculated as described in Baker and Soldat (Baker-Soldat 1992); takes both radioactive decay and biological turnover into account.

E_i = Effective energy absorbed, ($5.12 \cdot 10^4$ kg rad Ci^{-1} d^{-1} MeV^{-1} dis) (MeV dis^{-1}), using MeVs obtained from Baker and Soldat (Baker-Soldat 1992)

BW = Body weight, kg

AT = Averaging time, 1 year

The doses to predators were calculated similarly, substituting the concentration in the mouse for that in the plant. Radionuclide properties and transfer factors used in the calculations are listed in Tables D.6.3.7 and D.6.3.1, respectively. URFs were estimated to allow calculation of doses directly from media concentrations, without the necessity of separate calculations of uptake at each trophic level. URFs for food ingestion are summarized in Table D.6.3.8. Radiation doses were calculated as the product of the URF and the medium concentration.

Table D.6.3.7 Radionuclide Properties Used to Estimate Radiation Doses to Ecological Receptors

Table D.6.3.8 Food Ingestion Unit Risk Factors, Radionuclides

Doses resulting from ingestion of water, ingestion of soil, and inhalation were estimated in the same way, substituting the appropriate intake rates for the food ingestion rate and are summarized in Tables D.6.3.9, D.6.3.10 and D.6.3.11, respectively. As noted in Table D.6.2.1, inhalation and water ingestion rates were estimated using equations from the EPA (EPA 1993) when species-specific values were not available.

Table D.6.3.9 Water Ingestion Unit Risk Factors, Radionuclides

Table D.6.3.10 Soil Ingestion Unit Risk Factors, Radionuclides

Table D.6.3.11 Inhalation Unit Risk Factors, Radionuclides

Doses to pocket mice and plants via direct radiation were calculated using the equation:

(7) Dose rate (rad day^{-1}) = [(24)(2.12)(E)(C)]/p (Jacobs 1996)

Where:

24	= h/d
2.12	= Constant to convert units to rad h^{-1}
	= (U)(V)(W)(X)(Y)(Z), dis-rad-g/Ci-hr-MeV

Where:

U	= 1 Ci/10^6 Ci
V	= 3.7 10^{10} disintegrations/Ci-sec
W	= 3600 sec/hour
X	= 10^6 eV/MeV
Y	= 1.6 10^{-12} erg/eV
Z	= 1 rad-g/100 ergs
E	= Average gamma energy per disintegration, MeV/dis
C	= Radionuclide concentration in soil, uCi/cm^3
p	= Soil density, g/cm^3

URFs for direct exposure are listed in Table D.6.3.12.

Table D.6.3.12 Direct Radiation Unit Risk Factors, Radionuclides

D.6.4 RESULTS

Results are summarized in Tables D.6.4.1 through D.6.4. 11 . Overall, the results of this screening analysis fall into two extreme classes. Direct contact with waste, which would be unlikely even under the No Action alternative, is estimated to result in radiation doses that would likely be lethal in a short time (Table D.6.4.1). The chemical hazards associated with direct exposure to tank waste, while less dramatic, are still estimated to be up to several orders of magnitude higher than the 1.0 HI benchmark for concern (Table D.6.4.4). Any direct effects on individual organisms exposed to stored waste could lead to a variety of indirect effects on the ecosystem, including decreased biodiversity, habitat loss or alteration, and impacts on productivity and nutrient turnover. Exposure to routine air emissions under the No Action alternative is estimated to result in a radiation exposure far below background levels (Table D.6.4.2).

Exposure to contaminated groundwater reaching the Columbia River is not estimated to result in radiation doses approaching the 0.1 rad/day benchmark for terrestrial organisms (IAEA 1992) (Table D.6.4.3). Likewise, maximum radiation doses to aquatic organisms in the Columbia River, 300 or 500 years in the future, are well below the 1.0 rad/day benchmark for aquatic organisms (NCRP 1991) (Table D.6.4.6). Because the direct impacts of air and groundwater exposure are expected to be small, any associated indirect impacts on the ecosystem would be correspondingly minor.

Table D.6.4.1 Total Estimated Dose from Direct Contact with Waste, No Action Alternative, Summed by Cell (rad/d)

Table D.6.4.2 Estimated Radiation Doses to Ecological Receptors from Inhalation of Routine Releases, No Action Alternative

Table D.6.4.3 Estimated Maximum Radiation Doses (rad/d) from Ingestion of Groundwater Reaching the Columbia River, No Action Alternative

Table D.6.4.4 Total Hazard Index from Direct Contact with Waste, No Action Alternative, Summed by Cell

Table D.6.4.5 Estimated Maximum Hazard Indices from Ingestion of Groundwater Reaching the Columbia River, No Action Alternative

Table D.6.4.6 Maximum Radiation Doses to Aquatic Organisms Exposed to Groundwater Entering the Columbia River at 300 and 500 Years

Table D.6.4.7 Estimated Radiation Doses from Inhalation of Routine Releases, Ex Situ Intermediate Separations and Phased Implementation Alternatives

Table D.6.4.8 Estimated Radiation Doses from Inhalation of Routine Releases, In Situ Alternatives

Table D.6.4.9 Estimated Radiation Doses from Inhalation of Routine Releases, Ex Situ No Separation s Alternative

Table D.6.4.10 Estimated Radiation Doses from Inhalation of Routine Releases, Ex Situ/In Situ Combination 1 Alternative

Table D.6.4.11 Estimated Radiation Doses from Inhalation of Routine Releases, Ex Situ/In Situ Combination 2 Alternative

Table D.6.4.5 presents the maximum HIs associated with ingestion of groundwater calculated to reach the Columbia River under the No Action alternative. For concentrations of contaminants calculated to reach the Columbia River 300, 500, 2,500, 5,000, and 10,000 years in the future, the maximum HIs for the coyote, mule deer, red-tailed hawk and loggerhead shrike were all well below the HI criterion of 1.0. The ecological hazards were based on a conservative, bounding scenario involving consumption of groundwater contaminants at the point where groundwater daylights on the Columbia River bank (e.g., springs or seeps) and assumes no dilution of the groundwater contaminants by the river before the receptors have access to it. Based on the conservative nature of the exposure scenarios, the estimated hazards for the representative species indicate that no adverse effects would be expected for terrestrial receptor s consuming groundwater in the future. Consequently, no indirect ecosystem impacts would be anticipated from future groundwater consumption.

The only radiation or chemical exposures evaluated for ecological receptors during remediation were radiation doses associated with routine releases during tank waste remediation. No estimated radiation doses resulting from routine releases during the in situ or in situ/ex situ combination alternatives exceeded the 0.1 rad/day benchmark suggested by IAEA (IAEA 1992) for ecological impacts (Tables D.6.4.8 and D.6.4.11). For the Ex Situ Intermediate Separations and Phased Implementation alternatives, the maximum estimated radiation doses resulting from routine releases exceeded this benchmark because of C-14, Cs-137, I-129, and Sr-90 releases (Table D.6.4.7). Exposures exceeding 0.1

rad/day also would be expected under the Ex Situ No Separations and Ex Situ Extensive Separations alternatives (Table D.6.4.9). However, exceeding the 0.1 rad/day benchmark assumes long-term exposure at the location of the maximum Chi/Q. It is unlikely that any ecological receptor would spend all of its lifetime at this location of highest exposure. The exposure at the location of the minimum Chi/Q would be approximately 100,000 times lower. It is therefore considered unlikely that ecological receptors would be exposed to harmful levels of airborne radiation resulting from routine releases under any alternative. Corresponding indirect impacts on the ecosystem would be similarly unlikely.

D.6.5 UNCERTAINTY

The greatest uncertainty in calculating both the HIs and radiation doses was associated with the source data. Source terms are based on estimated inventories and, for radionuclides, subsequent decay. Additional or better source data could either increase or decrease the estimated hazards. Secondary contributors to uncertainty are the transfer factors used to estimate plant uptake and assimilation in the mouse. Additional data on these factors could either increase or decrease the estimated hazards. Additional likely secondary contributors to uncertainty are the NOAELs for chemical hazard and the water ingestion and inhalation rates. The CRITRII model (Baker-Soldat 1992) was used only for estimating maximum radiation doses to aquatic organisms exposed to groundwater entering the Columbia River at 300 to 500 years. These estimates were all lower than one millionth of a rad per day, the benchmark recommended by NCRP (NCRP 1991) as protective of aquatic organisms. It is unlikely that detailed uncertainty analysis would alter the conclusion that groundwater risks are very low. Additional discussion of the uncertainties in the ecological risk assessment is provided in Volume Five, Appendix K.

D.6.6 DERIVATION OF ECOLOGICAL NO OBSERVED ADVERSE EFFECT LEVELS

This section describes the derivation of those NOAELs not taken directly from Opresko et al. (Opresko et al. 1994) or DOE (DOE 1994). Table D.6.3.5 lists all the NOAELs used in this document.

D.6.6.1 Boron in Birds

According to Smith and Anders (Smith-Anders 1989), 30 mg/kg of boron in the diet substantially reduced weight gain in ducklings. Control ducklings weighed 36.2 g, (N = 23, SD = 0.7). 30 mg/kg of boron on a fresh weight basis was 35 mg/kg on a dry weight basis. Consider this portion of the study a subchronic study because it was less than 10 weeks, although the adult feeding portion included reproduction. Consider the 30 mg/kg in diet to be a subchronic lowest observed effect level (LOEL). Feeding rates of adult mallards were 222, 184, and 209 g food/day in feeding trials. The mean equals 205 g/day. Male adults weigh approximately 1.3 kg and females approximately 1.1 kg (Table 4 in Smith-Anders 1989). The mean duck weight is thus 1.2 kg. If a 1.2-kg adult consumes 205 g/day, a 36-g duckling is assumed to consume (36/1200) · 205 = 6.15 g/day.

[(30 mg B/ kg food) · (6.15 g food/day) · (1 kg/1000 g)]/0.036 kg body weight)] = 5.125 mg/kg/day as a subchronic LOEL.

5.125 mg/kg/day · 0.1 = 0.5125 mg/kg/day as a chronic LOEL for a 36-g mallard duckling, following the extrapolation suggested by Opresko et al. (Opresko et al. 1994).

D.6.6.2 Boron in Mammals

Table 9 in Eisler (Eisler 1990) states that rats fed 350 or 525 mg B/kg diet as borax or boric acid for 2 years had no observable effects on fertility, lactation, litter size, weight, or appearance. Using the rat weight of 0.35 kg from Opresko et al. (Opresko et al. 1994), estimate the food intake rate from EPA (EPA 1993) Equation 8 as 0.017 kg/day. Assume that 350 mg B/kg diet dry weight is a chronic NOAEL. Then, [(350 mg/kg food) · (0.017 kg/day)]/0.35 kg body weight = 17 mg/kg/day as a chronic NOAEL for a rat.

D.6.6.3 Cerium

The Hazardous Substance Data Bank (HSDB), May 1995 NTOX entry, reproduced in the following text, states that cerium compounds are nontoxic when ingested.

1 - HSDB

NAME - DICERIUM TRIOXIDE

RN - 1345-13-7

NTOX - INSOL CERIUM COMPD, SUCH AS THE OXIDES, ARE NONTOXIC WHEN INGESTED ORALLY... /CERIUM OXIDES/ [VENUGOPAL. METAL TOX IN MAMMALS 2 1978 , p. 151] **PEER REVIEWED**

D.6.6.4 Chromium in Birds

Rosomer et al. (Rosomer et al. 1961), as cited in Driver (Driver 1994) state that "chickens appear to be resistant to hexavalent chromium since exposure to 100 ppm in the diet did not cause any adverse effects." The title of the Rosomer article indicates a "growing chick." Assume that 100 ppm CrVI is a reasonable subchronic NOAEL for chicks (not adults). Using the body weight (BW) and food consumption rate (IR) from Opresko et al. (Opresko et al. 1994), Page A-24: BW = 0.534 kg, IR = 0.044 kg/d, 100 ppm = 100 mg/kg, then [(100 mg/kg food) · (0.044 kg food/day)]/0.534 kg BW = 8.24 mg/kg/day as a subchronic NOAEL.

It can be extrapolated from the subchronic value suggested by Opresko et al. (Opresko et al. 1994) to arrive at (8.24) · (0.1) = 0.824 mg/kg/day as a chronic avian NOAEL.

D.6.6.5 Molybdenum

Table 4 of Eisler (1989) states that female mule deer had no effects after 33 days on a diet of up to 200 mg Mo/kg in their feed. Assume this value is an acceptable subchronic NOAEL. Then, in a like manner, one can extrapolate a chronic NOAEL as follows:

$$\left(\frac{(200\text{ mg/kg food}) \cdot (37\text{ kg food/day})}{57\text{ kg Bw}}\right) \cdot (0.1) = 1.3\text{ mg/kg/day}$$

D.6.6.6 Nitrite

The reference for this HSDB entry from May 1995 is reproduced in the following text. The test species is a rat with a body weight of 0.35 kg (EPA 1988) and a water ingestion rate of 0.046 L/day (EPA 1988, Table 1-4). The study duration is three generations and resulted in a 100 mg/kg/day NOAEL, considered chronic due to the length of the study. The nitrite portion of sodium nitrite = (100-33.32) = 66.68 percent 100 · 0.6668 = 67 mg/kg/day. The final NOAEL is thus 67 mg/kg/day.

1 - HSDB

NAME OF SUBSTANCE SODIUM NITRITE

CAS REGISTRY NUMBER 7632-00-0

NONHUMAN TOXICITY EXCERPTS

... RATS RECEIVED SODIUM NITRITE AT 100 MG/KG IN DRINKING WATER DAILY DURING THEIR ENTIRE LIFE SPAN OVER THREE GENERATION; NO EVIDENCE OF CHRONIC TOXICITY,

CARCINOGENICITY, OR TERATOGENICITY ... FOUND. [NRC. DRINKING WATER & HEALTH 1977 , p. 420] **PEER REVIEWED**

D.6.6.7 Silver

The reference for this IRIS entry from May 1995 is reproduced in the following text. The test species is a human with a body weight of 70 kg (EPA 1989). The study duration was more than 2 years. The effect endpoint was argyria (skin discoloration) and the exposure route was oral and injection in medication at various dosages. Consider the reported NOAEL of 0.014 mg/kg/day to be a chronic NOAEL. Then the final NOAEL is 0.014 mg/kg/day.

1 - IRIS

NAME OF SUBSTANCE Silver

CAS REGISTRY NUMBER 7440-22-4

REFERENCE DOSE FOR ORAL EXPOSURE

ORAL RFD SUMMARY

Critical Effect	Experimental Doses*	UF	MF	RfD
Argyria	NOEL: None	3	1	5E-3 mg/kg/day
2- to 9-Year	LOAEL: 1 g (total dose); Human i.v. Study converted to an oral dose of 0.014 mg/kg/day (Gaul-Staud 1935).			

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*Conversion Factors: Based on conversion from the total i.v. dose to a total oral dose of 25 g (i.v. dose of 1 g divided by 0.04, assumed oral retention factor; see Furchner et al., 1968 in Additional Comments section) and dividing by 70 kg (154 lb) (adult body weight) and 25,500 days (a lifetime, or 70 years).

D.6.6.8 Tungsten

The reference is an HSDB entry from May 1995, reproduced in the following text. The test species is a rat with a body weight of 0.35 kg (EPA 1988) and a food ingestion rate of 0.017 kg/day, calculated using Equation 3-8, for rodents (EPA 1993). The study duration was 70 days. Two percent in the diet is considered a subchronic NOAEL, with the effect endpoint being growth rate and the exposure route being ingestion. The calculations are as follows:

([0.02] [0.017 kg/day][10^6 mg/kg])/0.35 kg = 971 mg/kg/day for a subchronic NOAEL. Multiply by 0.1 to get a chronic NOAEL of 97 mg/kg/day (Opresko et al. 1994).

NTOX - TUNGSTEN METAL POWDER FED 70 DAYS TO WEANLING RATS...@ LEVELS 2, 5, & 10 PERCENT OF DIET...RESULTED IN NO EFFECT ON GROWTH RATE OF MALE RATS BUT CAUSED 15 PERCENT REDN IN WT GAIN IN FEMALES FROM THAT OF CONTROLS. PARTICLE SIZE...NOT REPORTED. [PATTY. INDUS HYG & TOX 2ND ED VOL2 1963 , p. 1162] **PEER REVIEWED**

D.7.0 INTRUDER RISK

This section describes the potential risk to human health from inadvertent intrusion into the post-remediation contamination sources for each of the TWRS alternatives. The intruder scenarios used for this analysis were taken from prior Hanford Site evaluations, which estimated the risk from intrusion into a Hanford Site solid waste burial ground (Aaberg-Kennedy 1990, as modified in Rittmann 1994). The prior evaluations used 10 intruder scenarios summarized as follows.

1. **Well Driller -** A 30-cm (1-ft) diameter well is drilled through the waste. Dose to the intruder is from the 40-hour drilling activities.
2. **Post-Drilling Resident -** A resident has a vegetable garden in the soil exhumed by the well-drilling operation. This garden supplies 25 percent of the resident's vegetable intake each year.
3. **Excavation -** 100 m^3 (3,500 ft^3) of waste is exhumed in the course of constructing a house with a basement. Dose to the intruder is from the 80 hours excavation activity.
4. **Post Excavation -** A resident has a vegetable garden in the soil exhumed by the excavation operation.
5. **Residential Garden, Shallow Waste -** The waste is not disturbed but 30 percent of garden plant roots reach into the waste.
6. **Residential Garden, Deep Waste -** The waste is not disturbed but 1 percent of garden plant roots reach into the waste.
7. **Residential Garden, Deep Waste, Biotic Transport -** 1 percent of garden plants' roots reach into the waste and animals burrowing into the waste have been bringing contamination to the surface.
8. **Farming -** A farm over the waste site has 1 percent of plant roots in the waste. The farmer's intake is 25 percent of the vegetables and 100 percent of the meat and milk that are produced from this farm.
9. **Irrigated Garden -** A well near the waste site is used to irrigate a vegetable garden.
10. **Drinking Water -** Well water is consumed by the resident directly.

Of these 10 scenarios, the well driller and post-drilling resident were selected to represent inadvertent intrusion for this analysis. These two scenarios were selected based on their applicability to the deep contamination sources (i.e., tank residuals, LAW vaults, and capsules) involved in this analysis. The underground depth of both the tank residuals and LAW vaults would make them inaccessible to the shallow intrusion of the other scenarios.

The human health risk for the two intruder scenarios is calculated as the carcinogenic effect resulting from exposure to the radionuclides contained in the waste exhumed during well drilling. Risk is expressed in terms of cancer fatalities and cancer incidence. The carcinogenic effects from chemical carcinogens and the toxic effects from chemical noncarcinogens are not included in the analysis.

The source was calculated as the total activity in curies of each constituent exhumed and made available at the surface. The source is calculated from a representative tank, LAW vault, or capsule canister corresponding to each alternative. The source activity (Ci) is then multiplied by a unit dose factor (mrem/yr/Ci) for each receptor (well driller and post-drilling resident) to produce the dose (mrem/yr). Unit dose factors are calculated for a unit activity (Ci) for each constituent based on the exposure conditions defined for each receptor. The well driller dose is from 40 hours of external exposure to the exhumed contaminants. The post-drilling resident is assumed to spread the exhumed contaminants uniformly over an area of 2,500 m^2 (0.62 acre), and the contaminated surface soil becomes the basis for the dose received. This receptor supplies 25 percent of his vegetable intake each year from this contaminated land. The resultant risk for each receptor is the product of the total dose and the dose to risk conversion factor.

D.7.1 SOURCE

The source refers to the total inventory exhumed and brought to surface. The source for the intruder scenario is alternative dependent. The methodology used for estimating the source for each alternative is different and specific to the alternative.

D.7.1.1 No Action Alternative (Tank Waste)

Table D.7.1.1 shows the source term for this alternative for each of the eight aggregated source areas described in Volume Two, Appendix A. The source term is the inventory of each radionuclide (Ci_{exh}) in the volume of waste exhumed (v_{exh}) from a representative tank with a waste volume of V_{avg}. The inventory of each radionuclide in a representative tank (Ci_{avg}) within each of the eight source areas is calculated by dividing the radionuclide inventory for SST farms (Tables A.2.1.1 and A.2.1.2) and DST farms (Tables A.2.1.4 and A.2.1.5) by the number of tanks within each of the source areas. The exhumed activity (Ci_{exh}) from the average tank in each source area is calculated as follows:

$$Ci_{exh} = Ci_{avg} \cdot (v_{exh}/V_{avg})$$

$$V_{avg} = ? R^2_{avg} h_{avg}$$

$$v_{exh} = ? r^2_{exh} h_{exh}$$

$$h_{exh} = h_{avg}$$

$$Ci_{exh} = Ci_{avg} \cdot [? (r^2_{exh} h_{exh})/(? R^2_{avg} h_{avg})]$$

Therefore:

$$Ci_{exh} = Ci_{avg} \cdot [r_{exh}/R_{avg}]^2$$

Where:

R_{avg} is the radius of the average tank or 11.4 m (37.5 ft)

r_{exh} is the radius of the exhumed waste or 0.15 m (0.49 ft), and

h_{avg} represents the thickness or height of the waste in a representative tank.

h_{exh} represents the thickness or height of the waste exhumed.

Then:

$$Ci_{exh} = Ci_{avg} \times 1.73E\text{-}04.$$

D.7.1.2 Long-Term Management Alternative

The source term for the Long-Term Management alternative would be the same as for the No Action alternative. Table D.7.1.1 shows the amount of activity that is exhumed for the No Action alternative for the eight source areas.

Table D.7.1.1 Exhumed Inventory by Source Area for the No Action Alternative, Total Curies

D.7.1.3 In Situ Fill and Cap Alternative

The source term for the In Situ Fill and Cap alternative would be the same as for the No Action alternative. Table D.7.1.1 shows the amount of activity that is exhumed for the No Action alternative for the eight source areas.

D.7.1.4 In Situ Vitrification Alternative

Table D.7.1.2 shows the source term for the In Situ Vitrification alternative. The source term (Ci_{avg}) is estimated from the average concentration (C_{avg}) in Ci/m^3 of each radionuclide in the final waste form for this alternative as given in Table 7.1 of WHC (1995f). This concentration assumes that the entire tank farm is vitrified to an 18-m (59-ft) depth, including the areas between the tanks. The total activity of the exhumed waste (Ci_{exh}) is calculated by multiplying this average concentration by the volume of exhumed waste (v_{exh}) as follows.

$$Ci_{exh} = C_{avg} \cdot v_{exh}$$

$$v_{exh} = ? r^2_{exh} h_{exh}$$

$$= ? \times (0.15\ m)^2 \cdot 18\ m$$

$$= 1.27\ m^3$$

Therefore:

$$Ci_{exh} = C_{avg} \cdot 1.27\ m^3$$

Where:

r_{exh} is the radius of the exhumed waste or 0.15 m (0.49 ft), and

h_{exh} is the thickness or height of the waste or 18 m (59 ft).

Table D.7.1.2 Exhumed Inventory for the In Situ Vitrification Alternative, Total Curies

D.7.1.5 Ex Situ Intermediate Separations Alternative

Table D.7.1.3 shows the source term for tank residuals for the Ex Situ Intermediate Separations alternative. Table D.7.1.4 shows the source term for the LAW vaults for the Ex Situ Intermediate Separations alternative.

Table D.7.1.3 Exhumed Inventory by Source Area for Tank Residuals from the Ex Situ Intermediate Separations, Ex Situ No Separations, Ex Situ Extensive Separations, and Phased Implementation Alternatives, Total Curies

Table D.7.1.4 Exhumed Inventory for LAW Vaults for the Ex Situ Intermediate Separations, Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1, Ex Situ/In Situ Combinaton 2 , and Phased Implementation Alternatives, Total Curies

The source term for the tank residuals (Table D.7.1.3) is calculated using the same methodology as for the No Action alternative. However, the source term is estimated from 1 percent of the tank inventory in each of the eight source areas described in Volume Two, Appendix A because only 1 percent of the inventory is assumed to remain as residuals in the tanks after remediation.

The source term for LAW vaults (Table D.7.1.4) is estimated from data in Table 9.1 of WHC (WHC 1995j) and Jacobs (Jacobs 1996). The average concentration of each radionuclide in the vitrified waste form is multiplied by the volume exhumed. The volume exhumed is estimated to be 1.06 m^3 (37.4 ft^3) for a well with a diameter of 30 cm (1 ft) and a depth of 15 m (49 ft).

D.7.1.6 Ex Situ No Separations Alternative

Table D.7.1.3 shows the source term for tank residuals for the Ex Situ No Separations alternative. The source term for the tank residuals is the same as for the Ex Situ Intermediate Separations alternative. As stated previously, it is calculated using the same methodology as for the No Action alternative. However, the source term is estimated from 1 percent of the tank inventory in each of the eight source areas described in Volume Two, Appendix A.

D.7.1.7 Ex Situ Extensive Separations Alternative

Table D.7.1.3 shows the source term for tank residuals for the Ex Situ Extensive Separations alternative. Table D.7.1.4 shows the source term for the LAW vaults for the Ex Situ Extensive Separations alternative.

The source term for the tank residuals (Table D.7.1.3) is calculated using the same methodology as for the No Action alternative. However, the source term is estimated from 1 percent of the tank inventory in each of the eight source areas described in Volume Two, Appendix A.

The source term for LAW vaults (Table D.7.1.4) is estimated from data in Table 9.1B of WHC (WHC 1995e) and Jacobs (Jacobs 1996). The average concentration of each radionuclide in the vitrified waste form is multiplied by the volume exhumed. The volume exhumed is estimated to be 1.06 m^3 (37.4 ft^3) for a well with a diameter of 30 cm (1 ft) and a depth of 15 m (49 ft).

D.7.1.8 Ex Situ/In Situ Combination 1 Alternative

Table D.7.1.5 shows the source term for tank residuals for the Ex Situ/In Situ Combination 1 alternative. Table D.7.1.4 shows the source term for the LAW vaults for the Ex Situ/In Situ Combination 1 alternative.

Table D.7.1.5 Exhumed Inventory for Tank Residuals for the Ex Situ/In Situ Combination 1 Alternative, Total Curies

The source term for the tank residuals (Table D.7.1.5) is calculated using the same methodology as for the No Action alternative for the 70 tanks retrieved. However, the source areas include the tank inventory for the 107 tanks not retrieved, and the residuals remaining in the tank inventory for the tanks that were retrieved (1 percent of tank inventory).

The source term for LAW vaults (Table D.7.1.4) is estimated from Jacobs (Jacobs 1996). The average concentration of each radionuclide in the vitrified waste form is multiplied by the volume exhumed. The volume exhumed is estimated to be 1.06 m^3 (37.4 ft^3) for a well with a diameter of 30 cm (1 ft) and a depth of 15 m (49 ft).

D.7.1.9 Ex Situ/In Situ Combination 2 Alternative

Table D.7.1.6 shows the source term for tank residuals for the Ex Situ/In Situ Combination 2 alternative. Table D.7.1.4 shows the source term for the LAW vaults for the Ex Situ/In Situ Combination 2 alternative.

Table D.7.1.6 Exhumed Inventory for Tank Residuals for the Ex Situ/In Situ Combination 2 Alternative, Total Curies

The source term for the tank residuals (Table D.7.1.6) is calculated using the same methodology as for the No Action alternative for the 25 tanks retrieved. However, the source areas include the tank inventory for the 152 tanks not retrieved and the residuals remaining in the tank inventory for the tanks that were retrieved (1 percent of tank inventory).

The source term for LAW vaults (Table D.7.1.4) is estimated from Jacobs (Jacobs 1996). The average concentration of each radionuclide in the vitrified waste form is multiplied by the volume exhumed. The volume exhumed is estimated to be 1.06 m^3 (37.4 ft^3) for a well with a diameter of 30 cm (1 ft) and a depth of 15 m (49 ft).

D.7.1. 10 Phased Implementation Alternative

Table D.7.1.3 shows the source term for tank residuals for the Phased Implementation alternative. Table D.7.1.4 shows the source term for the LAW vaults for the Phased Implementation alternative.

The source term for the tank residuals (Table D.7.1.3) is calculated using the same methodology as for the No Action alternative. However, the source term is estimated from 1 percent of the tank inventory in each of the eight source areas described in Volume Two, Appendix A because only 1 percent of the inventory assumed to remain as residuals in the tanks after remediation.

The source term for LAW vaults (Table D.7.1.4) is estimated from data in Table 9.1 of WHC (WHC 1995j) and Jacobs (Jacobs 1996). The average concentration of each radionuclide in the vitrified waste form is multiplied by the volume exhumed. The volume exhumed is estimated to be 1.06 m^3 (37.4 ft^3) for a well with a diameter of 30 cm (1 ft) and a depth of 15 m (49 ft).

D.7.1. 11 No Action Alternative (Capsules)

There is no source term for the No Action (Capsules) alternative. This is because the alternative does not involve disposal of the waste. The waste would be stored elsewhere within 10 years or put to productive uses.

D.7.1. 12 Onsite Disposal Alternative

Table D.7.1. 7 shows the source term for the Onsite Disposal alternative. The source term for this alternative is the amount of activity resulting from exhuming the entire inventory of one drywell. A drywell contains one canister with a 30-cm (1-ft) diameter and a height of 3 m (10 ft). The canister contains three Sr-90 capsules and four Cs-137 capsules. Because the activity of the capsules varies, two cases are analyzed: an average case (38,470 Ci/capsule for Sr-90 and 40,100 Ci/capsule for Cs-137) and a maximum case (93,270 Ci/capsule for Sr-90 and 54,380 Ci/capsule for Cs-137) (Jacobs 1996).

Table D.7.1.7 Exhumed Inventory for the Onsite Disposal Alternative

D.7.1. 13 Overpack and Ship Alternative

There is no source term for the Overpack and Ship alternative because the capsules are shipped offsite to a geologic repository.

D.7.1. 14 Vitrify with Tank Waste Alternative

There is no source term for the Vitrify with Tank Waste alternative because the capsules are vitrified to HLW glass and shipped offsite to a geologic repository.

D.7.2 TRANSPORT

Contaminant transport is not considered for this analysis. The waste is assumed to be exhumed and spread over the surface of certain land areas. The intruders receive radiation exposures because of their proximity to and use of these contaminated surface areas.

D.7.3 EXPOSURE

To calculate exposures, the exhumed inventory in the source is multiplied by a unit dose factor to produce a dose to each receptor from each constituent. The exposure parameters and unit dose factors used for this analysis are consistent with those used by prior Hanford Site studies for estimating the dose from intrusion into a Hanford Site solid waste burial ground (Aaberg-Kennedy 1990, as modified in Rittmann 1994).

The dose to the well driller is from the inhalation and external pathways and is calculated in Rittmann (Rittman 1994). This intruder is assumed to inhale the exhumed waste for 1 hour. The well driller spreads the waste on the soil surface and works in this area for 40 hours with direct contact with the waste.

The post-drilling resident is assumed to live on a 2,500-m^2 (0.62-acre) parcel of land over which the exhumed waste has been spread (Rittmann 1994), grow different vegetables on this land, and obtain 25 percent of his vegetables from this garden. He ingests small amounts of contaminated soil each day and his total ingestion is 445 mg/yr. He inhales radionuclides suspended in the air by gardening activity and by wind for 4,380 hr/yr and is exposed externally to the contaminated soil while working in the garden or residing in the house built on top of the waste for 3,260 hr/yr.

Table D.7.3.1 presents the unit dose factors for each radionuclide in the exhumed waste under the previously listed exposure conditions for the well driller and post-drilling resident scenarios. These dose factors are calculated using the GENII computer code. The calculation methodology and assumptions are described in greater detail in Rittmann (Rittman 1994). Constituents listed in the source inventory tables that do not appear in Table D.7.3.1 are progeny in equilibrium with their parent, and the unit dose factor for the parent includes the dose from the progeny. Thus, all constituents in the source inventory are addressed. The unit dose factors shown in Table D.7.3.1 are calculated for a time 100 years from the present, corresponding to the time of assumed loss of institutional control. Time periods greater than 100 years are not evaluated because radioactive decay would cause the doses and corresponding risk at the later periods to be less than at 100 years.

Table D.7.3.1 Intruder Scenario Dose Factors at 100 Years from Present

Table D.7.3.2 presents the estimated doses to each receptor from intrusion into the eight tank sources and the LAW vaults under each alternative at 100 years from the present. These doses represent the total dose from all constituents in each source area. Of the eight tank source areas, Area 3EDS produces the greatest doses to both receptors under all the alternatives except the Ex Situ/In Situ Combination 2 alternative and is therefore carried forward to the risk calculation along with the LAW vaults. For the Ex Situ/In Situ Combination 2 alternative, the greatest doses are produced by Area 5EDS; therefore, area 5EDS, along with the LAW vaults, is carried forward to the risk calculation for the Ex Situ/In Situ Combination 2 alternative.

Table D.7.3.2 Dose to Receptor for the Eight Tank Source Areas and LAW Vaults for Each Alternative

The capsule alternative would involve the same drilling scenario, but it represents the dose from exhuming a canister from the drywell disposal facility. The dose from exhuming a canister is shown in Table D.7.3.3.

Table D.7.3.3 Dose to Receptor for the Onsite Disposal, Capsules Alternative

D.7.4 RISK

Risk is expressed in terms of the increased probability of the exposed receptor contracting a cancer (incidence) or dying from a cancer (fatality). The risk is calculated for each intruder as the product of the total dose times the dose-to-risk conversion factor. The dose for the driller is based on the annual doses provided in Tables D.7.3.2 and D.7.3.3. The risk for the post-driller resident is based on the annual doses provided in Tables D.7.3.2 and D.7.3.3 multiplied by an expected lifetime of 70 years. The dose-to-risk conversion factors used for the well driller are 4.00E-04 for cancer fatality and 4.80E-04 for cancer incidence. The dose-to-risk conversion factors used for the post-driller resident are 5.00E-04 for cancer fatality and 6.00E-04 for cancer incidence (ICRP 1991).

Table D.7.4.1 presents the estimated cancer incidence for the well driller and post-drilling resident from intrusion into tank source Area 3EDS or 5EDS and the LAW vaults under each alternative at 100 years from the present.

Table D.7.4.1 Cancer Incidence for TWRS Alternatives from Intrusion into Tanks and Vaults at 100 Years from 1995

Table D.7.4.2 presents the estimated cancer fatalities for the well driller and post-drilling resident from intrusion into tank source Area 3EDS or 5EDS and the LAW vaults under each alternative at 100 years from the present.

Table D.7.4.2 Latent Cancer Fatalities for TWRS Alternatives from Intrusion into Tanks and Vaults at 100 Years from 1995

D.7.5 UNCERTAINTY

The greatest uncertainty in calculating the intruder risk is associated with the source data. Source terms are based on the estimated inventory and an average tank within the eight aggregated tank farms of the 200 Areas. The uncertainties associated with the source term, as well as with the intrusion frequency and exposure parameters, are discussed in detail in Volume Five, Appendix K.

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APPENDIX E

RISK FROM ACCIDENTS

ACRONYMS AND ABBREVIATIONS

AIHA	American Industrial Hygiene Association
ARF	airborne release fraction
ARR	airborne release rate
ASA	accelerated safety analysis
AWF	aging waste facility
CEDE	committed effective dose equivalent
CES	Consensus Exposure Standard
Chi/Q	atmospheric dispersion coefficient
CSB	Canister Storage Building
DCRT	double-contained receiver tank
DOE	U.S. Department of Energy
DR	damage ratio
DST	double-shell tank
EBA	evaluation basis accident
EDE	effective dose equivalent
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERPG	emergency response planning guideline
FR	Federal Register
FSAR	Final Safety Analysis Report
FY	fiscal year
HEHF	Hanford Environmental Health Foundation
HEPA	high-efficiency particulate air

HLW high-level waste

IOSR Interim Operational Safety Requirement

ISB Interim Safety Basis

LAW low-activity waste

LCF latent cancer fatality

LFL lower flammability limit

LPF leak path factor

MAR material at risk

MEI maximally-exposed individual

MUST miscellaneous underground storage tank

NCR Nuclear Regulatory Commission

NEPA National Environmental Policy Act

PNL Pacific Northwest National Laboratory

RF respirable fraction

SAR Safety Analysis Report

SHMS standard hydrogen monitoring systems

SpG specific gravity

SSC safety system, structure, and component

SST single-shell tank

TOC total organic carbon

TWRS Tank Waste Remediation System

ULD unit liter dose

USQ unreviewed safety question

WESF Waste Encapsulation and Storage Facility

WHC Westinghouse Hanford Company

NAMES AND SYMBOLS

FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length

cm	centimeter
ft	foot
in	inch
km	kilometer
m	meter
mi	mile

Area

ac	acre
ft^2	square foot
ha	hectare
km^2	square kilometer
mi^2	square mile

Volume

cm^3	cubic centimeter
ft^3	cubic foot
gal	gallon
L	liter
m^3	cubic meter
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard

Mass

g	gram
kg	kilogram
lb	pound
mg	milligram
mt	metric ton

Radioactivity

Ci	curie
MCi	megacurie (1.0E+06)
mCi	millicurie (1.0E-03 Ci)
Ci	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

Electricity/Energy

A	ampere
J	joule
kV	kilovolt
kW	kilowatt
MeV	million electron volts
MW	megawatt
V	volt
W	watt

Temperature

C	degrees centigrade
F	degrees Fahrenheit

APPENDIX E

RISK FROM ACCIDENTS

ACRONYMS AND ABBREVIATIONS

AIHA American Industrial Hygiene Association

ARF airborne release fraction

ARR airborne release rate

ASA accelerated safety analysis

AWF aging waste facility

CEDE committed effective dose equivalent

CES Consensus Exposure Standard

Chi/Q atmospheric dispersion coefficient

CSB Canister Storage Building

DCRT double-contained receiver tank

DOE U.S. Department of Energy

DR damage ratio

DST double-shell tank

EBA evaluation basis accident

EDE effective dose equivalent

EIS Environmental Impact Statement

EPA	U.S. Environmental Protection Agency
ERPG	emergency response planning guideline
FR	Federal Register
FSAR	Final Safety Analysis Report
FY	fiscal year
HEHF	Hanford Environmental Health Foundation
HEPA	high-efficiency particulate air
HLW	high-level waste
IOSR	Interim Operational Safety Requirement
ISB	Interim Safety Basis
LAW	low-activity waste
LCF	latent cancer fatality
LFL	lower flammability limit
LPF	leak path factor
MAR	material at risk
MEI	maximally-exposed individual
MUST	miscellaneous underground storage tank
NCR	Nuclear Regulatory Commission
NEPA	National Environmental Policy Act
PNL	Pacific Northwest National Laboratory
RF	respirable fraction
SAR	Safety Analysis Report
SHMS	standard hydrogen monitoring systems
SpG	specific gravity
SSC	safety system, structure, and component
SST	single-shell tank
TOC	total organic carbon
TWRS	Tank Waste Remediation System
ULD	unit liter dose
USQ	unreviewed safety question
WESF	Waste Encapsulation and Storage Facility

WHC Westinghouse Hanford Company

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length

cm	centimeter
ft	foot
in	inch
km	kilometer
m	meter
mi	mile

Area

ac	acre
ft^2	square foot
ha	hectare
km^2	square kilometer
mi^2	square mile

Volume

cm^3	cubic centimeter
ft^3	cubic foot
gal	gallon
L	liter
m^3	cubic meter
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard

Mass

g	gram
kg	kilogram
lb	pound
mg	milligram
mt	metric ton

Radioactivity

Ci	curie
MCi	megacurie (1.0E+06)
mCi	millicurie (1.0E-03 Ci)
Ci	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

Electricity/Energy

A	ampere
J	joule
kV	kilovolt
kW	kilowatt
MeV	million electron volts
MW	megawatt
V	volt

Temperature		W	watt
C	degrees centigrade		
F	degrees Fahrenheit		

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E.1.0 INTRODUCTION AND METHODOLOGY

This appendix describes the current safety concerns associated with the tank waste and analyzes the potential accidents and associated potential health effects that could occur under the alternatives included in this Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS).

Current Tank Safety Issues

The 177 underground storage tanks and approximately 60 active and inactive miscellaneous underground storage tanks (MUST) included in the TWRS contain a wide variety of waste that has numerous safety concerns associated within their current condition. The principal safety issues associated with maintaining an adequate margin of safety for tank farm operations include flammable gas, noxious vapor, organic solvent, organic complexant, ferrocyanide, high-heat, criticality, and tank structural integrity. An accelerated safety analysis (ASA) is currently being developed that will more completely define the current hazards, provide a thorough accident analysis, and develop associated operational safety requirements (controls) that, when implemented, will provide an adequate safety margin for tank farm operations. A summary and status of the TWRS Safety Program, including current hazards and accident analysis, safety issues in progress, and the approach for their resolution is found in a document entitled TWRS Safety Basis (Lipke et al. 1995). The text from that document is presented nearly verbatim in the remaining paragraphs of Section E.1.0.

Historically, the Hanford Waste Tank Safety Program focused on resolving specific safety issues that were identified from a variety of sources. These issues include flammable gas, noxious vapor, organic solvent, organic complexant, ferrocyanide, high-heat, criticality, and tank structural integrity. The approach to evaluating waste tank safety concerns included developing a safety basis by applying safety analysis methodology. The TWRS ASA will provide the necessary documentation to define the safety margin for conducting safe tank farm operations.

The results from the ASA will demonstrate that the waste tanks can be safely managed with the appropriate controls as specified in the Interim Operational Safety Requirements (IOSRs). Continued characterization by sampling of the waste will be used to 1) further confirm the models of waste behavior used in the safety analysis; 2) reduce the uncertainty associated with the calculations; and 3) confirm the conservatism of the source-term data used in the analysis. This additional characterization information will provide the basis for confirming, reducing, or eliminating controls presently in place through the IOSRs.

Safety Issues

Several tank farm safety issues have been previously identified and progress has been made to resolve and close these safety issues with the appropriate documentation and/or controls. The major safety issues are related to the potential for flammable-gas generation, storage, and release, organic solvent combustion reactions, exothermic ferrocyanide-nitrate reactions, deflagration associated with organic complexants, criticality, high-heat generating waste, and tank structural integrity. Identifying and making progress toward resolving of these safety issues helped focus attention on the fact that the original safety basis for the Hanford Site waste tanks was lacking and that specific controls needed to be implemented to ensure that the health and safety of the public, workers, and environment were being adequately protected. Resolution of the remaining safety issues requires gathering information from laboratory energetics and waste degradation studies, assessing of existing sample data, evaluating historical data, and using various waste tank models to predict waste thermal behavior.

Safety Analysis

Developing the safe operating margin for the tanks system required integrating the current evolution of characterization data and understanding the safety issues to conservatively develop the safety basis for continued waste storage. An Interim Safety Basis (ISB) document was issued in November 1993 to establish the authorization basis for the tank farm facilities as part of implementing the U.S. Department of Energy (DOE) Order 5480.23, Nuclear Safety Analysis Reports. The ISB provided the basis for interim operations and controls until an upgraded Safety Analysis Report (SAR) for the tank farm facilities is completed.

Because of the importance of the safety issues associated with the Hanford Site waste tanks, a strategy was developed in mid fiscal year (FY) 1993 to accelerate the hazards and accident analyses for the waste tanks. Developing a full SAR that addressed each of the topics specified by the DOE order would follow, based on the completed hazards and accident analyses.

Application of Data to Determine Source-terms - Because of the variability of waste in the waste tanks, conservative assumptions were used to develop an upper bound for safe operations. Radiological and toxicological source-terms were developed from a combination of theoretical models, recent characterization sampling, and historical sample data. Existing data were evaluated from all sources to determine representative and bounding source-term concentrations for radioactive isotopes and hazardous chemical species. Data from further waste characterization efforts will result in reducing the conservatism in the source-terms used in the ASA analysis.

Development of Safety Envelope - The safety analysis as documented in a SAR for a nuclear facility is intended to define an operating margin or envelope including necessary controls to ensure that the facility can be operated, maintained, shut down, and decommissioned safely in compliance with applicable laws and regulations. The ASA documents the hazards and accident analysis information that will be used in the upgraded Hanford Site tank farm SAR. The ASA systematically identifies facility hazards, selects accident scenarios, and evaluates credible accident scenarios analyzed for potential consequences. When the ASA is approved, the results of the hazards and accident analyses, in combination with the IOSRs, will define the facility's safety envelope. Selecting safety class equipment and performing unreviewed safety question (USQ) determinations will be based on this safety envelope. Results presented in the ASA indicate that the tank farms can be safely maintained within acceptable bounds using appropriate design features and controls.

The hazards analysis validated that the selection of accidents analyzed in the ASA was an appropriate spectrum of bounding and representation events, which are known as evaluation basis accidents (EBAs). The hazard evaluation process also provides a thorough qualitative evaluation of the spectrum of potential accidents involving identified hazards.

The hazards analysis considered a comprehensive range of potential process-related hazards as well as those hazards associated with internal and external events for all 177 waste tanks. The hazards analysis forms the basis for understanding facility worker protection, environmental protection, selecting or confirming potential EBAs to be further developed and quantified, and determining the facility hazard classification.

The analysis results of the selected EBAs provided the basis for developing controls needed for protecting the public and co-located workers. The unmitigated consequences and associated likelihood of the EBAs were compared to the Hanford Site management and operating contractor's risk acceptance guidelines. If the unmitigated consequences and likelihoods exceeded the risk acceptance guidelines, appropriate design features, safety systems, structures and components (SSCs), or administrative controls were identified to reduce the consequence or frequency of the accidents to acceptable levels.

Each EBA was described in the following order:

- Accident scenario;
- Accident frequency;
- Radiological source-term and unmitigated consequences;
- Toxicological source-term and unmitigated consequences;
- Mitigated or prevented radiological consequences;
- Mitigated or prevented toxicological consequences; and
- SSCs, design features, or controls required to meet risk acceptance guidelines.

Table E.1.0.1 provides a list of the EBAs that were analyzed in the ASA and for which radiological and toxicological consequences were determined.

Table E.1.0.1 List of Evaluation Basis Accidents Analyzed in Accelerated Safety Analysis

A primary purpose of the accident analysis is to identify whether SSCs, design features, or controls are required for preventing or mitigating postulated accidents. By including this information in the evaluation basis accidents documentation, safety functions that required consideration for the IOSRs were easily identified. The IOSRs included the definition of acceptable conditions, safe boundaries, basis thereof, and management or administrative controls required to ensure safe operation of the tank farms.

Operational Controls

The accident analysis of the ASA calculated the consequences for unmitigated accidents and identified a range for the accident sequence event frequencies. For each accident sequence, if the consequence and frequency were outside of the risk acceptance guidelines, additional physical and/or administrative controls were established that would either prevent the postulated accident or reduce the calculated consequences or likelihood of the accident. The controls will be incorporated into the IOSRs (technical safety requirements when the SAR is completed) for the facility.

An example of the controls are those used for tanks containing flammable gases. The unmitigated consequences and associated likelihood of a flammable gas deflagration with a tank dome collapse were above the risk acceptance guidelines. Therefore, controls were developed to prevent a gas deflagration. The controls specifically addressed flammable gases accumulating within the tank vapor space, monitoring vapor space flammability concentrations, limiting or preventing ignition sources, and minimizing intrusive activities to reduce hazard exposure.

Safety Relationship with Characterization

The objective of safe waste storage and disposal requires that the waste tank characterization strategy be structured to provide priority support to addressing tank farm safety issues in the most efficient manner.

The Safety Program and characterization approach for resolving priority safety issues related to flammable gas, noxious vapor, organic solvent, organic complexant, ferrocyanide, high-heat generating waste, criticality, and tank structural integrity has been influenced by the progress made to date. The progress includes 1) completing safety analyses for flammable gas, ferrocyanide, criticality, organic solvent (tank 241-C-103), and sludge dry out; 2) successfully mitigating tank 241-SY-101 safety issues; 3) demonstrating actual and simulated waste energetics; 4) demonstrating waste degradation (aging resulting in lower energy products) in laboratory experiments and limited waste sampling for ferrocyanide and organics; 5) completing laboratory tests to define conditions required for condensed phase propagating reactions, and 6) developing an increased understanding of safety-related information that can be obtained from tank headspace sampling.

Safety Issues

The characterization approach for the safety issues continues to evolve as the parameters affecting safe storage and their relationship are better understood. In general, characterization demands are lessened as safety issues become better understood. This section reviews the current safety issues to ensure safe storage and examines the direction of future efforts.

The high-level waste (HLW) tank subcriticality safety assessment concluded that the waste in the Hanford Site waste tanks is in a form that is favorable to maintaining a large margin of subcriticality because of the small quantities of fissile material and the large amounts of neutron-absorbing materials.

The Characterization Program will continue to provide appropriate confirmatory sample data (e.g., fissile material, absorber content, and alkalinity information) as waste samples are obtained for other reasons.

High-heat tanks have been identified through temperature monitoring coupled with thermal analyses. However, only one tank, tank 241-C-106, has demonstrated any substantial high-heat load. This tank is scheduled for retrieval in late

1996. In the meantime, a chiller is being procured for this tank to mitigate potential risk that may be associated with leaks that might result from accelerated corrosion because of the increased temperature.

Waste tank structural integrity evaluations are being completed for all waste tanks. Structural and seismic evaluations are being completed, and the tank life expectancy is being determined for each tank.

Flammable Gases. Flammable gas species (mainly hydrogen and ammonia) are produced at low rates by radiochemical and thermochemical degradation reactions in waste. Vapor from organic solvents may also contribute to headspace flammability. While a mixture of gases may contain flammable constituents, a flammability hazard exists only if a minimum flammability concentration can be retained within the tank headspace (i.e., enough to exceed the minimum fuel concentration known as the lower flammability limit [LFL]). Otherwise, the gases will be dissipated to the atmosphere at concentrations too low to represent a flammability hazard.

For a flammable gas to ignite and burn, it must be mixed with an oxidizer (usually oxygen) and be provided sufficient energy to initiate the chemical reactions. A sufficiently dilute mixture of flammable gas (i.e., a concentration below the LFL) and oxidizer will not burn. The National Fire Protection Association recommends that processes be controlled so that flammable gas concentrations are less than 25 percent of the LFL. DOE requires that Hanford Site waste tanks be operated within National Fire Protection Association guidelines; therefore, management efforts must ensure that flammable gas levels are maintained below 25 percent of the LFL.

The flammable gas hazard can be classified according to the mode by which the flammable gases are released from the waste. For a steady-state gas release, gases are released at approximately the rate at which they are formed, and the concern is an accumulation of flammable gases in the tank headspace (i.e., a steady-state flammability hazard). For a limited number of tanks, gases are released episodically at comparatively high rates. For these episodic releases, flammable gas concentrations could and have exceeded 25 percent of the LFL for brief time periods. The LFL has been exceeded several times by tank 241-SY-101 (more than 100 percent of the LFL has been attained on occasion) and at least once by tank 241-AN-105. Forty-seven Hanford Site waste tanks are on a flammable gas Watchlist because the waste in these tanks is believed to have the potential to retain hydrogen gas until appreciable quantities are released. Monitors have been installed on these tanks and access controls have been imposed to minimize the potential hazard.

<u>Steady-State Release of Flammable Gases</u>. All double-shell tanks (DSTs) are actively ventilated, and air exchange is rapid enough (except during an episodic release) to keep steady-state bulk hydrogen concentrations in the headspace well below 25 percent of the LFL. However, most single-shell tanks (SSTs) are passively ventilated and only exchange air with the environment by relatively slow barometric pressure changes and instrument air purges. Therefore, potential accumulation of flammable gases in the headspace and risers of all SSTs has been explored.

Preliminary studies have examined the accumulation of flammable gases in the headspace and risers of SSTs that are not on the flammable gas Watchlist. A more detailed study on flammable gas accumulation is currently being developed. However, calculations performed thus far show that gas production and release rates from thermochemical and radiochemical processes are modest and that passive ventilation alone will keep the headspace well below 25 percent of the LFL. The contribution to the flammable gas mixture from organic solvent vapor is low because the bulk of organic solvent remaining in any tank would likely have a low vapor pressure. Sampling data from tank 241-C-103, which contains a floating organic layer, support this conclusion. Vapors from the organic solvent amount to less than 5 percent of the LFL.

<u>Episodic Release of Flammable Gases</u>. The ability of waste to retain large amounts of gas depends on its physical properties and chemical/radiological composition. The waste retains gases that increase the waste volume (slurry growth) until the gases escape. Slurry gas is only present in tank headspace at high concentrations when it is released by the waste; therefore, the most direct way to characterize gas may be to sample the waste directly.

The amount of gas retained in the waste will be estimated from analyzing the tank operational data. Tank monitoring data include changes in surface level (resulting from gas release events and changes in atmospheric pressure) and axial waste temperature profiles. New, more accurate level gages and instrument trees (that measure temperature) are being installed in Hanford Site waste tanks. In addition, standard hydrogen monitoring systems (SHMS) are also being installed on all flammable gas Watchlist tanks.

Near-Term Characterization of Flammable Gas. Sampling and/or continuous monitoring is being used to confirm that flammable gas does not accumulate in the SSTs. Headspace sampling results from 30 SSTs (none of which are on the flammable gas Watchlist) indicate that flammability in the headspace and risers is well below 25 percent of the LFL. Headspace sampling of passively ventilated SSTs for flammable gases will continue until all are sampled. None of these tanks are expected to contain steady-state flammable gas concentrations above 25 percent of the LFL. However, if concentrations greater than 25 percent of the LFL are measured for non-Watchlist tanks, then these tanks would become candidates for continuous gas monitoring and potential mitigation.

The headspace of tanks that are suspected of having waste that releases flammable gases episodically will be continuously monitored for flammable gases. SHMS have been designed, built, and installed on all flammable gas Watchlist tanks. SHMS contain instrumentation that support an online hydrogen detector and a gas grab sampler.

Future Characterization of Flammable Gases. Two techniques that are being developed to directly characterize waste for retained gas are 1) a void meter to measure the volume fraction of the gas phase in the waste, and 2) a retained gas sampling system to extract a waste sample from a tank so that the waste can be analyzed (gas can exist as a distinct phase in the waste, and it can also be absorbed on solid or dissolved in aqueous liquid phases). In the near future ammonia monitoring capability will be added to the SHMS. Another system is being developed for in situ measurement of physical properties (density, viscosity, shear strength) that are critical to evaluating stored gas. Development of these systems is underway.

Noxious Vapors

Several health and safety issues are related to noxious vapors that may be present in some of the HLW tanks at the Hanford Site. A tank-by-tank sampling approach is being pursued to resolve headspace issues dealing with flammability and noxious vapors. Vapor sampling will be conducted on all tanks in the Tank Farm Complex.

Modeling and vapor data from tank 241-C-103 indicate that the tank head space is well mixed except during an episodic gas release. To verify that the headspace is well mixed, additional headspace sampling at different vertical and horizontal locations will be conducted in selected tanks.

If any compounds are detected inside a tank dome with toxicological properties that exceed their respective trigger points, Westinghouse Hanford Company (WHC) Industrial Hygiene is advised that gases with toxicological concern are present in the tank headspace. The trigger point has been defined as 50 percent of the appropriate Consensus Exposure Standard (CES) concentration for all analyses of interest. A CES, which is generally defined as the most stringent of known regulatory or recommended toxicological values for the occupational setting, includes the threshold limit value, permissible exposure limit, recommended exposure limit, and biological exposure limit.

The data required to assess toxicity include 1) identifying chemical compounds in the tank headspace of concern for worker health and safety or toxicological importance; 2) estimating the concentrations of these toxicologically substantial compounds in the headspace; and 3) understanding the toxicological effects of these compounds and the CES for each constituent of concern.

Organic Solvents

Various separation processes involving organic solvents have been used at the Hanford Site. These organic solvents were inadvertently and/or purposely sent to the underground storage tanks, and subsequent waste transfer operations distributed organic solvents among several of the 177 HLW tanks. The potential hazards associated with organic solvent are 1) contributing to headspace flammability (as discussed previously); 2) igniting an organic solvent pool; and 3) igniting an organic solvent that is entrained in waste solids.

Currently, one tank (241-C-103) is known to contain an organic solvent pool. Additional tanks that may contain an organic solvent pool will be identified through continued vapor sampling of the tank headspace. Analyses have shown that solvent pool fires are difficult to initiate. Waste that may contain entrained organic solvent will also be identified through vapor sampling of the tank headspace. These analyses have been integrated into the noxious vapor sampling campaign. If vapor sampling suggests the presence of organic solvent, liquid grab samples and/or near-surface samples will be obtained to better quantify the potential for an organic solvent fire.

Fuel-Nitrate (Condensed-Phase) Reactions

Organic complexants and ferrocyanide were sent to the tanks. These compounds have the potential to act as a fuel when combined with an oxidizer. Nitrate salts have also precipitated in the tanks and are potential oxidizer sources. For the organic complexant (nonvolatile materials) and ferrocyanide safety issues, the approach to safety characterization is based on the fact that propagating reactions cannot occur if either the fuel, oxidizer, or potential initiators (e.g., temperature or energy) are controlled. Because specific limits of fuel, oxidizer, and initiators must be satisfied for a propagating chemical reaction to occur, waste can be stored safely if the conditions for the reaction are not possible. Therefore, the approach for obtaining characterization information is to obtain data that would confirm that one of the conditions of fuel or oxidizer is not present in sufficient quantities or that initiators are absent or can be controlled.

An important parameter in controlling propagating reactions is an inhibitor such as moisture. In sufficient quantity, moisture will prevent propagating reactions by 1) behaving as an inert diluent (lowering the effective fuel concentration); 2) preventing initiation of a propagating reaction (the energy from most credible initiators would be absorbed by the sensible and latent heat of the moisture before the waste reached the critical initiation temperature); and 3) providing a large heat sink that inhibits propagation (for a reaction to propagate, enough energy must be supplied to overcome the sensible and latent heat of the moisture present).

Fuel and Moisture Criteria - Experiments have shown that moisture can prevent condensed-phase propagating reactions. Tube propagation tests on waste simulants have shown that propagating reactions cannot occur in waste simulants containing more than 20 weight percent moisture. Sufficient moisture content can ensure that a propagating reaction will not occur, regardless of the fuel-oxidizer concentration. For example, if adequate moisture can be confirmed through monitoring, analysis, or sampling, then it can be concluded that condensed-phase exothermic reactions will not occur, thus ensuring interim safety waste storage.

The minimum required fuel concentration has been determined using a contact temperature ignition model. A necessary (but not sufficient) condition for a condensed-phased propagating chemical reaction is that the fuel concentration be greater than 4.5 weight percent total organic carbon (TOC), based on sodium acetate as fuel, or 1,200 joule/gram (J/g) on an energy equivalent basis. For fuel concentrations between 1,200 and 2,100 J/g, the waste moisture content required to prevent a propagating reaction varies linearly from 0 to 20 weight percent. Above 20 weight percent moisture, the fuel-moisture linear relationship no longer holds because the mixture become a continuous liquid phase, effectively preventing propagating reactions. Note that the TOC criteria depends on the chemical concentration of the waste. Table E.1.0.2 summarizes the criteria for safe storage.

Table E.1.0.2 Safe Storage Criteria

Parameters Affecting Fuel Concentration - Waste tank operations have affected fuel concentration in the tanks. Experiments on waste simulants have shown that the high-energy organic complexants (i.e., the organic salts that could support a propagating reaction) are highly soluble in the tank supernatant solutions. Subsequent pumping of the tank liquid might have removed most of the organic complexant fuels.

Ferrocyanide waste stored in Hanford Site tanks has been exposed to caustic solutions and radiation for nearly 40 years. Long-term degradation (aging) of ferrocyanide is known to have occurred through chemical and radiolytic processes in the waste. Analyses of core samples taken from six of the 18 ferrocyanide tanks reveal fuel values about an order of magnitude less than the original flowsheet concentrations. These remaining fuel values are well below the concentration of concern. Experimental work at Georgia Tech and Pacific Northwest National Laboratory (PNL) has demonstrated that complexants and other organics degrade under radiation and/or chemical oxidation conditions found in tanks. In addition, analysis of the original tank 241-SY-101 core sample complexant waste demonstrated extensive chemical degradation products.

Near-Term Characterization of the Condensed Phase - Current characterization efforts are focused on testing tank waste samples to confirm that the criteria shown in Table E.1.0.2 are conservative for actual waste. That is, if the waste meets the energy (fuel value), TOC, or moisture criterion, then the waste will not support a propagating reaction. Waste from selected tanks will be tested for reaction propagation in the same type of adiabatic calorimeter (the reactive system screening tool) that was used to develop the criteria.

Near-term sampling efforts are also focused on confirming degradation of ferrocyanide and organic complexant waste. Full-depth core samples from ferrocyanide tanks will be analyzed for fuel, nickel (a signature analyte of the sodium nickel ferrocyanide scavenging campaign), and total cyanide to confirm ferrocyanide aging. Full-depth core samples for organic complexant tanks will be analyzed for organic species to confirm that organic complexants have degraded to less energetic species.

In addition, liquid and solid samples from organic complexant tanks will be analyzed to confirm the laboratory demonstration that high-energy organic complexants are soluble.

Reaction Ignition

Credible Ignition Sources - If the waste has a sufficiently high fuel and low moisture content, a propagating reaction could be initiated if an energy source raised the temperature of the waste to the reaction initiation temperature. The potential for tank farm equipment and operations to initiate propagating reactions has been evaluated and is summarized in Table E.1.0.3. In this evaluation, all credible initiators would be located near the waste surface, with the exception of rotary-core drilling incidents and lightning.

Table E.1.0.3 Summary of Operation Evaluation

Although rotary-core drilling incidents and lightning strikes cannot be deemed incredible initiating events, the risk can be mitigated with controls. The rotary-core driller is designed with safety interlocks that limit increases in drill bit temperature. Ignition from lightning strikes can be prevented by appropriate grounding. The need to further ground the SSTs is being studied because of their unique construction.

The TWRS Safety Program is currently establishing the requirements for analytical data to confirm the models used in the safety analysis and the conservatism of the source-term. This additional characterization information will provide the basis for conforming, adjusting, or eliminating controls at Hanford Site waste tanks to ensure adequate protection of the workers, public, and the environment.

Criticality

Based on new information available to DOE, regarding nuclear criticality safety concerns during retrieval, transfer, and storage actions since the issuance of the Final Safe Interim Storage EIS, DOE has decided to defer a decision on the construction and operation of a retrieval system in tank 241-SY-102. Through an ongoing safety evaluation process, DOE recently revisited its operational assumptions regarding the potential for the occurrence of a nuclear criticality event during waste storage and transfers. Changes to the Tank Farm Authorization Basis for Criticality that were approved in September 1995 were rescinded by DOE in October 1995, pending the outcome of a criticality safety evaluation process outlined for the Defense Nuclear Facility Safety Board on November 8, 1995. Until these criticality safety evaluations are completed, the Hanford Site will operate under the historic limits, which maintain reasonable insurance of subcritical conditions during tank farm storage and transfer operations. Of the actions evaluated in the Final Safe Interim Storage EIS, only the retrieval of solids from tank 241-SY-102 was affected by the technical uncertainties regarding criticality. Based on the quantities of plutonium in tank 241-SY-102 sludge, retrieval of the solids falls within the scope of the criticality safety issues that will be evaluated over the next few months. As a result, a decision on retrieval of solids from tank 241-SY-102 was deferred in the Safe Interim Storage EIS Record of Decision. Also, pending the outcome of the technical initiative to resolve the tank waste criticality safety issue, transfers of waste (primarily saltwell liquid) through tank 241-SY-102 will be limited to noncomplexed waste. Tank 241-SY-101 mixer pump operations, interim operations of the existing cross-site transfer system, operation of the replacement cross-site transfer system, saltwell liquid retrievals, and 200 West Area facility waste generation all would occur within the applicable criticality limits and would be subcritical.

The remainder of this document analyzes potential accidents and the related consequences that could occur from implementing the alternatives addressed in this EIS.

Risk from Remediation Accidents

Accidents are unplanned events or a sequence of events that cause undesirable consequences. The risk associated with an accident is defined as the product of the probability of an accident occurring and the consequences of the accident. This includes nonradiological injuries, illnesses, and fatalities from construction, operations, or transportation accidents. Risk is also defined as the probability or the number of latent cancer fatalities (LCFs) from radiological or toxicological releases, given the occurrence and consequences of an accident. This analysis considers both types of risk.

An analysis was performed to determine the nonradiological and nontoxicological risks from construction, operations, and transportation. These are called occupational risks and include personal injuries, illnesses, and fatalities common to the work place such as falls, cuts, and operator-machine impacts.

An analysis was also performed to determine the potential for radiological and toxicological impacts. The results of the analyses are summarized in the following subsections. More detailed information concerning the methodology, supporting data, and assumptions for the basis of the analysis is contained in this appendix.

The alternatives, as described in Volume Two, Appendix B, include the following:

Tank Waste

- No Action alternative
- Long-Term Management alternative
- In Situ Fill and Cap alternative
- In Situ Vitrification alternative
- Ex Situ Intermediate Separations alternative
- Ex Situ No Separations alternative
- Ex Situ Extensive Separations alternative
- Ex Situ/In Situ Combination 1 and 2 alternatives
- Phased Implementation

Cesium (Cs) and Strontium (Sr) Capsules

- No Action alternative
- Onsite Disposal alternative
- Overpack and Ship alternative
- Vitrify with Tank Waste alternative

E.1.1 RADIOLOGICAL LATENT CANCER FATALITY RISK AND CHEMICAL EXPOSURE

The methodology used to identify and quantify the radiological cancer risks, chemical exposures, occupational injuries, illnesses and fatalities, and transportation risks from postulated accidents are discussed in this section. The radiological LCF risk and chemical exposure to humans from accidents was performed using the following steps:

- Identify the spectrum of potential accidents associated with each alternative (Section E.1.1.1, Accident Identification);
- Select the dominant (highest potential risk) accidents for risk analysis (Section E.1.1.2, Accident Scenario Selection);
- Determine the radiological and chemical inventories potentially released in the accidents (Section E.1.1.3,

Source-term and Direct Exposure);
- Calculate the probability of occurrence of the potential accident (Section E.1.1.4, Probabilities);
- Determine the location of the worker, noninvolved worker, and general public (receptors) relative to the point of release of the waste material (Section E.1.1.5, Receptor Locations);
- Determine the radiological dose and chemical exposure to the worker, noninvolved worker, and general public at the location of the receptor (Section E.1.1.6, Radiological Dose and Chemical Exposure Assessment); and
- Calculate the LCF risk and compare the chemical exposure to concentration limits (Section E.1.1.7, Risk Development).

The following subsections discuss these steps in detail.

E.1.1.1 Accident Identification

A hazard is an inherent physical or chemical characteristic that has the potential for causing harm. The potential release of high-level radioactive waste to the environment from the tank farms and processing facilities that are included in the various alternatives is of concern to DOE, Hanford Site workers, and the public. Initiating events that could result in such a release include natural phenomena, human error, component failure, and spontaneous reactions.

Accidents are unplanned events or a sequence of events that result in undesirable consequences. The first step in the analysis was to identify the spectrum of potential accidents associated with construction, transportation, and operation activities involved in each TWRS EIS alternative. Construction activities include potential occupational accidents. Transportation activities include potential radiological, toxicological, and occupational accidents. Operation activities include potential radiological, toxicological, and occupational accidents.

The compilation of potential accident scenarios for tank farms, waste transfer facilities, pretreatment facilities, and processing facilities for each alternative is contained in the accident data package (Shire et al. 1995). This accident data package was prepared specifically to support the TWRS EIS. The spectrum of potential accidents identified in the data package are summarized in Table E.1.1.1.

Table E.1.1.1 Summary of Potential Tank Waste Accidents

Each alternative was divided into six components as applicable: continued operations (C), retrieval (R), pretreatment (separations of HLW from low-activity waste [LAW]) (P), treatment or immobilization (I), transportation (T), and disposal (D). A determination was then made whether each potential accident could occur during each component for each alternative. Not all alternatives involve every component. For example, there is no treatment component for the No Action tank waste alternative. In addition, not every potential accident can occur in a particular component for every alternative. For instance a dropped canister filled with vitrified HLW could only happen during treatment in the Ex Situ Vitrification alternatives. In Table E.1.1.1, an "x" indicates that the accident is applicable to the component for the identified alternative.

Each potential accident in Table E.1.1.1 is coded with a multi-digit number corresponding to the subsection in which it was found in the accident data package (Shire et al. 1995 and Jacobs 1996). A more detailed description of these accidents is provided in the referenced sections in the data package.

E.1.1.2 Accident Scenario Selection

After the potential accidents were identified, accidents with highest risks for each general waste-handling activity were screened and analyzed in further detail.

Screening for the highest risk accidents involved listing all the potential accidents from Table E.1.1.1 on an accident screening table. Table E.1.1.2 is an example of a screening table. The table identifies the broad range of potential accidents and assigns calculated or estimated risk (frequency of the event times the consequences) of each accident. The potential hazards were grouped according to the mode of operation and subdivided further according to the activity within this mode. The risk shown in the last column is the product of the annual frequency of the event happening and the severity(consequences) of the accident. The values used in the annual frequency and severity columns are qualitative as defined in Tables E.1.1.3 and E.1.1.4. For the frequency of the event, factor values of 4 (anticipated); 3 (unlikely); 2 (extremely unlikely); and 1 (beyond design basis) were assigned. For the severity of the events, factor values of 4 (high); 3 (moderate); 2 (low); and 1 (no) were assigned. The factor values used for the frequency of the event and the severity of the event are numbers used only for the purpose of screening. Where the risk values for more than one event in the same category are the same, the rationale for choosing the scenario to be evaluated was based on the accident with the highest severity. It should be noted that accident scenarios with the worst radiological consequences would also result in the worst chemical exposures.

Table E.1.1.2 Example Accident Screening Table

Table E.1.1.3 Frequency Category Definition

Table E.1.1.4 Qualitative Accident Severity Levels

Beyond design basis accidents were also analyzed for each alternative. For this analysis, beyond design basis accidents are accidents with a frequency range of 1.0E-06 to 1.0E-07 per year (design basis accidents are greater than 1.0E-06 per year) for operator external accidents or below the Site-specific designated return frequency for natural events. This does not mean that the facilities have been designed to this accident frequency range. Accidents with frequencies less than 1.0E-07 (less than one in10million) per year were not examined because of their extremely low probability of occurrence.

When an alternative has been selected for remediation of the Hanford tank waste, if accidents associated with the alternative exceed the acceptable limits of risk, mitigation measures may be required to reduce the level of risk.

The types of accidents selected for evaluation in the TWRS EIS are consistent with the types of accidents currently being developed for the TWRS Final Safety Analysis Report (FSAR). The FSAR is comprehensive and detailed evaluation of the potential accidents that could occur within TWRS and will be used to establish safe operating methods. The preliminary FSAR is scheduled to be issued in the fall of 1996. Because the accident analyses for the FSAR are at different stages of development and review, they are subject to change at this time. The three worst-case scenarios being developed in the TWRS FSAR that were evaluated as bounding design basis accidents in the TWRS EIS are:

- Spray leak in a valve pit during waste transfer;
- Flammable gas deflagration in a waste storage tank; and
- Organic nitrate fire in a waste storage tank.

The spray leak in a valve pit was identified in the screening analysis as the accident with the highest risk during waste tank transfer for the continued operations component.

The flammable gas deflagration in a waste storage tank was identified as having a higher risk than an organic nitrate fire in a storage waste tank during continued operations; therefore, the flammable gas deflagration was selected for further evaluation to determine the radiological and toxicological risks.

The beyond design basis accident evaluated in the TWRS EIS is a seismic event resulting in the collapse of a SST dome. The TWRS FSAR is currently developing a beyond design basis earthquake scenario that would result in tank failure.

The consequences presented in the Final EIS are based on National Environmental Policies Act (NEPA) guidance that calls for an integrated risk assessment based on a "reasonably foreseeable" accidents that could occur over the lifetime of the operation. The consequences presented in the FSAR result from worst-case scenarios based on extreme parameters. The worst-case scenarios are used to determine the hazard classification and the safety classification and are not considered to be "reasonably foreseeable" scenarios and therefore inappropriate for an EIS. To develop an integrated risk for the EIS based on the worst-case scenarios would result in unrealistic and undefendable risk values.

E.1.1.3 Source-term and Direct Exposure

For this analysis the source-term is the respirable fraction of inventory from which the receptor dose is calculated. It is based on the inventory that could potentially be released to the environment from an accident, referred to as material at risk (MAR), multiplied by the applicable reduction factors listed in the following text. Use of the reduction factors is dependent on the nature of the accident (i.e., energy of accident at impact, waste form, and effectiveness of mitigating barriers such as high-efficiency particulate air [HEPA] filter).

Damage ratio (DR) - The fraction of the MAR impacted by the event.

Airborne release fraction (ARF) - The fraction of released material made airborne by the event at the point of origin.

Airborne release rate (ARR) - The fractional ARR of material resulting from the accident at the point of origin. ARR is converted to ARF by integrating over the time available for release.

Leak path factor (LPF) - The fraction that escapes the confinement boundary by design, natural causes, or degradation caused by the event.

Respirable fraction (RF) - The fraction of airborne droplets or particulate matter with individual particle aerodynamic equivalent diameter less than or equal to 10 micrometers (m) (3.9 E-04 inches [in.]).

Exposure also may result from direct exposure to radiation. Direct exposure is the direct gamma radiation dose rate to a receptor.

It should be noted that the ingestion and groundshine pathways were not included for remediation accidents because of the corrective action that would be taken by DOE to remediate the release from the accident. Corrective actions would be taken that would include 1) restricting access to the impacted area; 2) evacuating offsite populations within the area of impact; and 3) remediating contaminant deposition to levels that ensure protection of human health before access to the area would be allowed.

Under all accident scenarios, most of the deposition would occur near the tank farms and extend at diminishing levels to the Site boundary in the direction of the prevailing wind at the time of the accident. Deposition would also occur at much lower levels offsite, with the highest levels closest to the Site boundary and diminishing levels out to a 80 kilometers (km) (50-mile [mi]) radius of the Site where no depositions at levels that would impact human health or the environment would occur. In addition to the direct impacts to human health resulting from inhalation, if an accident were to occur there would be additional impacts that would potentially occur based on the magnitude of the accident. These impacts could include:

- Restrictions on access to sites sacred to Tribal Nations impacted by depositions on the Hanford Site during remediation of the depositions;
- Temporary disturbance to ecological, biological, and cultural resources impacted by depositions and the resulting remediation of the depositions; and
- Economic impacts associated with the cost of the remediation of depositions and the dislocation of populations within the area of impact.

All of the accident scenarios during remediation have small offsite consequences or the probability of the event is extremely unlikely. Therefore, a detailed analysis of environmental, socioeconomic, and cultural impacts from these accidents, in accordance with NEPA guidance (DOE 1993d), have not been performed. However, a relative comparison among the alternatives of the impacts of these potential accidents is possible based on the human health impacts addressed previously. In most cases, the greater the impact to human health, the greater the environmental, socioeconomic, and cultural impact that would result from the accident.

Post-remediation accidents that take place after the 100-year institutional control period assume no corrective action and include the added risk from groundshine, ingestion, and deposition.

E.1.1.3.1 Inventory

The tank waste inventory for the SSTs, DSTs, and MUSTs is presented in Appendix A, Section A.2.1, Tables A.2.1.1, A.2.1.2, and A.2.1.3 of this EIS. The Cs and Sr capsule inventory at the Waste Encapsulation Storage Facility (WESF) are presented in Table A.2.2.1. However, for developing tank farm accidents, a 100 percent inventory bounding composite was developed. This composite incorporates historical tank contents estimates, the results from prior individual tank analyses, and the results of recent tank characterization programs (Shire et al. 1995 and Jacobs 1996). This composite was developed because engineering information was not sufficiently mature to determine which tanks would have their inventory mixed during retrieval and transfer. This could be thought of as a single tank containing the highest activity concentration for each nuclide found in the sample data. This maximum sample activity composite grouping means the highest radioactivity concentration for each radionuclide is combined to define a hypothetical "highest concentration" inventory used to bound the accidents. For process facility accidents a 90 percent composite was assumed.

A less conservative approach was also used to estimate the inventory of radioactive materials contained in the fuel from the single-pass reactors and N Reactor and sent to the tank farms. Total radionuclide inventories were calculated based on the complete operating history of all of the Hanford Site production reactors. Reduction factors were then applied to the total inventories to account for plutonium (Pu) and uranium (U) extracted from the waste sent to the tanks. Reduction factors also were applied to Cs and Sr, which also were extracted from the waste. The 11 radionuclides that contribute to over 99 percent of the total dose as reported in the supporting document for developing the unit liter doses (ULDs) (WHC 1996c) are shown in Table E.1.1.5 with the total activity of each nuclide.

Table E.1.1.5 Tank Inventory Based On Reactor Products

Because the tank waste inventory has not yet been well characterized, bounding and nominal radiological and toxicological consequences are presented in the analysis to provide a risk range.

E.1.1.4 Probabilities

The probabilities of radiological and toxicological accidents occurring were taken from the accident data package (Shire et al. 1995 and Jacobs 1996). The accident probability data package was prepared specifically to support the TWRS EIS. The accident initiator frequencies were established using currently accepted sources of occurrence frequency such as natural phenomena statistics for the Hanford Site, recent analysis of the initiators, or industry-accepted frequencies.

The probabilities have conservatively not taken into account 1) the frequency of time the wind blows in the direction of the presumed receptor location (the wind is always assumed to blow towards the receptor); 2) the likelihood the receptor would be at the presumed receptor location for the duration of the plume passage; 3) the likelihood that the source-term (composite inventory) would be released. It is assumed that the composite inventory would always be released; and 4) emergency planning and evacuation programs are in place at the Hanford Site to mitigate potential consequences resulting from an accident. In the event of an accident, the Emergency Control Center is responsible for determining the correct plan of action in accordance with the Emergency Management Procedures (WHC 1996a). For example, if the appropriate plan of action is to take cover, individuals are notified by announcements over the public address system to go inside building(s). The ventilation system is turned off to prevent unfiltered air, with contaminants, from entering the buildings. If the appropriate plan of action is to evacuate the Site, an orderly evacuation with designated meeting places is conducted. It has been demonstrated that evacuation can be conducted in less than an hour (Sutton 1996).

Accidents with annual frequencies greater than 1.0E-06 were considered to be within design basis accidents. Beyond design basis accidents have an annual frequency range from 1.0E-06 to 1.0E-07. Accidents with annual frequencies less than 1.0E-07 were not examined.

E.1.1.5 Receptor Locations

The radiological dose to a receptor depends on the location of the receptor relative to the point of release of the radioactive material. Doses for a maximally-exposed individual (MEI) and population dose were computed for each receptor (worker, noninvolved worker, and general public). Workers are those involved in the proposed action and are in the work place performing work at the facility. Noninvolved workers are onsite workers but not involved in the proposed action. The general public are those located off the Hanford Site. The MEI for each of these three receptor categories is a single individual that is assumed to receive the highest exposure in the category. The location of each receptor is discussed in the following text.

Worker Population and Maximally-Exposed Individual Worker - The worker population and MEI worker are those individuals directly involved in implementing the alternatives. They are assumed to be in the center of a 10 m (33.0 foot [ft]) radius hemisphere where the airborne released material has spread instantaneously and uniformly and would expose a typical size crew of 10 people.

Noninvolved Worker Population - The noninvolved worker population was based on the Site employment and was assumed to extend from 100m (330 ft) out to the Hanford Site boundary. The Hanford Site specific population was obtained from the Hanford Site phone directory and increased by 10 percent to account for uncertainties. No reduction was applied for multiple work shifts or absences. All employees were assumed to be present. For accidents at the tank farms, the noninvolved worker population would be 1,835. For accidents at the vitrification facilities, the population would be 5,500.

Maximally-Exposed Individual Noninvolved Worker - The MEI noninvolved worker was assumed to be located at 100m (330 ft) from the release point in the direction that produces the highest dose. This distance was used rather than the actual nearest building location, because new construction or movement of trailers and relocateable buildings can change the actual nearest building locations.

General Public Population - The offsite population distribution from the Hanford Site boundary to a distance of 80 km (50 mi) was taken from the GENII computer code (Napier et al. 1988). The offsite population would be 114,734.

Maximally-Exposed Individual General Public - The MEI general public was assumed to be located at the Hanford Site boundary (Volume 1, Figure 1.0.1) in the direction that produces the highest dose. An adjusted Site boundary that excludes areas likely to be released by DOE in the near future was used in the analysis. The Site boundary for the EIS was defined as follows:

- N. Columbia River - 0.4 km (0.25 mi) south of the south river bank.
- E. Columbia River - 0.4 km (0.25 mi) west of the west river bank.
- S. A line running west from the Columbia River, just north of the Washington Public Power Supply System (Supply System) leased area, through the Wye Barricade to Highway 240.
- W. Highway 240 and Highway 24.

E.1.1.6 Radiological Dose and Chemical Exposure Assessment

The computer code GXQ was used to calculate the dispersion of potential radiological releases into the atmosphere referred to as the atmospheric dispersion coefficient (Chi/Q). GXQ has been verified and benchmarked against the GENII computer code. The calculations use the most recent available meteorological joint frequency data based on the nine-year (1983 through 1991) average data from the Hanford Site meteorology tower in the 200 Area (Schreckhise 1993). The method for computing Chi/Q is based on Nuclear Regulatory Commission (NRC) Regulatory Guide 1.145 (NRC 1982). All accident-induced releases were assumed to be ground level releases, and plume meander was factored into the GXQ model. Plume rise, building wake, and dry deposition were not used. The receptor was assumed to be located at the plume centerline (i.e., at the location of peak concentration). For the bounding scenarios, the greater of the 99.5 percent maximum sector or 95 percent overall Site Chi/Q values were used.

Doses for atmospheric releases were computed with the GENII code, which has been verified and validated. The doses from radioactivity deposited inside the body were computed using weighting factors for various body organs and the results summed to calculate a committed effective dose equivalent (CEDE). The computer code was used to calculate the inhalation dose for a 70-year dose commitment period.

The radiological dose [D (Sv)] for the noninvolved worker and general public receptors were calculated using the straight-line Gaussian dispersion model as shown in the following equation:

$$D\ (Sv) = [Q\ (L)] \cdot [Chi/Q\ (s/m^3)] \cdot [R\ (m^3/s)] \cdot [ULD\ (Sv/L)]$$

Where:

Q = Liters of respirable waste released from the accident

Chi/Q = Time integrated atmospheric dispersion coefficient calculated by GXQ code

R = Typical acute breathing rate of 3.3E-04 cubic meter per second (m^3/s) (1.2E-02 cubic feet per second (ft^3/s) (ICRP 1975)

ULD = CEDE per unit liter inhaled.

The liters of respirable waste released (Q) is the source-term as defined in Section E.1.1.3. The Chi/Q is generated by the GXQ computer code (Section E.1.1.5.3). The breathing rate (R) is the typical acute (light activity) breathing rate. The ULD was generated by the GENII computer code for composite source-terms and the values are given in terms of CEDE per unit liter of waste inhaled at the receptor location.

The radiological dose [D (Sv)] for the worker receptor was calculated using the following equation:

$$D\ (Sv) = [Q\ (L)] \cdot [BR\ (m^3/s)] \cdot [t\ (s)] \cdot [2/3\ ?\ r^3]^{-1} \cdot [ULD\ (Sv/L)]$$

Where:

Q = Liters of respirable tank waste released

t = Duration of worker exposure

BR = Typical acute breathing rate, 3.3E-04 m^3/s (1.2E-02 ft^3/s)

r = Assumed 10 m (33ft) radius from point of release for distribution of source activity

ULD = CEDE per unit liter inhaled.

Peak concentrations, C (mg/m^3), for a continuous release of solid or liquid chemical materials were calculated using the following equation:

$$C\ (mg/m^3) = [Q\ (mg/s)] \cdot [Chi/Q\ (s/m^3)]$$

Where:

Q = Chemical material release rate

Chi/Q = Continuous release atmospheric dispersion coefficient.

The volume of respirable material released (Q) is the source-term and the Chi/Q was generated by GXQ computer code.

For instantaneous or short duration releases of chemicals, the maximum puff Chi/Q was used. The following equation was used to calculate the peak concentration:

$$C\ (mg/m^3) = Q\ (mg) \cdot Chi/Q\ (1/m^3)$$

Where:

Q = Toxic material released

Chi/Q = Puff release atmospheric dispersion coefficient.

E.1.1.7 Risk Development

Radiological risk. The likelihood that a dose of radiation would result in a fatal cancer at some future time is known as LCF and is calculated by multiplying the calculated dose (radiation effective man [rem]) by a risk factor, or dose-to-risk conversion factors. Conversion factors are predictions of health effects from radiation exposure. The dose-to-risk conversion factors used for estimating cancer deaths from low doses of radiological exposure and from high doses were taken from Recommendations of the International Commissions on Radiological Protection (ICRP 1991). They are summarized as follows:

- Onsite (worker and noninvolved worker) - 4.0E-04 LCF/person-rem or 400 cancer fatalities per million person-rem for low doses (less than 20 rem) and 8.0E-04 LCF/rem or 800 cancer fatalities for million person-rem for doses greater or equal to 20 rem.
- Offsite (general public) - 5.0E-04 LCF/person-rem or 500 cancer fatalities per million person rem for low doses (less than 20 rem) and 1.0E-03 LCF/rem or 1,000 cancer fatalities per million person-rem for high doses greater or equal to 20 rem. The difference in the onsite and offsite conversion factors is attributable to the presence of children offsite.

Multiplying the dose by the conversion factor shows the risk only if the accident takes place. Because the probability of the accident also needs to be factored into the evaluation, the radiological LCF risk is the product of the receptor dose, the dose-to-risk conversion factor, and the probability of the accident.

The quantitative estimate for the population receptors is the number of fatal cancers resulting from the radiological exposure. For the MEI receptors it is the probability the individual will die from cancer as a result of the exposure.

Other biological effects may result from radiological exposures. Somatic effects that occur early as a result of receiving a large dose in a short period of time (acute exposure) include vomiting, nausea, and diarrhea from a dose of 25 rem up to 220 rem. Deaths begin to occur beyond 220 rem with up to 100 percent deaths from doses between 500 to 750 rem.

Chemical risk - Potential acute hazards associated with exposure to concentrations of postulated accidental chemical releases were evaluated using a screening-level approach for the MEI worker, MEI noninvolved worker, and the MEI general public. This screening-level assessment involved direct comparison of calculated exposure point concentrations of chemicals to a set of site-specific (i.e., Hanford Site-specific) air concentration screening criteria, known as emergency response planning guidelines (ERPGs).

ERPGs, as developed by the American Industrial Hygiene Association (AIHA), are specific levels of chemical contaminants in air designed to be protective of acute adverse health impacts for the general population. ERPGs are defined in the following text.

ERPG-1 - The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse effects or perceiving a clearly defined objectionable odor.

ERPG-2 - The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action.

ERPG-3 - The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

For the accident scenarios evaluated, AIHA ERPGs were used as the primary criteria. For those chemicals lacking published AIHA ERPGs, Hanford Site-specific ERPGs were used as published in the Toxicological Evaluation of

Tank Waste Chemicals, Hanford Environmental Health Foundation (HEHF) Industrial Hygiene Assessments (Dentler 1995). These tank farm-specific ERPGs were developed by HEHF for the purpose of evaluating health hazards associated with chemicals in the tank farms from accidental releases.

Chemicals were subdivided based on acute health impacts into toxic chemicals or corrosive/irritant chemicals. Given the lack of quantitative data and large number of target organs affected by a chemical from acute exposure, chemicals within each group were conservatively assumed to be additive. Cumulative hazards or the Acute Hazard Index for the toxic and corrosive/irritant chemical classes were evaluated as follows:

$$\text{Cumulative Hazard (Acute Hazard Index)} = C_1/E_1 + C_2/E_2 + ... + C_i/E_i$$

Where

C_i = Calculated airborne exposure point concentration for the ith chemical, (mg/m^3)

E_i = The ERPG for the ith chemical (mg/m^3)

Cumulative hazard indices were estimated for each MEI receptor and for each ERPG screening level (e.g., ERPG-1, ERPG-2, and ERPG-3). A cumulative hazard index greater than 1.0 (unity) indicates that the acute hazard guidelines for a mixture of chemicals has been exceeded and the chemical mixture may pose a potential acute health impact.

For accident scenarios involving the waste storage tanks (e.g., mispositioned jumper resulting in spray release, loss of tank ventilation filtration, and dome collapse, and hydrogen deflagration in storage tanks), the upper-bound, maximum receptor population that could be potentially impacted by an ERPG exceedance is:

- 10 workers (involved);
- 335 noninvolved workers at 290 m (950 ft);
- 1,500 noninvolved workers at 1,780 m (5,840 ft) ;
- 1 MEI noninvolved worker at 100m (330 ft); and
- 114,734 general public receptors.

For accident scenarios involving the vitrification plant (e.g., pretreatment line break in ventilated vault and canister of vitrified HLW inadvertently dropped), the upper-bound, maximum population that could be potentially impacted by an ERPG exceedance is:

- 10 workers (involved);
- 1,500 noninvolved workers at 1,050 m (3,340 ft);
- 1,000 noninvolved workers at 20,500 m (12.7 mi);
- 3,000 noninvolved workers at 30,500 m (19.0 mi);
- 1 MEI noninvolved worker at 100m (330 ft); and
- 114,734 general public receptors.

For any of the above receptor populations, a cumulative acute hazard index greater than 1.0 would be expected to result in the following ERPG-specific effects:

- ERPG-1 exceedance could result in mild transient effects such as minor irritation or objectionable odor perception;
- ERPG-2 exceedance could result in reversible adverse effects such as nausea, vomiting or bronchitis; and
- ERPG-3 exceedance could result in lethal exposures for some or all of the exposed population.

A calculated acute hazard index greater than 1.0 for an ERPG level (ERPG exceedance) is conservatively assumed to impact the entire receptor population.

Potential carcinogenic health effects from chemical exposure were not evaluated for these accident scenarios. Exposure to chemicals from accidental releases was assumed to occur only once, with a maximum duration of 24 hours. All of the carcinogenic chemicals have been shown to produce a carcinogenic response only after administering high doses for a lifetime of exposure. None of these carcinogenic chemicals have been shown to produce a carcinogenic response from an acute exposure. Consequently, a single acute dose can not be evaluated using cancer slope factors derived from chronic or lifetime studies.

E.1.2 OCCUPATIONAL INJURIES, ILLNESSES, AND FATALITIES

Total recordable cases, lost workday cases, and fatalities resulting from construction and operations were calculated by the following equations:

Total recordable cases = (occupational incidence rate) · (manpower required to complete the alternative)

Lost workday cases = (occupational incidence rate) · (manpower required to complete the alternative)

Fatalities = (occupational fatality rate) · (manpower required to complete the alternative).

The injuries, illnesses, and fatalities rates used in the analysis are incidence rates taken from the occupational injuries summary report (DOE 1994j). The total recordable case (injuries and illnesses requiring medical care) and lost workday case (an injury or illness resulting in an employee missing work) rates are specific to the Hanford Site from 1988 through 1992. The fatality rate is the average for all DOE sites from 1988 through 1992 (the report does not distinguish between construction fatalities and operation fatalities). These incidence rates are summarized in Table E.1.2.1.

Table E.1.2.1 DOE and Contractor Incidence Rates

E.1.3 TRANSPORTATION FATALITIES AND INJURIES

Truck and Rail Transport Accidents

The rates of transportation accidents are assumed comparable to that of average truck and rail transport in the United States. Unit-risk factors were developed based on statistics compiled by the U.S. Department of Transportation (Rao et al. 1982). These unit-risk factors are summarized in Table E.1.3.1.

Table E.1.3.1 Unit-Risk Factors for Fatalities and Injuries for Truck and Rail

The number of injuries and fatalities was calculated by multiplying the total distance traveled in each population zone by the appropriate risk factors shown in Table E.1.3.1. The distance traveled in each population zone was calculated by applying the fractions of travel from NUREG-0170 (NRC 1977). The values are 5 percent of the travel in urban, 5 percent of the travel in suburban, and 90 percent of the travel in rural areas. For this analysis the Hanford Site (onsite) is considered to be a suburban zone.

Employee Commuting Accidents

To calculate the expected number of injuries and fatalities resulting from vehicle accidents for employees commuting to and from work, the following injury/fatality rates were taken from the 1993 Washington State Highway Accident Report (WSDT 1993):

- 7.14E-07 injuries/km; and
- 8.98E-09 fatalities/km.

There were 18 recorded injuries and no fatalities at the Hanford Site for both 1993 and 1994. The estimated average vehicle distance driven was 3.46E+07 km (2.15E+07 mi). The injury rate for 1993 and 1994 is therefore calculated at 5.20E-07 injuries/km, which is comparable to the Washington State injury rates listed previously.

E.1. 4 UNCERTAINTY

The uncertainties in calculating the radiological doses and the toxicological exposures resulting from operation accidents include the tank inventory concentration and the atmospheric dispersion once the source-term is in the air. To demonstrate these uncertainties, a sample accident scenario is presented in Volume 5, Appendix K.

The accident initiator frequencies were established using currently accepted sources of occurrence frequency such as natural phenomena statistics for the Hanford Site or recent analysis of the initiators from safety assessment reports. The frequency of these accidents is presented as estimates and is provided as an aid in screening accident scenarios. Differences in frequencies are significant only when orders of magnitude are present. An accident scenario with a frequency of 1E-06 and one with a frequency of 5E-05 should not be considered significantly different in frequency.

The nonradiological injuries and fatalities resulting from construction and operation accidents were based on incidence rates taken from the occupational injuries summary report (DOE 1994j). The transportation injuries and fatalities from trucks and train were based on incidence rates taken from statistics compiled by the U.S. Department of Transportation (Rao et al. 1982). Injuries and fatalities resulting from employee vehicle accidents were based on incidence rates taken from the Washington State Highway Accident Report (WSDT 1993). Because these are widely accepted incidence rates, there was no attempt to evaluate the uncertainties.

E.2.0 NO ACTION ALTERNATIVE (TANK WASTE)

This section analyzes the risk resulting from potential accidents associated with the No Action alternative. The No Action alternative is to continue the following activities:

- Perform routine management and maintenance activities; and
- Continue pumping and evaporating liquid for 10 years.

This section analyzes the transportation and operation risk associated with this alternative. Because tanks and facilities would not be constructed under this alternative, there would be no risk from construction.

E.2.1 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative include employees commuting to work each day.

E.2.1.1 Radiological Cancer Risk

All operations would be conducted within established operating parameters for the tanks and would not involve transporting radioactive materials by container. Therefore, there would be no radiological cancer risk resulting from transportation. Accidents involving the transportation of waste in the transfer lines are discussed in Section E.2.2.

E.2.1.2 Chemical Exposure

Because there would be limited transportation of toxic materials (such as lubricants that are used in continued operations), it is extremely unlikely there would be any accidents resulting in chemical exposures. Therefore, transportation accidents involving chemical exposures were not quantified.

E.2.1.3 Occupational Injuries and Fatalities

Employee Traffic Accidents

Workers and other personnel required to perform the various activities would drive to the Hanford Site in their vehicles. The total person-years to perform the activities was estimated at 1.04E+05 (Jacobs 1996).

Each person was assumed to work 260 days a year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 kilometers (km) (87 miles [mi]) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total employee vehicle distance was therefore calculated to be 2.80E+09 km (1.74E+09 mi).

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents are calculated as follows:

Injuries = (2.80E+09 km) · (7.1E-07 injuries/km) = 2.00E+03

Fatalities = (2.80E+09 km) · (8.98E-09 fatalities/km) = 2.52E+01

E.2.2 OPERATION ACCIDENTS

The potential exists for accidents resulting from routine operation activities. The routine operations are discussed in

Volume Two, Appendix B.

The dominant accident scenarios analyzed in the following subsections were selected from the Accident Screening Table (Table E.2.2.1). The accidents listed in Table E.2.2.1 were taken from the accidents analysis data package (Shire et al. 1995 and Jacobs 1996). The methodology of screening was previously discussed in Section 1.1.2.

Table E.2.2.1 Accident Screening Table for the No Action Alternative (Tank Waste)

E.2.2.1 Continued Operations Accident - Tank Waste Transfers

Continued operations include transferring liquid waste from the SSTs to an evaporator where the solids and liquid are separated. Types of radiological releases resulting from potential accidents associated with continued operations include sprays, leaks, fires/deflagrations, explosions, and ventilation. From Table E.2.2.1 the credible accident (accidents with a frequency of occurring greater than 1.0E-06 per year) identified as having the highest risk was Accident 4.1.7: "mispositioned jumper in SST double-contained receiver tank pump pit with cover off."

A pressurized-liquid spray release from a mispositioned jumper was postulated to occur in an SST double-contained receiver tank (DCRT) pump pit that services the transfer from DCRT to DST or pumps into or out of a receiver tank. A jumper is a short connection pipe that is used in a jumper pit to route tank waste transfers from one line to another line in sending tank waste to a specific location.

E.2.2.1.1 Scenario and Source-term Development for - Mispositioned Jumper

This analysis was based on the following assumptions:

- A jumper was mispositioned and pinhole leaks develop at both ends of the jumper;
- The pump pressure was 1.43E+06 Pascals (Pa) (207 pounds per square inch [psi]);
- The maximum spray leak from each end was calculated to be 0.027 liters per minute (L/min) 0.007 gallons per minute (gal/min) or 0.054 L/min (0.014 gal/min) total;
- All spray particles were assumed to evaporate to less than 10 m before reaching the ground on their calculated trajectory; therefore, 100 percent of the spray was considered respirable;
- The fine spray is not detectable with installed leak detection devices;
- The pump pit was unintentionally left uncovered;
- The release time was for two shifts or 16 hours (960 min); and
- The source-term consists of 70 percent SST liquids and 30 percent SST solids.

Source-term - Assuming a spray duration of two shifts or 16 hours, the source-term was calculated as follows:

$$(0.054 \text{ L/min}) \cdot (960 \text{ min}) = 52 \text{ L } (14 \text{ gal})$$

E.2.2.1.2 Probability of Mispositioned Jumper

The frequency of a mispositioned jumper in a SST DCRT pump pit with its cover off was calculated to range from 1.1E-02 per year to 8.0E-03 per year (Shire et al. 1995 and Jacobs 1996). For conservatism, the frequency of 1.1E-02 was assumed for calculating risk. Waste transfers would take place for up to 10 years; therefore, the probability of the accident was calculated to be 1.1E-01.

E.2.2.1.3 Radiological Consequence from Mispositioned Jumper

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section 1.1.6. The results, which were taken from the accident data package (Shire et al. 1995 and Jacobs 1996), are summarized in Table E.2.2.2.

Table E.2.2.2 Dose Consequence from Mispositioned Jumper

E.2.2.1.4 Radiological Cancer Risk from Mispositioned Jumper

The LCF risk is the product of the dose to the receptor measured in rem, the dose to risk conversion factor, and the probability of the event. A dose-to-risk conversion factor of 8.0E-04 LCF per person-rem for the workers, MEI worker, and MEI noninvolved worker was used because the individual doses were greater than 20 rem. Dose-to-risk conversion factors of 4.0E-04 LCF per person-rem for the noninvolved worker and 5.0E-04 LCF per person-rem for the general public were used, because the individual doses were less than 20 rem.

Using the workers as an example, a dose to the workers of 5.9E+02 person-rem would result in an estimated 4.7E-01 latent cancer deaths if the accident were to occur. Factoring in the probability of 1.1E-01 the LCF risk (point estimate) was calculated as follows:

$$(5.9E+02 \text{ rem}) \cdot (1.1E-01) \cdot (8.0 E-04 \text{ LCF/rem}) = 5.2E-02 \text{ LCF}$$

The LCF risks for each receptor are calculated in Table E.2.2.3.

Table E.2.2.3 Latent Cancer Fatality Risk from Mispositioned Jumper

The bounding calculations show all 10 workers would potentially receive a fatal dose from radiation if the accident occurred. Approximately seven noninvolved workers would receive fatal cancers, and two LCFs would be incurred to the general public. The nominal scenario calculations show there would be no LCFs.

E.2.2.1.5 Chemical Consequences of Mispositioned Jumper

The chemical exposure to the receptors from the postulated accident were calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996 and Jacobs 1996) and summarized in the exposure column in Tables E.2.2.4 and E.2.2.5 for nominal and bounding toxic effects, and Tables E.2.2.6 and E.2.2.7 for nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of the postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Table E.2.2.4 Comparison of Chemical Concentrations to Toxic Concentration Limits for Mispositioned Jumper

Table E.2.2.5 Comparison of Bounding Chemical Concentrations to Toxic Concentration Limits for Mispositioned Jumper

Table E.2.2.6 Comparison of Nominal Chemical Concentrations to Corrosive/Irritant Concentration Limits for Mispositioned Jumper

Table E.2.2.7 Comparison of Bounding Chemical Concentrations to Corrosive/Irritant Concentration Limits for Mispositioned Jumper

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated since death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.0, indicating that only mild, reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated since death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 1.10E-01.

E.2.2.2 Continued Operations Accident - Waste Storage Tanks

Types of radiological releases resulting from potential accidents associated with unstabalized tank waste are fires, deflagrations, and tank leaks. From Table E.2.2.1 the credible accident identified as having the highest risk was Accident 7.1: "hydrogen deflagration in waste storage tank."

E.2.2.2.1 Scenario and Source-term Development for Hydrogen Deflagration in Waste Storage Tank

Hydrogen could be generated in tank waste, rise into tank headspace, and reach the concentrations necessary for combustion. Ignition would occur in the tank headspace during a 1-hour time period when the gas concentration exceeds the LFL. Turbulence accompanying rapid combustion could suspend waste as aerosols and pressure drive some of the particulate out the ventilation system into the environment.

Source-term - The MAR was assumed to be 5.0E+05 L (1.3E+05 gal), the ARF RF = 6.5E-06, and the LPF = 7.5E-01. The source-term was calculated as follows:

$$(5.0E+05\ L) \cdot (6.5E-06) \cdot (7.5E-01) = 2.4\ L\ (0.6\ gal)$$

E.2.2.2.2 Probability of Hydrogen Deflagration in Waste Storage Tank

The frequency of a hydrogen deflagration in a waste storage tank was estimated at 7.2E-03 per year for the tank farms (LANL 1995). The probability for this scenario based on 100 years of operation was therefore estimated to be 7.2E-01.

E.2.2.2.3 Radiological Consequence from Hydrogen Deflagration in Waste Storage Tank

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section 1.1.6. The results are presented in Table E.2.2.8.

Table E.2.2.8 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

E.2.2.2.4 Radiological Cancer Risk from Hydrogen Deflagration in Waste Storage Tank

In the bounding scenario a ll 10 workers would potentially receive a fatal dose and would assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The LCFs and LCF point estimate risk are presented in Table E.2.2.9. The nominal scenario calculations show there would be no LCFs.

Table E.2.2.9 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

E.2.2.2.5 Chemical Consequences from Hydrogen Deflagration in Waste Storage

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs) and summarized in the exposure column in Tables E.2.2.10 and E.2.2.11 nominal and bounding toxic effects, respectively and Tables E.2.2.12 and E.2.2.13 for nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of the postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Table E.2.2.10 Comparison of Nominal Chemical Concentrations to Toxic Concentration Limits for Hydrogen Deflagration in Waste Storage Tank

Table E.2.2.11 Comparison of Bounding Chemical Concentrations to Toxic Concentration Limits for Hydrogen Deflagration in Waste Storage Tank

Table E.2.2.12 Comparison of Nominal Chemical Concentrations to Corrosive/Irritant Concentration Limits for Hydrogen Deflagration in Waste Storage Tank

Table E.2.2.13 Comparison of Bounding Chemical Concentrations to Corrosive/Irritant Concentration Limits for Hydrogen Deflagration in Waste Storage Tank

Under bounding conditions c hemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio) However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100m (330 ft) from the source area. The first, anticipated noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life-threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to:

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 7.20E-01.

E.2.2.3 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of

LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.2.2.3.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid specific gravity (SpG) of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100 \text{ mg/m}^3) \cdot (1 \text{ g/1,000 mg}) \cdot (1 \text{ L/1,000 g}) \cdot (1{,}000 \text{ m}^3) \cdot (1/1.5) = 6.67\text{E-02 L } (1.8\text{E-02 gal}).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500 \text{ L}) \cdot (2.0\text{E-03}) = 5.0 \text{ L } (1.3 \text{ gal}).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500 \text{ L}) \cdot (4.0\text{E-05/hr}) \cdot (24 \text{ hr}) = 2.4 \text{ L } (0.6 \text{ gal}).$$

The combined source-term for the acute release is calculated as follows:

$$(6.67\text{E-02 L}) + (5.00\text{E+00 L}) + (2.4 \text{ L}) = 7.4 \text{ L } (2.0 \text{ gal}).$$

E.2.2.3.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 100 years of operation was therefore estimated to be 1.40E-02.

E.2.2.3.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.2.2.14.

Table E.2.2.14 Dose Consequence from Seismic Event

E.2.2.3.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.2.2.15.

Table E.2.2.15 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.2.2.3.5 Chemical Consequences from a Beyond Design Basis Earthquake

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.2.2.16 and E.2.2.17 for the nominal and bounding toxic effects, respectively, and Tables E.2.2.18 and E.2.2.19 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Table E.2.2.16 Comparison of Nominal Chemical Concentrations to Toxic Concentration Limits for Earthquake - 1 Tanks Collapse - SST Solids

Table E.2.2.17 Comparison of Bounding Chemical Concentrations to Toxic Concentration Limits for Earthquake - 1 Tank Collapse - SST Solids

Table E.2.2.18 Comparison of Nominal Chemical Concentrations to Corrosive/Irritant Concentration Limits for Earthquake - 1 Tanks Collapse - SST Solids

Table E.2.2.19 Comparison of Bounding Chemical Concentrations to Corrosive/Irritant Concentration Limits for Earthquake - 1 Tanks Collapse - SST Solids

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.16), the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio, for the nearest noninvolved worker population consisting of 335 workers located 290 m (950 ft) away, was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected. No acute health effects are calculated to occur for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential

exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 (5,840 ft) away, was 2.15 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs and no acute health effects would be expected.

Under bounding conditions (Table E.2.2.19), the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

Based on the discussion presented above, no irreversible corrosive/irritant effects would be anticipated for the nearest noninvolved worker population.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74 and 1.42, respectively for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 1.40E-02.

E.2.2.4 Occupational Injuries and Fatalities from Operations

The total person-years required for operations was estimated at 1.04E+05 (Jacobs 1996) for the 100 years of continued operations. The total recordable injuries or illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (1.04E+05 person-years) · (2.2E+00 incidences /100 person-years) = 2.29E+03

Lost Workday Cases = (1.04E+05 person-years) · (1.1E+00 incidences/100 person-years)= 1.14E+03

Fatalities = (1.04E+05 person-years) · (3.2E-03 fatalities/100 person-years) = 3.33E+00

E.2.3 POST-REMEDIATION ACCIDENT

For the No Action (tank waste) alternative, the waste would remain in the tanks and the tanks would not be stabilized. During the 100-year institutional control period, the tanks would be maintained. After the 100 years there would be no additional maintenance of the aging tanks (the design life of the tanks would be exceeded) and the tanks would deteriorate and lose their structural strength. With the tanks in an unstable condition, a seismic event (a 0.2 gravity earthquake with an annual frequency of 8.0E-04) collapses the tank dome into the tanks resulting in an acute release of contaminants followed by a chronic release at much lower levels until the waste would be covered with earth by natural forces.

Source-Term Development

It was conservatively assumed that all 177 tanks collapse and that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5 and a headspace volume of 1,000 m^3, the potential source-term contribution from the headspace release for 177 tanks was calculated as follows:

$$(100 \text{ mg/m}^3)\ (1 \text{ g/L,000 mg}) \cdot (1 \text{ L/1,000 g}) \cdot (1\text{,000 m}^3) \cdot (1/1.5) \cdot (177) = 1.18\text{E+01 L (3.1 gal)}$$

It was conservatively assumed that the liquids had drained from leaks in the tanks so that the surface was dry and crumbly and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated a substantial air movement to suspend a fraction the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from entrainment for all 177 tanks was calculated as follows:

$$(2\text{,500 L}) \cdot (2.0\text{E-03}) \cdot (177) = 8.85\text{E+02 L (234 gal)}$$

The combined source-term for the acute release is calculated as follows:

$$(1.18\text{E+01 L}) + (8.85\text{E+02 L}) = 8.97\text{E+02 L (237 gal)}$$

Following the initial release, no corrective action would be taken and the waste would continually be released by air currents lifting a fraction of the waste into the air for 1 year. After the first year it was assumed the waste would be covered by natural forces. It was assumed that the dome and overburden covers most of the waste surface reducing the MAR to 10 percent or 250 L (66 gal) , and a respirable release fraction of 4.0E-05/hr was assumed. The source-term for the chronic release for one year from 177 tanks is calculated as follows:

$$(2.50E+02) \cdot (4.0E\text{-}05/hr) \cdot (8.74E+03\ hr/yr) \cdot (177) = 1.55E+04\ L\ (4{,}090\ gal)$$

Consequence for Tank Dome Collapse

The nominal tank inventory was used in calculating the radiological dose to the receptors. It was assumed that the offsite population size and location remained the same and the onsite population of people living on the Hanford Site was 10 percent of the current Hanford population or 1,090. The radiological dose to the receptors was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6.

The radiological consequences to the onsite population would result in approximately 42 LCFs. E xposure to toxic chemicals that would exceed the ERPG-3 threshold values by a factor of 2.25E+02.

The radiological consequences to the offsite populations would result in approximately 4 LCFs. The population living closest to the Hanford Site would receive an exposure to toxic chemicals that would exceed the ERPG- 1 threshold value by a factor of 1.08E+01 indicating they would suffer from mild, transient health effects.

E.2.4 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.2.4.1 The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.2.4.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.2.4.3. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.2.4.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.2.4.2 Summary of Potential Radiological Accident Consequences

Table E.2.4.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.3.0 LONG-TERM MANAGEMENT ALTERNATIVE

This section analyzes the risk resulting from potential accidents associated with the Long-Term Management alternative. The Long-Term Management alternative is to continue safe storage activities. This includes:

- Perform routine management and maintenance activities;
- Continue pumping and evaporation of liquid;
- Construct replacement DSTs and associated evaporators;
- Waste transfer system upgrade (W314); and
- Transfers waste via pipeline to the Evaporator Facility or replacement tanks.

E.3.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the Long-Term Management alternative are discussed in Volume Two, Appendix B of the EIS. It should be noted that there are no radiological or chemical consequences associated with construction accidents because the replacement tanks and associated transfer lines and evaporators would be constructed in uncontaminated areas. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated in the following text.

Construction would require an estimated 3.75E+03 person-years (Jacobs 1996). The total recordable injuries and illnesses, lost workday cases, and fatalities for the 10 years of construction were calculated using the incidence rates from Table E.1.2.1 as follows:

Total Recordable Cases = (3.75E+03 person-years) · (9.75E+00 incidences/100 person-years) = 3.66E+02

Lost Workday Cases = (3.75E+03 person-years) · (2.45E+00 incidences/100 person-years) = 9.19E+01

Fatalities= (3.75E+03 person-years) · (3.2E-03 fatalities/100 person-years) = 1.2E-01

E.3.2 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative are 1) transporting construction material from offsite; and 2) employees commuting to work each day.

E.3.2.1 Radiological Cancer Risk

All operations would be conducted within established operating parameters for the tanks and would not involve transporting radioactive materials by container. Therefore, there would be no radiological cancer risks resulting from transportation. Accidents involving the transfer of waste in the transfer lines are discussed in Section E.3.3.

E.3.2.2 Chemical Exposure

Because there would be very limited transportation of toxic materials (e.g., lubricants for routine operations), it is extremely unlikely there would be any accidents resulting in chemical exposures. Therefore, transportation accidents involving chemical exposures were not quantified.

E.3.2.3 Occupational Injuries and Fatalities Truck and Rail Transportation Accident

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Truck and rail transportation activities to transport material and supplies to the Hanford Site for this alternative are summarized in Table E.3.2.1. The total distance was calculated by multiplying the number of trips by the round-trip distance.

Table E.3.2.1 Summary of Transportation Activities for the Long-Term Management Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.3.2.2 by the appropriate unit risk factors shown in Table E.3.2.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3. The expected injuries and fatalities resulting from truck and rail transportation accidents associated with the Long-Term Management alternative are summarized in Table E.3.2.3.

Table E.3.2.2 Distance Traveled in Population Zones for the Long-Term Management Alternative

Table E.3.2.3 Injuries and Fatalities Resulting from Truck and Rail Transportation Accidents for the Long-Term Management Alternative

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, Site workers and other personnel required to perform the various activities would drive to the Site in their vehicles. The total person-years to perform the activities was estimated at 1.08E+05 (Jacobs 1996).

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents are calculated as follows:

Injuries = (2.91E+09 km) · (7.1E-07 injuries/km) = 2.08E+03

Fatalities = (2.91E+09 km) · (8.98E-09 fatalities/km) = 2.61E+01

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck and rail transport and employee vehicle accidents and are summarized in Table E.3.2.4.

Table E.3.2.4 Cumulative Injuries and Fatalities from Traffic Impacts for the Long-Term Management Alternative

Each person was assumed to work 260 days of the year. The round trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total employee vehicle distance was therefore calculated to be 2.91E+09 km (1.81E+09 mi).

E.3.3 OPERATION ACCIDENTS

The potential exists for accidents resulting from continued operation activities. The continued operations are discussed in Volume Two, Appendix B.

E.3.3.1 Continued Operations Accident - Tank Waste Transfers

The dominant continued operations accident during tank waste transfers is the "mispositioned jumper accident" previously discussed in the No Action (Tank Waste) alternative Section E.2.2.1 and summarized as follows:

Source-term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The probability of occurrence is based on 20 years of waste transfers to accommodate the retanking operations. Therefore, the probability was calculated to be 2.2E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.3.3.1.

Table E.3.3.1 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the Long-Term Management alternative; however, the LCF risk (point estimate) is not the same because of the difference in probabilities. The LCFs and the LCF risks are calculated in Table E.3.3.2.

Table E.3.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

The bounding scenario calculations show all 10 workers would potentially receive a fatal dose and would assumably die directly after the exposure if the accident occurred. Approximately seven noninvolved workers would receive fatal cancers, and two LCFs would be incurred to the general public. The nominal scenario calculators show there would be no LCFs.

Chemical Consequences

For the Long-Term Management alternative, the potential acute hazards associated with the mispositioned jumper are the same as the acute hazards presented in Tables E. 2.2.4 and E.2.2.7 for the No Action alternative.

Toxic Impact From Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.0E+00, indicating that only mild, reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 2.20E-01.

E.3.3.2 Continued Operations Accident - Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and is summarized as follows:

Source-term - The source-term resulting from a hydrogen deflagration in Section E.2.2.2.1 was calculated to be 2.4 L (0.6 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2.2 was estimated to be 7.2E-03 per year. The probability of the scenario based on 100 years of operation was therefore estimated to be 7.2E-01.

Radiological Consequences - The radiological consequences presented in Table E.2. 2.8 are reproduced in Table E.3.3.3.

Table E.3.3.3 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Radiological Cancer Risk

The LCFs calculated in Section E.2.2.2.4 are reproduced in Table E.3.3.4.

Table E.3.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

In the bounding scenario all 10 workers would potentially receive a fatal dose and would assumably die directly after the exposure. T here would also be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

The potential acute hazards associated with the hydrogen deflagration in a waste storage tank are summarized in Table E. 2.2.10 through E.2.2.13 for toxic and corrosive/irritant effects, respectively.

Under bounding conditions c hemical impacts were not evaluated for the worker because all workers would receive a lethal radiation dose as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio) However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100m (330 ft)from the source area. The first, anticipated noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100m (330 ft)from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life-threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions the probability of a hydrogen deflagration event in a waste storage tank is 7.20E-01.

E.3.3.3 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.3.3.3.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ \text{mg/m}^3) \cdot (1\ \text{g/1,000 mg}) \cdot (1\ \text{L/1,000 g}) \cdot (1{,}000\ \text{m}^3) \cdot (1/1.5) = 6.67\text{E-02 L } (1.8\text{E-02 gal}).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated a air movement sufficient to suspend a fraction the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500\ \text{L}) \cdot (2.0\text{E-03}) = 5.0\ \text{L } (1.3\ \text{gal}).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500\ \text{L}) \cdot (4.0\text{E-05/hr}) \cdot (24\ \text{hr}) = 2.4\ \text{L } (0.6\ \text{gal}).$$

The combined source-term for the acute release is calculated as follows:

$$(6.67\text{E-02 L}) + (5.00\text{E+00 L}) + (2.4\ \text{L}) = 7.4\ \text{L } (2.0\ \text{gal}).$$

E.3.3.3.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 100 years of operation was therefore estimated to be 1.40E-02.

E.3.3.3.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.3.3.5.

Table E.3.3.5 Dose Consequence from Seismic Event

E.3.3.3.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.3.3.6

Table E.3.3.6 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.3.3.3.5 Chemical Consequences from a Beyond Design Basis Earthquake

For the Long-Term Management alternative, the potential acute hazards associated with a beyond design basis earthquake are the same as the acute hazards presented in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and E.2.2.19 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.16), the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population consisting of 335 workers located 290 m (950 ft) away was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below

1.00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild, irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs and no acute health effects would be expected.

Under bounding conditions, the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

Based in the discussion presented above, even through the acute hazard ratio exceeded ERPG-3, the noninvolved worker population would not experience irreversible health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 1.40E-02.

E.3.3. 4 Occupational Injuries and Fatalities from Operations

The number of operation personnel was estimated at 1.04E+05 person-years (Jacobs 1996) during 100 years of routine operations. The total recordable injuries or illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (1.04E+05 person-years) · (2.2E+00 incidences/100 person-years) = 2.29E+03

Lost Workday Cases = (1.04E+05 person-years) · (1.1E+00 incidences/100 person-years) = 1.14E+03

Fatalities = (1.04E+05 person-years) · (3.2E-03 fatalities/100 person-years) = 3.33E+00

E.3.4 POST-REMEDIATION ACCIDENT

The post remediation accident for the Long-Term Management alternative would be the tanks collapsing due to an earthquake, as discussed in Section E.2.3. The radiological consequences to the onsite population would result in approximately 42 LCFs. E xposure to toxic chemicals would exceed the ERPG-3 threshold values by a factor of 2.25E+02.

The radiological consequences to the offsite population would result in approximately 4 LCFs. The population living closest to the Hanford Site would receive an exposure to toxic chemicals that would exceed the ERPG-2 threshold value by a factor of 1.08E+01 indicating they would suffer from mild, transient health effects.

E.3.5 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.3.5.1. The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.3.5.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.3.5.3. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.3.5.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.3.5.2 Summary of Potential Radiological Accident Consequences

Table E.3.5.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.4.0 IN SITU FILL AND CAP ALTERNATIVE

Under this alternative, all excess liquid from the DSTs would be evaporated at the 242-A Evaporator. The tanks would then be backfilled with gravel and a Hanford Barrier would be constructed over the tanks. The waste in the MUSTs would be grouted in situ.

E.4.1 CONSTRUCTION ACCIDENTS

Although construction activities are limited for the In Situ Fill and Cap alternative, the potential exists for accidents. The construction activities are discussed in Appendix B of the EIS.

The number of construction personnel was estimated at 7.25E+02 person-years (Jacobs 1996). The number of total recordable injuries and illnesses, lost workday cases, and fatalities were calculated using the incidence rates from Table E.1.2.1 as follows.

Total Recordable Cases = (7.25E+02 person-years) · (9.75E+00 incidences/100 person-years) = 7.07E+01

Lost Workday Cases = (7.25E+02 person-years) · (2.45E+00 incidences/100 person-years) = 1.78E+01

Fatalities = (7.25E+02 person-years) · (3.20E-03 fatalities/100 person-years) = 2.32E-02

E.4.2 TRANSPORTATION ACCIDENTS

Transporting activities associated with this alternative include:

- Transporting construction material from offsite for the waste transfer system upgrade (W-314);
- Transporting cement from offsite to grout MUSTs;
- Transporting sand and gravel from the Pit 30 borrow site to grout MUSTs;
- Transporting earthen material from onsite borrow sites for the Hanford Barrier; and
- Employees commuting to work each day.

E.4.2.1 Radiological Cancer Risk

All operations would be conducted within established operating parameters for the tanks and would not involve transporting radioactive materials by container. Therefore, there would be no radiological cancer risks from transportation.

E.4.2.2 Chemical Exposure

Because there would be very limited transportation of toxic materials (e.g., lubricants for routine operations), it is extremely unlikely there would be any accidents resulting in chemical exposures. Therefore, transportation accidents involving chemical exposures were not quantified.

E.4.2.3 Occupational Injuries and Fatalities

Truck Transport Accidents

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Truck transportation activities to transport materials and supplies to the Hanford Site for this alternative were estimated

(Jacobs 1996) and are summarized in Table E.4.2.1.

Table E.4.2.1 Summary of Transportation Activities for the In Situ Fill and Cap Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.4.2.2 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3.

Table E.4.2.2 Distance Traveled in Population Zones for the In Situ Fill and Cap Alternative

The expected injuries and fatalities resulting from transportation accidents associated with the In Situ Fill and Cap alternative are summarized in Table E.4.2.3.

Table E.4.2.3 Injuries and Fatalities Resulting from Truck Transportation Accidents for the In Situ Fill and Cap Alternative

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck, site workers and other personnel required to perform the various activities would be driving to the site in their vehicles. The total person-years to perform the activities was estimated at 2.61E+04 (Jacobs 1996). Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total employee vehicle distance was therefore calculated as follows:

$$(2.61E+04 \text{ person-years}) \cdot (260 \text{ days/year}) \cdot (140 \text{ km/day}) \cdot (1/1.35) = 7.05E+08 \text{ km } (4.37E+08 \text{ mi})$$

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (7.05E+08 km) · (7.14E-07 injuries/km) = 5.03E+02

Fatalities = (7.05E+08 km) · (8.98E-09 fatalities/km) = 6.33E+00

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck transport and employee vehicle accidents. The results are summarized in Table E.4.2.4.

Table E.4.2.4 Cumulative Injuries and Fatalities from Traffic Impacts for the In Situ Fill and Cap Alternative

E.4.3 OPERATION ACCIDENTS

The potential exists for accidents resulting from operation activities. The operations are discussed in Appendix B.

This analysis separates and analyzes operations according to the following modes of operation:

- Continued operations - These operations have been previously discussed in No Action alternative; and
- Treatment - After excess liquid has been removed from the tank waste the tanks are filled with gravel.

The dominant accident scenarios analyzed in the following subsections were selected from the Accident Screening Table (Table E.4.3.1). The accidents listed in Table E.4.3.1 were taken from the Accident Analysis Data Package (Shire et al. 1995 and Jacobs 1996). The methodology of screening was previously discussed in Section 1.1.2.

Table E.4.3.1 Accident Screening Table for the In Situ Fill and Cap Alternative

E.4.3.1 Continued Operation Accident - Tank Waste Transfers

The dominant continued operations accident during tank waste transfers is the mispositioned jumper accident previously discussed in the No Action alternative (Section E.2.2.1) and summarized as follows**:**

Source-term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The In Situ Fill and Cap alternative was based on 1 2 years of operations. Therefore, the probability was calculated to be 1.3E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 were reproduced in Table E.4.3.2.

Table E.4.3.2 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the In Situ Fill and Cap alternative however, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.4.3.3. The bounding scenario calculations show all 10 workers would potentially receive fatal dose and would assumably die directly after the exposure if the accident occurred. Approximately seven noninvolved workers would receive fatal cancers, and two LCFs would be incurred to the general public. The nominal scenario calculations show there would be no LCFs.

Table E.4.3.3 Latent Cancer Fatality Risk from Mispositioned Jumper

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper accident are summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant bounding conditions) for the No Action alternatives.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0E+00, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.0E+00, indicating that only mild, reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild, reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 1.32E-01.

E.4.3.2 Continued Operations Accident - Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and summarized as follows:

Source-term - The source-term resulting from a hydrogen deflagration in Section E.2.2.2.1 was calculated to be 2.4 L (0.6 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2.2 was estimated to be 7.2E-03 per year. The probability of the scenario based on 12 years of operation was therefore estimated to be 8.6E-02.

Radiological Consequences - The radiological consequences presented in Table E.2.2.8 are reproduced in Table E.4.3.4.

Table E.4.3.4 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.2.4 are reproduced in Table E.4.3.5.

Table E.4.3.5 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Chemical Consequences

Potential acute hazards associated with a hydrogen deflagration in a waste storage tank are summarized in Tables E.2.2.10 (toxic chemicals, nominal conditions), E.2.2.11 (toxic chemicals, bounding conditions), E.2.2.12 (corrosive/irritant chemicals, nominal conditions) and E.2.2.13 (corrosive/irritant chemicals bounding conditions) for the No Action alternative. Chemical impacts were not evaluated for the MEI worker since all workers would receive a lethal radiation dose, as discussed previously.

In the bounding scenario all 10 workers, would potentially receive a fatal dose and would assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57E+00 for ERPG-2, indicating that reversible, acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38E+00, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio) However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100m (330 ft) from the source area. The first anticipated noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);

- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82E+00 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life-threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74E+00 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 8.64E-02.

E.4.3. 3 Treatment Accident

The treatment accidents identified in the accident engineering data package (Shire et al. 1995 and Jacobs 1996) are summarized in Table E.4.3.1. The rock slinger ignites gas plume in tank accident, which would lead to a partial tank dome collapse, was identified as the dominant accident.

E.4.3. 3 .1 Scenario and Source-Term Development for Deflagration In Tank During Fill and Cap

It was postulated that hydrogen deflagration could occur while filling the tank with gravel using a rock slinger. A spark from the gravel ignites a hydrogen gas plume, which is suddenly released from the solids or salt cake causing the tank to overpressurize. This in turn causes the HEPA filters to blow out (in the case of DST) or the dome to collapse (in the case of SST). The impact of the postulated accident would result in an airborne release of radionuclides and chemical constituents in the tank.

For this event to occur, the following conditions must exist.

- Flammable gases must be generated from the waste;
- The concentration of the flammable gas must exceed the lower flammability limit;
- There must be an ignition source; and
- The deflagration would have to generate enough energy to blow out the HEPA filters or collapse the tank dome.

Generation of Flammable Gas

All 177 waste tanks produce flammable gases at the molecular level such as hydrogen, ammonia, and methane due to radiolysis and organic degradation. The generation of flammable gas has been demonstrated in all the tanks and has resulted in 25 tanks being included on the Watchlist for hydrogen buildup. These 25 tanks include 19 SSTs and 6 DSTs.

Gas Concentration

Gases that are constantly being released into the headspace, and subsequently removed from the tank through the tank ventilation system, are unable to reach the lower flammability limits and do not pose a potential hydrogen deflagration event. Active ventilation systems can be engineered to provide removal of flammable gases and prevent gas concentrations from reaching 25 percent of the LFL.

Of concern are conditions in which the gas is not readily released from the waste leading to retention of substantial volumes of gas in the waste matrix. These trapped pockets of gas could be triggered into an instant release by pressure from the fill material on the tank waste. This would result in a gas plume in the head space. Studies made on the flammable gas Watchlist tanks (LANL 1995) have shown the potential for concentrations of hydrogen in these gas pockets to exceed the LFL. The composition of the mixture is important. If the mixture is hydrogen and air, it takes a relatively small ignition source (0.01 mJ - equivalent to pieces of fabric rubbing together or stray radio waves) to ignite the mixture.

Ignition of Gas

As the gravel is thrown into the tank by the rock slinger, it has the potential to create a spark by striking against metal inside the tank or against the gravel in the tank. The spark could ignite the sudden release of a plume of gas if hydrogen concentration exceeds the LFL. The probability of these events occurring at the same instant is low. At this time, it cannot be ruled out that the hydrogen concentration in the gas plume will exceed the LFL. The time it would take for the plume to diffuse and drop the hydrogen concentration to below the LFL by dilution from the ventilation system depends on the size and concentration of the plume, which cannot be accurately estimated at this time. Therefore, it may be assumed that the plume occurs and ignites.

The probability of the plume igniting could be reduced substantially by using wet sand or soil and possibly grout as fill instead of gravel.

Loss of Containment

The pressure necessary to cause failure in a SST varies from 76 kPa (11 psi) for a 3,800,000-L (1,000,000-gal) tank to 97 kPa (14 psi) for a 1,900,000-L (500,000-gal) tank (Julyk 1994). The pressure necessary to cause failure in a DST is 410 kPa (60 psi) because it has a steel liner. The pressure generated by the ignited plume is dependent on the plume size, head space, heat transfer, and ventilation. A plume of flammable gas (16 m^3 [570 ft^3]) sufficiently concentrated, if ignited, will cause an overpressure of 100 kPa (15 psi), which is more than enough to collapse the dome of a SST (Fox-Stepnewski 1994). For the DST, 100 kPa (15 psi) may not breach the dome but would blow out the HEPA filters. These potential overpressures do not take into account the 42-in. risers that penetrate the tank dome, which would absorb some of the pressure from a deflagration.

Additional saltwell pumping of the SSTs is expected to reduce the probability of hydrogen burps by removing liquids, which tend to trap gases in the saltcake. Additional saltwell pumping also would be expected to remove organic materials, such as complexants, which degrade to form flammable gases. The risk of a plume burn could also be reduced by filling the 25 Watchlist tanks last. It has been shown in tank waste that hydrogen generation rates drop by about one-half every 15 years. By waiting approximately 15 years to fill the 25 Watchlist tanks, the hydrogen generation rate of these tanks would drop by about 50 percent.

Source-term for SST Dome Collapse

It was conservatively assumed that all radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by sudden pressure difference. Assuming a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3, the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ mg/m^3) \cdot (1\ g/L\ 1{,}000\ mg) \cdot (1\ L/1{,}000\ g) \cdot (1{,}000\ m^3) \cdot (1/1.5) = 1.8E\text{-}02\ L\ (1.8E\text{-}02\ gal).$$

It was assumed that gravel fill takes place after saltwell pumping that has reduced the liquid in the SSTs to less than 0.5 percent. It was conservatively assumed the surface was dry and crumbly and the MAR was 2,500 L (660 gal). It was postulated that the fall of the objects generated a substantial air movement to suspend a fraction the MAR.

Assuming the respirable release fraction to be 2.0E-03, the potential source-term contribution from entrainment was calculated as follows:

$$(2{,}500\ L) \cdot (2.0E\text{-}03) = 5.0\ L\ (1.3\ gal).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500\ L) \cdot (4.0E\text{-}05/hr) \cdot (24\ hr) = 2.4\ L\ (0.6\ gal).$$

The combined source-term of the potential SST accident is calculated as follows:

$$(0.07\ L) + (5.0\ L) + (2.4\ L) = 7.5\ L\ (2.0\ gal).$$

Source-term for the DSTs

For the DSTs, a consequence analysis was performed (LANL 1995) based on a dome space loading of 0.39 L (0.10 gal) in the vapor space plus 3.30 L (0.87 gal) entrained by the deflagration. It was assumed that the HEPA filter was destroyed by the pressure pulse generated by the ignited gases. The amount of material on the filter was assumed to be

0.45 L (0.12 gal). Therefore, the amount of inventory released from the tank would be 4.14 L (1.09 gal). The bounding source-term or respirable amount released from a DST and made airborne was 2.0 L (0.5 gal) for tank 241-SY-101 (LANL 1995).

E.4.3. 3 .2 Probability of the Event

The probability of a plume burn is assumed to be a likely event due to the gas pockets that exist in the waste and the available ignition source. However, the magnitude of the deflagration is uncertain. It is more likely that the gas burn would be small and would not have sufficient energy to blow out the HEPA filters or breach the tank. It is therefore assumed to be an extremely unlikely event, and for the purpose of this analysis, a probability of 1E-04 is used to calculate the point estimates.

E.4.3. 3 .3 Radiological Consequence for Tank Dome Collapse

The tank dome collapse would be bounding so the radiological dose to the receptors was calculated from the source-term for the SST by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results (Shire et al. 1995 and Jacobs 1996) are summarized in Table E.4.3. 6 .

Table E.4.3.6 Dose Consequence for Tank Dome Collapse Due to Deflagration

E.4.3. 3 .4 Radiological Cancer Risk for Tank Dome Collapse

All 10 workers and the MEI noninvolved worker potentially would receive a lethal dose. The LCFs and LCF point estimate risk were calculated for the receptors and presented in Table E.4.3. 7 .

Table E.4.3.7 Latent Cancer Fatality Risk from Tank Dome Collapse Due to Deflagration

In the bounding scenario all 10 workers would die from a lethal dose . T he calculations show there would be 11 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. In the nominal scenario there would be no LCF.

E.4.3. 3 .5 Chemical Consequences of Tank Dome Collapse

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.4.3.8 and E.4.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.4.3.10 and E.4.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Table E.4.3.8 Comparison of Nominal Chemical Concentrations to Toxic Concentration Limits for Tank Dome Collapse

Table E.4.3.9 Comparison of Bounding Chemical Concentrations to Toxic Concentrations Limits for Tank Dome Collapse

Table E.4.3.10 Comparison of Nominal Chemical Concentrations to Corrosive/Irritant Concentration Limits for Tank Dome Collapse

Table E.4.3.11 Comparison of Bounding Chemical Concentrations to Corrosive/Irritant Concentration Limits for Tank Dome Collapse

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.4.3.8), the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio, for the nearest noninvolved worker population consisting of 335 workers located 290 m (950 ft) away, was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.4.3.9), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 (5,840 ft) away, was 2.15 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.4.3.10), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within

1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.

- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

For the next nearest noninvolved worker population (1,500 workers at 1,780 [5,840 ft]), the cumulative acute hazard ratio was 1.20 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs and no acute health effects would be expected.

Under bounding conditions (Table E.4.3.11), the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74 and 1.42, respectively for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 1.00E-04.

E.4.3.4 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.4.3.4.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ mg/m^3) \cdot (1\ g/1{,}000\ mg) \cdot (1\ L/1{,}000\ g) \cdot (1{,}000\ m^3) \cdot (1/1.5) = 6.67E\text{-}02\ L\ (1.8E\text{-}02\ gal).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction of the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500\ L) \cdot (2.0E\text{-}03) = 5.0\ L\ (1.3\ gal).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500\ L) \cdot (4.0E\text{-}05/hr) \cdot (24\ hr) = 2.4\ L\ (0.6\ gal).$$

The combined source-term for the acute release is calculated as follows:

$$(6.67E\text{-}02\ L) + (5.00E{+}00\ L) + (2.4\ L) = 7.4\ L\ (2.0\ gal).$$

E.4.3.4.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 12 years of operation was therefore estimated to be 1.7E-03.

E.4.3.4.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.4.3.12.

Table E.4.3.12 Dose Consequence from Seismic Event

E.4.3.4.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.4.3.13.

Table E.4.3.13 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.4.3.4.5 Chemical Consequences from a Beyond Design Basis Earthquake

Potential acute hazards associated with a beyond design basis earthquake are identical to those summarized in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and E.2.2.19 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as described previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.16), the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population consisting of 335 workers located 290 m (950 ft) away was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects. For the next nearest noninvolved worker population, (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs, and no acute health effects would be expected.

Under bounding conditions (Table E.2.2.19), the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker, and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively, for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 1.68E-03.

E.4.3.5 Occupation Injuries, Illnesses, and Fatalities from Operations

The number of operation personnel to support the In Situ Fill and Cap alternative is summarized as follows:

- Continued operations - 2.39E+04 person-years; and
- Treatment operations - 1.51E+03 person-years.

Therefore, there would be a total of 2.54E+04 person-years for the In Situ Fill and Cap alternative. The total recordable injuries and illnesses lost workday cases and fatalities were calculated as follows:

Total Recordable Cases = (2.54E+04 person-years) · (2.2E+00 incidences/100 person-years) = 5.59E+02

Lost Workday Cases = (2.54E+04 person-years) · (1.1E+00 incidences/100 person-years) = 2.80E+02

Fatalities = (2.54E+04 person-years) · (3.2E-03 fatalities/100 person-years) = 8.13E-01

E.4.4 POST-REMEDIATION ACCIDENT

E.4.4.1 Deflagration in Storage Tank

After the tanks have been filled with gravel, the dome sealed off, and the Hanford Barrier placed over the tank farms, it was postulated that hydrogen builds up in the tank, reaches the LFL, and ignites. The probable sequence of events is that the tank would breach and possibly the asphalt layer in the Hanford Barrier would crack allowing an increased movement of the residual tank waste into the groundwater from increased infiltration. An explosion that could breach the dome, displace 23 m (7 ft) of overburden, and displace an additional 50 m (15 ft) of the Hanford Barrier, is considered to be incredible. For this event to occur, the following conditions must exist:

- Flammable gases must be generated from the waste;
- The concentration of the flammable gas must exceed the lower flammability limit;
- There must be an ignition source; and
- The deflagration would have to generate enough energy to breach the tank and crack the asphalt liner.

Generation of Flammable Gas

All 177 waste tanks produce flammable gases at the molecular level such as hydrogen, ammonia, and methane along with nitrous oxide (an oxidizer) due to radiolysis, organic degradation, and corrosion.

Gas Concentration

Gases generated from the residual tank waste would diffuse and accumulate in the voids within the gravel and the tank headspace created by the waste settling under the pressure of the fill. If the hydrogen is not allowed to escape from the tank through leaks or cracks in the tank, the hydrogen concentration will continue to increase as long as the potential for radiolysis, organic degradation, or corrosion exists.

It has been shown in tank waste that hydrogen generation rates may drop by approximately one-half every 15 years. Therefore, the gas concentration potential could be reduced by allowing the tanks to vent for 100 years (during institutional controls) through vent pipes passing up through the Hanford Barrier. The vents could then be sealed off. Allowing the tanks to vent for 100 years would reduce the probability of hydrogen reaching the LFL in the tank. Hydrogen gas concentration could be retarded by placing catalytic recombiners in the tank that would recombine hydrogen and oxygen. The buildup of hydrogen could be mitigated over the long-term by engineering permanent measures to allow the gas to escape into the atmosphere. This may include cutting small openings in the tanks domes and the asphalt layer within the Hanford Barrier.

Ignition of Gas

If the gas concentrations in the tank manage to exceed the LFL, the ignition sources are limited. Possible ignition sources would include a lightning strike, an earthquake, or heat produced by reactions taking place in the materials remaining in the tank. If the gas was ignited, the propagation of the burn through the gravel is dependent on the size of the voids in the gravel matrix. Flames will not propagate in a porous material if the pore size is less than a critical value.

Consequences of Deflagration

The probable sequence of events is that the tank would breach and possibly the asphalt layer in the Hanford Barrier would crack allowing an increased leaching of the residual tank waste into the groundwater.

Consequences of Gas Building Up Under the Asphalt Barrier

If the hydrogen gas generated in the tanks was able to permeate from the tank through leaks and cracks, it could potentially build up under the asphalt layer of the Hanford Barrier if the permeation rate through the asphalt is slower than the rate in which it reaches the asphalt. Because hydrogen is highly diffusible, it is extremely unlikely that this would be the case. However, if hydrogen did build up under the asphalt layer, the worst credible consequences would result in the asphalt cracking allowing an increased movement of the residual tank waste into the groundwater. This event could be mitigated by placing catalytic recombiners under the asphalt that would recombine hydrogen and oxygen or venting the asphalt layer.

E.4.4.2 Seismic Induced Rupture of Stabilized Tanks

An evaluation was performed to determine if displacement on a fault could increase exposure to the waste after remediation was completed. For this to occur, a capable fault (a fault on which displacement can occur) would have to intersect one or more tanks and cause displacement equal to the thickness of the soil cover on the tank and the Hanford Barrier, a total of 6.4 m (21 ft).

The seismicity of the area was studied extensively when the area was a potential candidate site for a potential geologic repository (Rockwell 1983). This report concludes that earthquakes in the central Columbia Plateau indicate the stress regime that exists today has been relatively unchanged for more than 14 million years, and no change of this stress regime is anticipated over the next 100,000 years. Deformation was in progress in the late Grande Ronde time (approximately 14.5 million years before present) and continued at an average low rate of uplift (vertical strain) from 14.5 to 10.5 million years before present as determined from the aerial and thickness distribution of basalt flows.

Strain appears to be concentrated in steeply dipping strata and on major structures. New first-order structures do not appear to have developed in the Quaternary, nor are they anticipated to develop in the next 10,000 to 100,000 years (Rockwell 1983).

Seismicity in the central Columbia Plateau is confined to a thin, 2.6-m (8.5-ft) crust and is characterized by temporally and spatially limited swarms of low magnitude (magnitude 3.5), shallow (0.6-m [2-ft]) earthquakes that may be characteristic of brittle deformation in basalt.

Earthquakes in the central Columbia Plateau presently are not associated with mapped geologic faults, nor in a manner that suggests the presence of unmapped faults. Swarms have occurred on the flanks of the Saddle Mountains, a first-order structure which is faulted, but the events do not correspond with mapped faults. However, swarms also have occurred elsewhere where there are no mapped geologic structures. Some small alignments are indicated by the migration of swarm events in the Saddle Mountains.

An average displacement rate of 0.03 to 0.06 mm/yr (0.0012 to 0.0024 in/yr) was calculated. While a fault model has been assumed, this estimate could represent the total deformation associated with a wider zone north and south of the crest of the Saddle Mountains structure.

Because the average deformation rate of the region is 0.06 mm/yr (0.0024 in./yr), there would be 0.6 m (2 ft) of deformation in 10,000 years. This is much less than the 6.4 m (21 ft) of cover over the tanks. Therefore, even if all displacement in the region were concentrated on one fault and that fault intersected a tank, there would be only 0.6 m (2 ft) of displacement over 10,000 years and therefore, waste would not be displaced to the surface. The tanks would most likely crack, allowing increased infiltration to the groundwater.

E.4.5 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.4.5.1 The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.4.5.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.4.5.3. The chemical hazard is expressed as exceedance of the ERPG threshold values.

Table E.4.5.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.4.5.2 Summary of Potential Radiological Accident Consequences

Table E.4.5.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.5.0 IN SITU VITRIFICATION ALTERNATIVE

This section analyses the risk resulting from potential accidents associated with the In Situ Vitrification alternative. The In Situ Vitrification alternative would involve the following activities:

- Construct and operate a tank farm confinement facility that would support in situ vitrification of tank waste including MUSTs;
- Waste transfer system upgrade construction (W-314);
- Continue evaporating liquid through the 242-A Evaporator;
- Fill tank voids with sand prior to in situ vitrification; and
- Construct Hanford Barriers over tank farms.

E.5.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the In Situ Vitrification alternative are discussed in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated as follows.

The number of construction personnel was estimated at an average 2.25E+04 person-years (Jacobs 1996). The total recordable injuries and illnesses, lost workday cases, and fatalities during the 22 years of construction were calculated using the incidence rates from Table E.1.2.1 as follows:

Total Recordable Cases = (2.25E+04 person-years) · (9.75E+00 incidences/100 person-years) = 2.19E+03

Lost Workday Cases = (2.25E+04 person-years) · (2.45E+00 incidences/100 person-years) = 5.51E+02

Fatalities = (2.25E+04 person-years) · (3.2E-03 fatalities/100 person-years) = 7.19E-01

E.5.2 TRANSPORTATION ACCIDENTS

Transporting activities associated with this alternative include:

- Transporting construction material from offsite for the tank farms confinement facility and the waste transfer system upgrade;
- Transporting earthen material from onsite borrow site for the waste transfer system upgrade and to fill tank voids;
- Transporting aggregate from onsite borrow site for concrete;
- Transporting process chemicals for off-gas treatment;
- Transporting earthen material from onsite borrow site for the Hanford Barrier; and
- Employees commuting to work each day.

E.5.2.1 Radiological Cancer Risk

All operations would be conducted within established operating parameters for the tanks and would not involve transporting radioactive materials by container. Therefore, there would be no radiological cancer risks from transportation.

E.5.2.2 Chemical Exposure

Anhydrous ammonia would be transported to the Hanford Site by rail to support the off-gas treatment process. The toxicological impacts of anhydrous ammonia were analyzed in Green (Green 1995). The annual quantities and annual shipments for in situ vitrification are similar to those analyzed in Green (Green 1995). The toxicological impacts are summarized in Table E.5.2.1. Table E.5.2.1 compares the concentration of the postulated chemical release to exposure limits discussed in Section 1.1.7. The general public exposure to anhydrous ammonia would exceed the ratio of exposure to ERPG-3 by 1.24E+01 and propane would exceed the ratio of exposure to ERPG-1 by 3.67E+00 for corrosive/irritant chemicals. Based on the magnitude of the anhydrous ammonia exceedance, potential lethal effects would be expected.

Table E.5.2.1 Comparison of Chemical Concentrations to Corrosive/Irritant Concentration Limits for the In Situ Vitrification Alternative

E.5.2.3 Occupational Injuries and Fatalities

Truck and Rail Transportation

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Truck and rail transportation activities to transport materials and supplies to the Site for this alternative were estimated in the In Situ Vitrification engineering data package (WHC 1995f) and are summarized in Table E.5.2.2. The total distance was calculated by multiplying the number of trips by the round-trip distance.

Table E.5.2.2 Summary of Transportation Activities for the In Situ Vitrification Alternative

The number of fatalities and injuries were calculated by multiplying the total distance traveled in each zone, shown in Table E.5.2.3, by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3. The expected injuries and fatalities resulting from transportation accidents associated with the In Situ Vitrification alternative are summarized in Table E.5.2.4.

Table E.5.2.3 Distance Traveled in Population Zones for the In Situ Vitrification Alternative

Table E.5.2.4 Injuries/Fatalities Resulting from Truck and Rail Transportation Accidents for the In Situ Vitrification Alternative

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, Site workers and other personnel required to perform the various activities would be driving to the Site in their vehicles. The total person-years to perform the activities was estimated at 4.88E+04 (Jacobs 1996).

Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-City area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total personnel vehicle distance was therefore calculated to be 1.32E+09 km (8.2E+09 mi).

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section 1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents was calculated as follows:

Injuries = (1.32E+09 km) · (7.14E-7 injuries/km) = 9.40E+02

Fatalities = (1.32E+09 km) · (8.98E-9 fatalities/km) = 1.18E+01

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts is the sum of the truck, rail, and employee vehicle accidents. The results are summarized in Table

E.5.2.5.

Table E.5.2.5 Cumulative Injuries and Fatalities from Traffic Impacts for the In Situ Vitrification Alternative

E.5.3 OPERATION ACCIDENTS

The potential exists for accidents resulting from operation activities. The operations are discussed in Appendix B.

This analysis separates and analyzes operations according to the following modes of operation:

- Continued operations - These operations have been previously discussed in the No Action alternative;
- Treatment - An off-gas hood would be placed over the tank and a confinement enclosure installed over the hood and the tank farm. The void space in the tank is filled with sand from the Hanford Site. Electrodes are positioned in the tank and surrounding the tank, and the tank waste is vitrified in place as well as the soil column surrounding the tanks.
- Hanford Barrier - After vitrification, the off-gas hood and confinement enclosure are removed. A multi-layer barrier of earthen material would be placed over the tank farms.

The dominant accident scenarios analyzed in the following subsections were selected from the Accident Screening Table (Table E.5.3.1). The accidents listed in Table E.5.3.1 were taken from the accident analysis data package (Shire et al. 1995 and Jacobs 1996). The methodology of screening was previously discussed in Section 1.1.2.

Table E.5.3.1 Accident Screening Table for the In Situ Vitrification Alternative

E.5.3.1 Continued Operation Accidents - Tank Waste Transfers

The dominant continued operations accident during tank waste transfers is the "mispositioned jumper accident" previously discussed in the No Action alternative in Section E.2.2.1 and is summarized as follows:

Source-term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The In Situ Vitrification alternative is based on 1 6 years of operations. Therefore, the probability for the In Situ Vitrification alternative was calculated to be 1.8E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.5.3.2.

Table E.5.3.2 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the In Situ Vitrification alternative; however, the LCF point estimate risk is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.5.3.3. The bounding calculations show all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure if the accident occurred. Approximately seven noninvolved workers would receive fatal cancers and there would be two fatal cancers to the general public. The nominal scenario calculations show there would be no LCFs.

Table E.5.3.3 Latent Cancer Fatality Risk from Mispositioned Jumper

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper are identical to those summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.00E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 1.76E-01.

Corrosive/Irritant Impact from Chemical Exposure

For the MEI worker, the cumulative ratio of exposure to ERPG-2 values for corrosive/irritant chemicals was 1.93E+00, exceeds 1.0, and would be indicative of reversible acute effects. The MEI noninvolved worker cumulative ratio of exposure to ERPG-1 values was 3.10E+00. This acute hazard index is primarily attributable to sodium hydroxide (approximately 90 percent of the total hazard). The acute hazard index for the MEI general public was less than 1.0 for ERPG-1 comparisons and would not be indicative of acute effects.

E.5.3.2 Continued Operations Accident - Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and is summarized as follows:

Source-term - The source-term resulting from a hydrogen deflagration in Section E.2.2.2.1 was calculated to be 2.4 L (0.6 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2.2 was estimated to be 7.2E-03 per year. The probability of the scenario based on 16 years of operation was therefore estimated to be 1.2E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.8 are reproduced in Table E.5.3.4.

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.2.4 are reproduced in Table E.5.3.5.

In the bounding scenario all 10 workers would potentially receive a fatal dose and would assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Table E.5.3.4 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Table E.5.3.5 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Chemical Consequences

Potential acute hazards associated with a hydrogen burn in a waste storage tank are identical to those summarized in Tables E.2.2.10 (toxic chemicals, nominal conditions), E.2.2.11 (toxic chemicals, bounding conditions), E.2.2.12 (corrosive/irritant chemicals, nominal conditions) and E.2.2.13 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38E+00, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio). However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100m (330 ft) from the source area. The first anticipated noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion

would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 m (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82E+00 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74E+00 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 1.15E-01.

E.5.3. 3 Treatment Accidents

Types of potential accidents with treatment include ventilation failure, fire, explosion, exothermic reactions, mechanical impacts, and criticality. From Table E.5.3.1 the credible accident identified as having the highest risk was Accident 4.4.4.3, "rupture off-gas duct". It was postulated that a double-ended break occurs in the off-gas line between the off-gas hood and the off-gas treatment facility. The initiating event was postulated to be an earthquake.

E.5.3. 3 .1 Scenario and Source-term Development for Off-Gas Rupture

Most radionuclides are volatilized at the vitrifying temperature and would be drawn into the off-gas hood and ventilation system by exhaust flow. The break would result in a release directly to the environment without the benefit of off-gas treatment.

The normal off-gas flow was calculated to be 300 m^3/min. A respirable airborne concentration of 200 mg/m^3 was assumed in the tank headspace because of the high temperature associated with the vitrification process. The airborne concentration was assumed to be less than 30 percent radioactive waste because of the presence of a frit. An SpG of 1.00 was assumed for the tank waste. The exposure time was assumed to be 16 hours. The respirable source-term was calculated as follows:

$$(300\ m^3/min) \cdot (200\ mg/m^3) \cdot (30\ percent) \cdot (1.0E\text{-}06\ L/mg) \cdot (960\ min) = 17\ L\ (4.6\ gal)$$

E.5.3. 3 .2 Probability of Off-Gas Duct Rupture

The annual exceedance frequency of the earthquake was assumed to be 1.00E-03 in the accident data package (Shire et al. 1995 and Jacobs 1996). The probability for this scenario based on 16 years of operation was therefore estimated to be 1.6E-02.

E.5.3. 3 .3 Radiological Consequence of Off-Gas Duct Rupture

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section 1.1.6. The results are presented in Table E.5.3. 6 .

Table E.5.3.6 Dose Consequence for Off-Gas Duct Rupture

E.5.3. 3 .4 Radiological Cancer Risk for Off-Gas Duct Rupture

The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.5.3. 7 .

Table E.5.3.7 Latent Cancer Fatality Risk from Off-Gas Duct Rupture

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. T he calculations show there would be 36 fatal cancers to the noninvolved worker population and 5 fatal cancers to the general public population attributable to this exposure if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.5.3. 3 .5 Chemical Consequences of Off-Gas Duct Rupture

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.5.3.8 and E.5.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.5.3.10 and E.5.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Table E.5.3.8 Comparison of Nominal Chemical Concentrations to Toxic Concentration Limits for Off Gas Duct Rupture - DST Solids

Table E.5.3.9 Comparison of Bounding Chemical Concentrations to Toxic Concentration Limits for Off Gas Duct Rupture - DST Solids

Table E.5.3.10 Comparison of Nominal Chemical Concentrations to Corrosive/Irritant Concentration Limits for Off Gas Duct Rupture - DST Solids

Table E.5.3.11 Comparison of Bounding Chemical Concentrations to Corrosive/Irritant Concentration Limits for Off Gas Duct Rupture - DST Solids

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.5.3.8), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.5.3.9), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.54 for ERPG-1, indicating that only mild, transient acute health effects would be expected. No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.5.3.10), the cumulative acute hazard ratio for the MEI worker was 1.09 for ERPG-2, indicating that reversible acute irritant effects would be expected. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker and general public, the cumulative acute hazard ratios were less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for these populations

Under bounding conditions (Table E.5.3.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.16 for ERPG-1, indicating that only mild transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of an offgas duct rupture is 1.60E-02.

E.5.3.4 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.5.3.4.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by sudden a pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ \text{mg/m}^3) \cdot (1\ \text{g}/1{,}000\ \text{mg}) \cdot (1\ \text{L}/1{,}000\ \text{g}) \cdot (1{,}000\ \text{m}^3) \cdot (1/1.5) = 6.67\text{E-}02\ \text{L}\ (1.8\text{E-}02\ \text{gal}).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction of the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500\ \text{L}\ [660\ \text{gal}]) \cdot (2.0\text{E-}03) = 5.0\ \text{L}\ (1.3\ \text{gal}).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

(2,500 L [660 gal]) · (4.0E-05/hr) · (24 hr) = 2.4 L (0.6 gal).

The combined source-term for the acute release is calculated as follows:

(6.67E-02 L) + (5.00E+00 L) + (2.4 L) = 7.4 L (2.0 gal).

E.5.3.4.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 16 years of operation was therefore estimated to be 2.2E-03.

E.5.3.4.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.5.3.12.

Table E.5.3.12 Dose Consequence from Seismic Event

E.5.3.4.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.5.3.13.

Table E.5.3.13 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.5.3.4.5 Chemical Consequences from a Beyond Design Basis Earthquake

Potential acute hazards associated with a beyond design basis earthquake are identical to those summarized in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and E.2.2.19 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as described previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.16), the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population consisting of 335 workers located 290 m (950 ft) away was less than 1.0 for all

ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m (950 ft) away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects. For the next nearest noninvolved worker population, (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs, and no acute health effects would be expected.

Under bounding conditions (Table E.2.2.19), the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker, and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively, for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 2.25E-03.

E.5.3.5 Occupational Injuries and Fatalities from Operations

The number of operation personnel was estimated at approximately 2.64E+04 person-years (Jacobs 1996). The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (2.64E+04 person-years) · (2.2E+00 incidences/100 person-years) = 5.80E+02

Lost Workday Cases = (2.64E+04 person-years) · (1.1E+00 incidences/100 person-years) = 2.90E+02

Fatalities = (2.64E+04 person-years) · (3.2E-03 fatalities/100 person-years) =8.43E-01

E.5.4 POST-REMEDIATION ACCIDENT

E.5.4.1 Deflagration in Storage Tank

After the tank waste was vitrified in-place and the organics destroyed in the process, the probability of a tank generating enough hydrogen to exceed the LFL is considered to be incredible.

E.5.4.2 Seismic Induced Rupture of Stabilized Tanks

As discussed in Section E.4.4.2, displacement on a fault resulting in an airborne release of the waste after remediation is considered incredible. The tanks would most likely crack, allowing increased infiltration to the groundwater.

E.5.5 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.5.5.1. The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.5.5.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.5.5.3. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.5.5.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.5.5.2 Summary of Potential Radiological Accident Consequences

Table E.5.5.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.6.0 EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE

The Ex Situ Intermediate Separations alternative for tank waste would involve constructing and operating vitrification and support facilities, low-level vitrified waste burial vaults, and transfer lines from the tank farms and T Plant to the vitrified facilities. This alternative would also involve transporting retrieved tank waste to a vitrification facility and vehicle traffic of the personnel required to support the alternative. This section analyzes the construction, operation, and transportation risks associated with this alternative.

E.6.1 CONSTRUCTION ACCIDENTS

The potential exists for accidents resulting from construction activities. The construction activities are outlined in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated as follows.

The number of construction personnel was estimated at an average 3.11E+04 person-years (Jacobs 1996). The number of total recordable injuries and illnesses, lost workday cases, and fatalities were calculated using the incidence rates from Table E.1.2.1 as follows:

Total Recordable Cases = (3.11E+04 person-years) · (9.75E+00 incidences/100 person-years) = 3.03E+03

Lost Workday Cases = (3.11E+04 person-years) · (2.45E+00 incidences/100 person-years) = 7.61E+02

Fatalities = (3.11E+04 person-years) · (3.2E-03 fatalities/100 person-years) = 9.94E-01

E.6.2 TRANSPORTATION ACCIDENTS

Under the Ex Situ Intermediate Separations alternative, Hanford Site tank waste would be stabilized by vitrification. The vitrified HLW would be shipped to onsite storage and the LAW would be buried in vaults on the Hanford Site. These waste streams would be transported by pipeline, truck, and rail. In addition to transporting the waste, construction materials and process chemicals would be transported to the Hanford Site by truck and rail. This alternative would also be supported by a work force of employees that would commute to work each day.

E.6.2.1 Radiological Cancer Risk

Radiological exposures resulting from accidents were analyzed using RADTRAN 4 (Neuhauser-Kanipe 1992). Exposures resulting from accidents from the following transportation activities were included in the analysis.

- Transporting residual waste from the SSTs to the processing facility by truck; and
- Transporting waste from MUSTs to the processing facility by truck.

The analysis addressed radiological accident impacts as an integrated population risk (i.e., accident frequencies times consequences integrated over the entire shipping campaign) using RADTRAN 4 and a maximum credible accident using GENII computer codes (Napier et al. 1988).

The population doses were dependent on the accident probability, release quantities, atmospheric dispersion parameters, population distribution parameters, human uptake, and dosimetry models.

Radiological exposure to the MEI was calculated for a bounding scenario accident by GENII computer code (Green 1995). The public and worker dose calculated by GENII were dependent on the release quantities of radioactive material, release duration, receptor location, and meteorology.

E.6.2.1.1 Truck Transport of Retrieved Tank Waste

The receptor dose and LCF risk resulting from the accident analysis for retrieval of MUST waste and SST residuals is presented in Table E.6.2.1 for the integrated population and Table E.6.2.2 for the MEI worker and MEI general public.

Table E.6.2.1 Integrated Radiological Impact from Retrieval Transport Accidents

Table E.6.2.2 MEI Radiological Impact from Retrieval Transport Accidents

There would be no LCFs resulting from an accident while transporting retrieved waste on site.

E.6.2.2 Chemical Exposure

Chemicals transported to the Hanford Site to support the pretreatment and vitrification processes would have the greatest chemical impact. An analysis was performed to 1) identify the hazardous chemicals that could result in the largest toxicological impacts; and 2) evaluate the toxicological impacts of the maximum credible accidents involving the highest hazard chemicals (Green 1995). A preliminary screening analysis was performed to identify the chemicals representing the highest potential toxicological hazard. The highest hazard chemicals in terms of toxicity were determined to be nitric acid, sodium hydroxide, anhydrous ammonia, and dicyclopentadiene. The chemical concentrations resulting from the maximum credible accident at 100 m (330 ft) and the frequency of the accidents (Green 1995) are summarized in Table E.6.2.3.

Table E.6.2.3 Chemical Releases from Postulated Accidents for the Ex Situ Intermediate Separations Alternative

Table E.6.2.4 compares the respirable concentration of the postulated chemical releases to exposure limits discussed in Section E.1.1.7.

Table E.6.2.4 Comparison of Chemical Concentrations to Corrosive/Irritant Concentration Limits for the Ex Situ Intermediate Separations Alternative

Table E.6.2.4 shows the general public exposure to anhydrous ammonia would exceed the ratio of exposure to ERPG-3 by 1.24E+01 and sodium hydroxide would exceed the ratio of exposure to ERPG-1 by 2.45E+00 for corrosive/irritant chemicals. The magnitude of the anhydrous ammonia exceedance indicates potential lethal effects for the MEI general public.

E.6.2.3 Occupational Injuries and Fatalities

Truck and Rail Transportation

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Rail and truck transportation activities to transport materials and supplies to the Site for this alternative were estimated (WHC 1995j) and are summarized in Table E.6.2.5.

Table E.6.2.5 Summary of Transportation Activities for the Ex Situ Intermediate Separations Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.6.2.6 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3. The expected injuries and fatalities resulting from transportation accidents associated with the Ex Situ Intermediate Separations alternative are summarized in Table E.6.2.7.

Table E.6.2.6 Distance Traveled in Population Zones for the Ex Situ Intermediate Separations Alternative

Table E.6.2.7 Injuries and Fatalities Resulting from Truck and Rail Transportation Accidents for the Ex Situ Intermediate Separations Alternative

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, Site workers and other personnel required to perform the various activities would be driving to the site in their vehicles. The total person-years to perform the activities was estimated at 8.58E+04.

Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total employee vehicle distance was therefore calculated as follows:

(8.58E+04 person-years) · (260 days/year) · (140 km/day) · (1/1.35) = 2.31E+09 km (1.44E+09 mi)

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (2.31E+09 km) · (7.14E-07 injuries/km) = 1.65E+03

Fatalities = (2.31E+09 km) · (8.98E-09 fatalities/km) = 2.08E+01

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck and rail transport and employee vehicle accidents. The results are summarized in Table E.6.2.8.

Table E.6.2.8 Cumulative Injuries and Fatalities from Traffic Impacts for the Ex Situ Intermediate Separations Alternative

E.6.3 OPERATION ACCIDENTS

Operations are discussed in Appendix B. The operations are separated and analyzed according to the following modes of operation:

- Continued operations - Previously discussed in the No Action alternative.
- Retrieval operations - DST waste would be extracted from tanks using slurry pumping. Hydraulic sluicing would be used to remove SST waste. If hydraulic sluicing did not meet waste retrieval goals, robotic arm-based retrieval methods would be used. Pipelines would transfer waste from the tank farms to a pretreatment facility.
- Pretreatment - Pretreatment would consist of sludge washing and chemical processes to separate the waste into HLW and LAW streams. The solids in the tank would be washed to dissolve salts to the extent practical and those salts bearing liquid would be added to the supernatant stream going to Cs removal. The sludge remaining in the tanks would be washed to remove additional solids and to minimize the feed to the HLW vitrification facility.
- Treatment - LAW would be pumped into a LAW vitrification facility where it would be mixed with feed material and vitrified into glass. Vitrification is a high-temperature process where waste is blended with additives and fused into a glass-like form suitable for disposal. The HLW would be routed from a lag storage facility, where it would be temporarily stored before treatment, to a HLW vitrification facility where it would be mixed with feed material (such as glass formers) and then fused into glass.
- Disposal - The LAW glass would be placed into a near-surface retrievable disposal facility on the Hanford Site. A Hanford Barrier would be constructed over the retrievable LAW disposal site to inhibit migration of contaminants or intrusion by humans or animals. The high-level vitrification waste glass would be placed in

aboveground storage facility at the Hanford Site. It would then be shipped by rail to an offsite potential geologic repository for permanent disposal.

The potential for accidents exists during the operation of these activities. The dominant accident scenarios analyzed in the following subsections were selected from the Accident Screening Table (Table E.6.3.1). The methodology of the table was previously discussed in Section E.1.1.2.

Table E.6.3.1 Accident Screening Table for the Ex Situ Intermediate Separations Alternative

E.6.3.1 Routine Operation Accidents - Tank Waste Transfers

The dominant routine operations accident during tank waste transfer is the mispositioned jumper accident previously discussed in the No Action alternative in Section E.2.2.1 and summarized as follows:

Source-term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The Ex Situ Intermediate Separations routine operation activity was based on 25 years of operations; therefore, the probability was calculated to be 2.8E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.6.3.2.

Table E.6.3.2 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the Ex Situ Intermediate Separations alternative. However, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.6.3.3.

Table E.6.3.3 Latent Cancer Fatality Risk from Mispositioned Jumper

The bounding calculations show all 10 workers would potentially receive fatal dose and assumably die directly after the exposure if the accident occurred. Approximately seven noninvolved workers would receive fatal cancers and two fatal cancers would be incurred to the general public. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper are identical to those summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for

ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.00E+00, indicating that only mild, reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 2.75E-01.

E.6.3.2 Continued Operations Accidents - Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and is summarized as follows.

Source-term - The source-term resulting from the fire in Section E.2.2.2.1 was calculated to be 2.4 L (0.6 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2.2 was estimated to be 7.2E-03 per year. The probability of the scenario based on 25 years of operation was therefore estimated to be 1.8E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.8 are reproduced in Table E.6.3.4.

Table E.6.3.4 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.2.4 are the same for the Ex Situ Intermediate Separations alternative. However, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCR and the LCF risk are calculated in Table E.6.3.5.

Table E.6.3.5 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

In the bounding all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

Potential acute hazards associated with a hydrogen burn in a waste storage tank are identical to those summarized in Tables E.2.2.10 (toxic chemicals, nominal conditions), E.2.2.11 (toxic chemicals, bounding conditions), E.2.2.12 (corrosive/irritant chemicals, nominal conditions) and E.2.2.13 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38E+00, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio) However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100m (330 ft) from the source area. The first anticipated noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 m (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82E+00 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was

1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to:

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74E+00 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 1.80E-01.

E.6.3.3 Retrieval Accidents

The types of potential accidents associated with retrieval are leaks, sprays, ventilation failure, fire/deflagration, mechanical impacts, and criticality. From the Accident Screening Table (Table E.6.3.1), the accident within design basis identified as having the highest risk was Accident E.4.3.1.10, "loss of filtration."

A tank dome collapse analysis (Shire et al. 1995 and Jacobs 1996) concluded that the annual frequency of the event would be incredible depending on barrier configuration and administrative controls. The collapse of a tank dome would require a heavy vehicle on the dome. Large objects such as the tank 241-SY-101 mixer pump do not represent sufficient weight to cause damage to the tank dome because they are suspended from a support structure in the central pit. Mechanical barriers such as posts spaced closely together would prevent large vehicles from driving on top of the domes without removing the posts. Post removal would be administratively controlled through a controlled locking system. Failure of the barrier configuration and the administrative control system was calculated to be 1.0E-07/year.

E.6.3.3.1 Scenario and Source-term Development for Loss of Filtration

It was postulated that a ventilation heater failure could occur due to an electrical fault resulting in humid air plugging the HEPA filter and filter blowout. A condenser maintenance backflush error could also result in plugging the HEPA filter and filter blowout. Loss of both stages of filtration would allow an unfiltered release LPF of 1.00 for the bounding scenario.

The impact of the postulated accident during retrieval of tank waste would result in an airborne release of the radionuclides in the headspace of the tank. Assuming a respirable concentration of radionuclides in the headspace of 100 mg/m^3 (based on a partition fraction between liquid and aerosol of 1.0E-07), a liquid SpG of 1, and a headspace volume of 2,500 m^3, the potential source-term from the headspace release was calculated as follows:

$$(100\ \text{mg/m}^3) \cdot (2{,}500\ \text{m}^3) \cdot (1\ \text{g}/1{,}000\ \text{mg}) \cdot (1\ \text{L}/1{,}000\ \text{g}) \cdot (1) = 0.25\ \text{L}\ (0.066\ \text{gal}).$$

E.6.3.3.2 Probability of Loss of Filtration

The annual frequency of the event was calculated in the potential accident data package (Shire et al. 1995 and Jacobs 1996) as follows:

The failure rate of an electrically powered air heater was calculated to be 8.8E-03/yr based on an hourly failure rate of 1.0E-06. The HEPA filtration system would have a monitoring and alarm system that could detect the change in the differential pressure caused by a filter plug or filter blowout. This system was given a failure rate of 1.0E-03/yr. The annual frequency of this event was therefore calculated to be 8.8E-06. Based on 25 years of operation, the probability was calculated to be 2.2E-04.

E.6.3.3.3 Radiological Consequence from Loss of Filtration

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results (Shire et al. 1995 and Jacobs 1996) are summarized in Table E.6.3.6.

Table E.6.3.6 Dose Consequence from Loss of Filtration

E.6.3.3.4 Radiological Cancer Risk from Loss of Filtration

The LCFs and the LCF point estimate risk were calculated for the receptors and are presented in Table E.6.3.7.

Table E.6.3.7 Latent Cancer Fatality Risk from Loss of Filtration

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be less than one LCF attributed to the exposure to the noninvolved workers and general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.6.3.3.5 Chemical Consequences from Loss of Filtration

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.8 and E.6.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.10 and E.6.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Table E.6.3.8 Comparison of Nominal Chemical Concentrations to Toxic Concentration Limits for Loss of Filtration

Table E.6.3.9 Comparison of Bounding Chemical Concentrations to Toxic Concentration Limits for Loss of Ventilation - SST Solids

Table E.6.3.10 Comparison of Nominal Chemical Concentrations to Corrosive/Irritant Concentration Limits for Loss of Filtration

Table E.6.3.11 Comparison of Bounding Chemical Concentrations to Corrosive/Irritant Concentration Limits for Loss of Filtration - SST Solids

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.8) the cumulative acute hazard ratio for the MEI worker was less than 1.0 for all ERPGs, indicating that no adverse acute health effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio was 1.84 for ERPG-1, indicating that only mild, transient acute health effects would be expected. No acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.9), the cumulative acute hazard ratio for the MEI noninvolved worker was 7.27E+01 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Uranium (approximately 48 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio);

- Mercury (approximately 13 percent of the total hazard ratio); and
- TOC (approximately 7 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population (335 workers) located 290 m (950 ft) from the source was 5.40E+00 for ERPG-2, indicating that reversible acute health effects would be expected. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Loss of Filtration

Under nominal conditions (Table E.6.3.10), the cumulative acute hazard ratio for the MEI worker was 2.11E+00 for ERPG-2, indicating that reversible corrosive/irritant effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 1.72E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 3.02, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 2.47E+01 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 82 percent of the total hazard ratio); and
- Calcium (approximately 9 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 4.38 for ERPG-1, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a loss of filtration event is 2.20E-04 for the MEI worker, MEI noninvolved worker and MEI general public.

E.6.3.4 Pretreatment

Types of potential accidents associated with pretreatment are spills, sprays, and explosions. From the Accident Screening Table (Table E.6.3.1), the design basis accident identified as having the highest risk was a pressurized spray release, Accident 4.5.1.1.2, "line break occurs within vault due to earthquake."

It was postulated that a line break could occur within a ventilated vault because of a design basis earthquake. The vault would be located between the separations facility and the HLW vitrification facility. The pump pressure to the line would be 1,430 kPa (207 psi).

E.6.3.4.1 Scenario and Source-term Development for Seismic Induced Line Break in Vault

It was determined a maximum respirable spray release from the ruptured line with a pump pressure of 1,430 kPa (207 psi) would be approximately 7.6 L/min (2.0 gal/min) (Shire et al. 1995 and Jacobs 1996). The total released quantity would be drawn through a double-stage HEPA filter before being released to the environment.

Assumptions were as follows:

- The spray was limited to 16 hours (960 minutes); and
- HEPA filters provided an assumed LPF of 1.0E-05.

The source-term was calculated as follows:

(7.6 L/minutes) · (960 minutes) · (1.0E-05) = 7.3E-02 L (1.9E-02 gal).

E.6.3.4.2 Probability of Seismic Induced Line Break in Vault

The annual exceedance frequency of the event was assumed to be 6.5E-04 (Shire et al. 1995 and Jacobs 1996). This is the frequency of a 0.23 g design basis earthquake at the Hanford Site. It is assumed the leak would occur given the probability of the design basis earthquake. Based on 25 years of operation the probability was calculated to be 1.6E-02.

E.6.3.4.3 Radiological Consequences of Seismic Reduced Line Break in Vault

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code using the methodology discussed in Section E.1.1.4. The results (Shire et al. 1995 and Jacobs 1996) are summarized in Table E.6.3.12.

Table E.6.3.12 Dose Consequence for Seismic Reduced Line Break in Vault

E.6.3.4.4 Radiological Cancer Risk of Seismic Induced Line Break in Vault

Based on a dose-to-risk conversion factor of 4.0E-04 LCF per person-rem for the workers and noninvolved workers and 5.0E-04 per person-rem for the general public, the LCFs and the LCF risk (point estimate) were calculated for the receptors and presented in Table E.6.3.13. The calculations show there would be no LCFs attributable to this exposure if the accident occurs for the bounding or nominal scenarios.

Table E.6.3.13 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

E.6.3.4.5 Chemical Consequences of Seismic Induced Line Break in Vault

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.14 and E.6.3.15 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.16 and E.6.3.17 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Table E.6.3.14 Comparison of Nominal Chemical Concentrations to Toxic Concentration Limits for Pretreatment Spray Release - SST Solids

Table E.6.3.15 Comparison of Bounding Chemical Concentrations to Toxic Concentration Limits for Pretreatment Spray Release - SST Solids

Table E.6.3.16 Comparison of Nominal Chemical Concentrations to Corrosive/Irritant Concentration Limits for Pretreatment Spray Release - SST Solids

Table E.6.3.17 Comparison of Bounding Chemical Concentrations to Corrosive/Irritant Concentration Limits for Pretreatment Spray Release - SST Solids

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.14), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.15), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.16), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.17), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Under both nominal and bounding conditions, the probability of a pretreatment spray release is 1.63E-02.

E.6.3.5 Treatment Accidents

The treatment section of the Accident Screening Table (Table E.6.3.1) shows the radiological consequences to be insignificant for all credible accidents. The dominant accident was identified as Accident 4.5.4.4 "A Canister Dropped Due to Mechanical Failure or Human Error."

E.6.3.5.1 Source-term for Breached Canister

The source-term for a 24-hour release through a two-stage HEPA filter was calculated in Shire (Shire et al. 1995 and Jacobs 1996) to be 2.5E-06 grams (8.8E-08 ounces).

E.6.3.5.2 Radiological Consequences of Immobilization Accident

Accident 4.5.4.4, "a canister dropped due to mechanical failure or human error," has the highest dose consequences. As calculated in the accident data package (Shire et al. 1995 and Jacobs 1996) the radiological dose to the receptors are shown in Table E.6.3.18.

Table E.6.3.18 Dose Consequence for Breached Canister

E.6.3.5.3 Probability of Breached Canister

The annual frequency of the accident was considered in the accident data package (Shire et al. 1995 and Jacobs 1996) to be 6.0E-01. This was based on the frequency of a canister being dropped during transfer of 3.0E-04 per transfer and 2,000 transfers per year. Based on 25 years of operation the probability was calculated to be 1.0E+00.

E.6.3.5.4 Radiological Cancer Risk of Breached Canister

The LCFs and the LCF risk (point estimate) were calculated for the receptors and presented in Table E.6.3.19.

Table E.6.3.19 Latent Cancer Fatality Risk from Breached Canister

The calculations show there would be no LCFs attributable to this exposure for the bounding or nominal scenarios.

E.6.3.5.5 Chemical Consequences of Breached Canister

No chemical consequences were evaluated in (Shire et al. 1995 and Jacobs 1996) since the release would first pass through a two-stage HEPA filters that would reduce the source-term to a very small amount, well below the cumulative ratio of exposure to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.6.3.6 Disposal/Storage Accidents

No design basis accidents resulting in a radiological or chemical consequences to the receptors were identified. This is largely due to the vitrified waste form of the material and the engineered structural packaging of the vitrified LAW in burial vaults and vitrified HLW in shipping containers.

E.6.3.7 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.6.3.7.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ \text{mg/m}^3) \cdot (1\ \text{g}/1{,}000\ \text{mg}) \cdot (1\ \text{L}/1{,}000\ \text{g}) \cdot (1{,}000\ \text{m}^3) \cdot (1/1.5) = 6.67\text{E-}02\ \text{L}\ (1.8\text{E-}02\ \text{gal}).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction of the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500\ \text{L}\ [660\ \text{gal}]) \cdot (2.0\text{E-}03) = 5.0\ \text{L}\ (1.3\ \text{gal}).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500\ \text{L}\ [660\ \text{gal}]) \cdot (4.0\text{E-}05/\text{hr}) \cdot (24\ \text{hr}) = 2.4\ \text{L}\ (0.6\ \text{gal}).$$

The combined source-term for the acute release is calculated as follows:

$$(6.67\text{E-}02\ \text{L}) + (5.00\text{E+}00\ \text{L}) + (2.4\ \text{L}) = 7.4\ \text{L}\ (2.0\ \text{gal}).$$

E.6.3.7.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 25 years of operation was therefore estimated to be 3.5E-03.

E.6.3.7.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.6.3.20.

Table E.6.3.20 Dose Consequence from Seismic Event

E.6.3.7.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.6.3.21.

Table E.6.3.21 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.6.3.7.5 Chemical Consequences from a Beyond Design Basis Earthquake

Potential acute hazards associated with a beyond design basis earthquake are identical to those summarized in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and E.2.2.19 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as described previously.

Toxic Impact from Chemical Exposure

Under nominal conditions, the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population consisting of 335 workers located 290 m (950 ft) away was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker population (335 workers located 290 m (950 ft) away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.

- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects. For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs, and no acute health effects would be expected.

Under bounding conditions, the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively, for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 3.50E-03.

E.6.3.8 Occupational Injuries and Fatalities

The number of operation personnel to support the Ex Situ Intermediate Separations alternative was estimated (Jacobs 1996) and is summarized as follows:

- Retrieval operations - 3.74E+04 person-years; and
- Vitrification operations - 1.73E+04 person-years.

The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (5.47E+04 person-years) · (2.2E+00 incidences/100 person-years) = 1.20E+03

Lost Workday Cases = (5.47E+04 person-years) · (1.1E+00 incidences/100 person-years) = 6.02E+02

Fatalities = (5.47E+04 person-years) · 3.2E-03 fatalities/100 person-years) = 1.75E+00

E.6.4 POST-REMEDIATION ACCIDENT

E.6.4.1 Deflagration in Storage Tank

After 99 percent of the tank waste has been removed from each tank, the probability of a tank generating enough hydrogen to exceed the LFL is considered to be incredible.

E.6.4.2 Seismic-Induced Rupture of Stabilized Tanks

As discussed in Section E.4.4.2, displacement on a fault that would increase exposure to the waste after remediation is considered incredible. The tanks would most likely crack, allowing increased infiltration to the groundwater.

E.6.5 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.6.5.1. The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.6.5.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.6.5.3. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.6.5.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.6.5.2 Summary of Potential Radiological Accident Consequences

Table E.6.5.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.7.0 EX SITU NO SEPARATIONS ALTERNATIVE

The Ex Situ No Separations alternative would not separate waste into LAW and HLW streams. The SST and DST waste would be blended and vitrified (as HLW) into glass cullet. The cullet would be packed into canisters, placed into concrete overpack shielding casks, and held on interim site storage pads to await shipment to a permanent potential geologic repository for final disposal. This section analyzes and compares the construction, operation, and transportation risks associated with this alternative.

E.7.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the Ex Situ No Separations alternative are discussed in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated in the following text.

The number of construction personnel to support the Ex Situ No Separations alternative was estimated (Jacobs 1996) and summarized as follows:

- Waste transfer system upgrade - 1.63E+02 person-years;
- Retrieval construction - 1.06E+04 person-years;
- Vitrification construction - 1.48E+04 person-years; and
- Grout fill MUSTs and closure - 4.62E+02 person-years.

The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (2.60E+04 person-years) · (9.75E+00 incidences/100 person-years) = 2.54E+03.

Lost Workday Cases = (2.60E+04 person-years) · (2.45E+00 incidences/100 person-years) = 6.38E+02.

Fatalities = (2.60E+04 person-years) · (3.20E-03 fatalities/100 person-years) = 8.33E-01.

E.7.2 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative are:

- Transporting residual SST waste and MUST waste to vitrification facility;
- Transporting earthen material from onsite borrow site to fill tank voids;
- Transporting earthen material from onsite borrow site for Hanford Barrier;
- Transporting construction material to the Hanford Site; and
- Employees commuting to work each day.

E.7.2.1 Radiological Consequences

The methodology for determining radiological consequences from accidents while transporting residual SST waste and MUST waste to a vitrification facility was previously discussed in Section E.6.2.1.

The receptor dose and LCF risk resulting from the accident analysis for retrieval of MUST waste and SST residuals is presented in Table E.7.2.1 for the integrated population and Table E.7.2.2 for the MEI worker and MEI general public. There would be no LCFs resulting from an accident while transporting retrieved waste onsite.

Table E.7.2.1 Integrated Radiological Impact from Retrieval Transport Accidents

Table E.7.2.2 MEI Radiological Impact from Retrieval Transport Accidents

E.7.2.2 Chemical Consequences

The chemical exposure for the Ex Situ No Separations alternative is the same as that previously discussed in Section 6.2.2 for the Ex Situ Intermediate Separations alternative with the exclusion of the dicyclopentadiene. The results are reproduced in Table E.7.2.3. The general public's exposure to anhydrous ammonia would exceed the ratio of exposure to ERPG-3 by 1.24E+01 for corrosive/irritant chemicals. Consequently, this exposure to the MEI general public could result in potential lethal effects.

Table E.7.2.3 Comparison of Chemical Concentrations to Corrosive/Irritant Concentration Limits for the Ex Situ No Separations Alternative

E.7.2.3 Occupational Injuries and Fatalities

Truck and Rail Transportation

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Rail and truck transportation activities to transport materials and supplies to the site for this alternative were estimated in the No Separations data package (WHC 1995c) and summarized in Table E.7.2.4.

Table E.7.2.4 Summary of Transportation Activities for the Ex Situ No Separations Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.7.2.5 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3.

Table E.7.2.5 Distance Traveled in Population Zones for the Ex Situ No Separations Alternative

The expected injuries and fatalities resulting from transportation accidents associated with the Ex Situ No Separations alternative are summarized in Table E.7.2.6.

Table E.7.2.6 Injuries and Fatalities Resulting from Truck and Rail Transportation Accidents for the Ex Situ No Separations Alternative

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, site workers and other personnel required to perform the various activities would be driving to the site in their vehicles. The total person-years to perform the activities was estimated at 6.73E+04 (Jacobs 1996). Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total employee vehicle distance was therefore calculated as follows:

$$(6.73\text{E+}04 \text{ person-years}) \cdot (260 \text{ days/year}) \cdot (140 \text{ km/day}) \cdot (1/1.35) = 1.82\text{E+}09 \text{ km } (1.1\text{E+}09 \text{ mi})$$

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (1.82E+09 km) · (7.1E-07 injuries/km) = 1.30E+03

Fatalities = (1.82E+09 km) · (8.98E-09 fatalities/km) = 1.63E+01

Cumulative Transportation Injuries and Fatalities

The cumulative, nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts is the sum of the truck and rail transport and employee vehicle accidents. The results are summarized in Table E.7.2.7.

Table E.7.2.7 Cumulative Injuries and Fatalities from Traffic Impacts for the Ex Situ No Separations Alternative

E.7.3 OPERATION ACCIDENTS

The radiological and chemical operation accidents, consequences, and risk for the Ex Situ No Separations alternative are summarized in the following text.

E.7.3.1 Continued Operation - Mispositioned Jumper Accident - Tank Waste Transfers

The dominant continued operations accident during tank waste transfer is the mispositioned jumper accident previously discussed in the No Action alternative in Section E.2.2.1 and summarized as follows:

Source-term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The Ex Situ No Separations continued operation activity was based on 22.5 years of operations; therefore, the probability was calculated to be 2.5E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.7.3.1.

Table E.7.3.1 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the Ex Situ No Separations alternative; however, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.7.3.2. The bounding scenario calculations show all 10 workers potentially receive a fatal dose and assumably die directly after the exposure if the accident occurred. There would be approximately seven LCFs from the noninvolved worker population and two from the general public. The nominal scenario calculations show there would be no LCFs.

Table E.7.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper are identical to those summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.00E+00, indicating that only mild, reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 2.48E-01.

E.7.3.2 Continued Operations Accident -Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and summarized as follows:

Source-term - The source-term resulting from the fire in Section E.2.2.2.1 was calculated to be 2.4 L (0.6 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2.2 was estimated to be 7.2E-03 per year. The Ex Situ No Separations alternative was based on 23 years of operation, therefore the probability was calculated to be 1.7E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.8 are reproduced in Table E.7.3.3.

Table E.7.3.3 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.2.4 are the same for the Ex Situ No Separations alternative. However, the LCF point estimate risk is not the same due to the difference in probabilities. The LCF and the LCF risk are calculated in Table E.7.3.4.

Table E.7.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The noninvolved scenario calculations show there would be no LCFs.

Chemical Consequences

Potential acute hazards associated with a hydrogen burn in a waste storage tank are identical to those summarized in Tables E.2.2.10 (toxic chemicals, nominal conditions), E.2.2.11 (toxic chemicals, bounding conditions), E.2.2.12 (corrosive/irritant chemicals, nominal conditions) and E.2.2.13 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38E+00, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio) However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100m (330 ft) from the source area. The nearest noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects;
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded; and
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 m (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82E+00 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to:

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 1.66E-01.

E.7.3.3 Retrieval - Loss of Filtration Accident

The dominant retrieval operations accident is the loss of filtration accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.3 and is summarized as follows:

Source-term - The source-term resulting from the airborne release in Section E.6.3.3.1 was calculated to be 2.5E-01L (6.6E-02 gal).

Probability - The frequency of a loss of filtration in Section E.6.3.3.2 was 8.8E-06 per year. The Ex Situ No Separations retrieval activity was based on 23 years of operations; therefore, the probability was calculated to be 2.2E-04.

Radiological Consequences - The radiological consequences presented in Section 6.3.3.3 are reproduced in Table E.7.3.5.

Table E.7.3.5 Dose Consequence from Loss of Filtration

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and are presented in Table E.7.3.6.

Table E.7.3.6 Latent Cancer Fatality Risk from Loss of Filtration

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. The calculations show there would be less than one LCF attributed to the exposure to the noninvolved workers and the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.8 and E.6.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.10 and E.6.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.8), the cumulative acute hazard ratio for the MEI worker was less than 1.0 for all ERPGs, indicating that no adverse acute health effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio was 1.84E+00 for ERPG-1, indicating that only mild, transient acute health effects would be expected. No acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.9), the cumulative acute hazard ratio for the MEI noninvolved worker was 7.27E+01 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Uranium (approximately 48 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio);
- Mercury (approximately 13 percent of the total hazard ratio); and
- TOC (approximately 7 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population (335 workers) located 290 m (950 ft) from the source was 5.40E+00 for ERPG-2, indicating that reversible acute health effects would be expected. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Loss of Filtration

Under nominal conditions (Table E.6.3.10), the cumulative acute hazard ratio for the MEI worker was 2.11E+00 for ERPG-2, indicating that reversible corrosive/irritant effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 1.72E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 3.02E+00, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 2.47E+01 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 82 percent of the total hazard ratio);and
- Calcium (approximately 9 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 4.38 for ERPG-1, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a loss of filtration event is 2.02E-04.

E.7.3.4 Treatment - Canister of Vitrified High-Level Waste Inadvertently Drops and Ruptures

The dominant immobilization operations accident is the "canister of vitrified HLW inadvertently drops and ruptures" accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.5 and summarized as follows:

Source-term - The source-term resulting from the airborne release in Section E.6.3.5.1 was calculated to be 2.5E-06 g (8.8E-08 oz) based on a solid glass form in the canister. The canisters for the Ex Situ No Separations alternative are filled with glass cullet, therefore it was assumed that the MAR would be increased by a factor of two. This increase would result in a source-term of 5.0E-06 g (1.8E-07 oz).

Probability - The frequency of the accident in Section E.6.3.5.2 was 6.0E-01 per year. The Ex Situ No Separation treatment activity was based on 23 years of operations; therefore, the probability was calculated to be 1.0E+00.

Radiological Consequences - The radiological consequences in Section 6.3.5.3 were increased by a factor of two, based on the increased inventory, and are presented in Table E.7.3.7.

Table E.7.3.7 Dose Consequence from Breached Canister

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and are presented in Table E.7.3.8. The calculations show that there would be no LCFs attributable to this exposure if the accident occurs for the bounding or nominal scenarios.

Table E.7.3.8 Latent Cancer Fatality Risk from Breached Canister

Chemical Consequences - No chemical consequences were evaluated (Shire et al. 1995 and Jacobs 1996) since the release would first pass through two-stage HEPA filters that would reduce the source-term to a very small amount, well below the cumulative ratio of exposure to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.7.3.5 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.7.3.5.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ \text{mg/m}^3) \cdot (1\ \text{g}/1{,}000\ \text{mg}) \cdot (1\ \text{L}/1{,}000\ \text{g}) \cdot (1{,}000\ \text{m}^3) \cdot (1/1.5) = 6.67\text{E-}02\ \text{L}\ (1.8\text{E-}02\ \text{gal}).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500 \text{ L } [660 \text{ gal}]) \cdot (2.0\text{E-}03) = 5.0 \text{ L } (1.3 \text{ gal}).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500 \text{ L } [660 \text{ gal}]) \cdot (4.0\text{E-}05/\text{hr}) \cdot (24 \text{ hr}) = 2.4 \text{ L } (0.6 \text{ gal}).$$

The combined source-term for the acute release is calculated as follows:

$$(6.67\text{E-}02 \text{ L}) + (5.00\text{E+}00 \text{ L}) + (2.4 \text{ L}) = 7.4 \text{ L } (2.0 \text{ gal}).$$

E.7.3.5.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 23 years of operation was therefore estimated to be 3.2E-03.

E.7.3.5.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.7.3.9.

Table E.7.3.9 Dose Consequence from Seismic Event

E.7.3.5.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.7.3.10.

Table E.7.3.10 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.7.3.5.5 Chemical Consequences from a Beyond Design Basis Earthquake

Potential acute hazards associated with a beyond design basis earthquake are identical to those summarized in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and E.2.2.19 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as described previously.

Toxic Impact from Chemical Exposure

Under nominal conditions, the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population (consisting of 335 workers located 290 m [950 ft] away) was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects;
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded; and
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects. For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs and no acute health effects would be expected.

Under bounding conditions, the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively, for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 3.22E-03.

E.7.3.6 Occupation Injuries, Illnesses, and Fatalities from Operations

The number of operation personnel to support the Ex Situ No Separations alternative was estimated (Jacobs 1996) and is summarized as follows:

- Retrieval operations - 3.15E+04 person-years.
- Vitrification operations - 9.78E+03 person-years.

The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (4.13E+04 person-years) · (2.2E+00 incidences/100 person-years) = 9.08E+02

Lost Workday Cases = (4.13E+04 person-years) · (1.1E+00 incidences/100 person-years) = 4.54+02

Fatalities = (4.13E+04 person-years) · (3.20E-03 fatalities/100 person-years) = 1.32E+00

E.7.4 CALCINATION SUBALTERNATIVE

A subalternative to vitrification for the No Separations alternative is calcination. Rather than vitrifying the waste stream, it would be calcined. There would be no change in the construction and operation accidents.

E.7.4.1 Transportation

Transportation activities associated with this alternative are:

- Transporting residual SST waste and MUSTs waste to calcination facility;
- Transporting earthen material from borrow sites to fill tank voids and for Hanford Barrier;
- Transporting construction material to Hanford Site; and
- Employees commuting to work each day.

E.7.4.1.1 Radiological Consequences

The methodology for determining radiological consequences from accidents while transporting residual SST waste and MUST waste to a calcination facility was previously discussed in Section E.6.2.1.

The receptor dose and LCF risk resulting from the accident analysis for retrieval of MUST waste and SST residuals is presented in Table E.7.4.1 for the integrated population and Table E.7.4.2 for the MEI worker and MEI general public.

Table E.7.4.1 Integrated Radiological Impact from Retrieval Transport Accidents

Table E.7.4.2 MEI Radiological Impact from Retrieval Transport Accidents

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.7.4.4 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3.

There would be no LCFs resulting from an accident while transporting retrieved waste onsite.

E.7.4.1.2 Chemical Exposure

The chemical exposure for calcination would be the same as that previously discussed for vitrification in Section

E.7.2.2. The general public exposure to anhydrous ammonia would exceed the ratio of exposure to ERPG-3 by 1.24E+01 for corrosive/irritant chemicals and could potentially result in lethal effects.

E.7.4.1.3 Occupational Injuries and Fatalities

Truck and Rail Transportation

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Rail and truck transportation activities to transport materials and supplies to the site for this alternative were estimated in the No Separations data package (WHC 1995c) and summarized in Table E.7.4.3.

Table E.7.4.3 Summary of Transportation Activities for the Ex Situ No Separations Alternative (Calcination)

Table E.7.4.4 Distance Traveled in Population Zones for the Calcination Subalternative

The expected injuries and fatalities resulting from transportation accidents associated with the Ex Situ No Separations alternative are summarized in Table E.7.4.5.

Table E.7.4.5 Injuries and Fatalities Resulting from Truck and Rail Transportation Accidents for the Calcination Subalternative

Employee Traffic

Employee Traffic would be the same as for Vitrification, as calculated in Section E.7.2.2, which would result in 1.30E+03 injuries and 1.63E+01 fatalities.

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.7.4.4 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3.

The expected injuries and fatalities resulting from transportation accidents associated with the calcination subalternative are summarized in Table E.7.4.5.

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck and rail transport and employee vehicle accidents. The employee impacts from calcination would remain the same as vitrification. The results are summarized in Table E.7.4.6.

Table E.7.4.6 Cumulative Injuries and Fatalities from Traffic Impacts for the Calcination Subalternative

E.7.5 POST-REMEDIATION ACCIDENT

E.7.5.1 Deflagration in Storage Tank

After 99 percent of the tank waste has been removed from each tank, the probability of a tank generating enough hydrogen to exceed the LFL is considered to be incredible.

E.7.5.2 Seismic Induced Rupture of Stabilized Tanks

As discussed in Section E.4.4.2, displacement on a fault that would increase exposure to the waste after remediation is considered to be incredible. The tanks would most likely crack, allowing increased infiltration to the groundwater.

For the MEI general public, the cumulative ratio of exposure to ERPG-1 values for toxic chemicals was 4.06E-02, which does not exceed the ratio of 1.0 and indicates no acute effects.

Corrosive/Irritant Impact from Chemical Exposure

For the MEI noninvolved worker located 100m (330 ft) from the accident, the cumulative ratio of exposure to ERPG-3 values for corrosive/irritant chemicals was 9.08E+00 and exceeds 1.0, which indicates potential irreversible health effects or death. This acute hazard index is primarily attributable to:

- Sodium hydroxide (approximately 62 percent of the total hazard);
- Chromium (approximately 14 percent of the total hazard); and
- Calcium (approximately 13 percent of the total hazard).

For the noninvolved worker population located 290 m (950 ft) from the accident, the cumulative ratio of exposure to ERPG-1 values for corrosive/irritant chemicals was 1.66E+00, which exceeds the ratio of 1.0 and indicates only minor, transient effects. For the noninvolved worker population located 1,780 m (5,840 ft) from the accident, the cumulative ratio of exposure to ERPG-1 values was 2.23E-02, which does not exceed the ratio of 1.0 and indicates no acute effects.

For the MEI general public, the cumulative ratio of exposure to ERPG-1 values for corrosive/irritant chemicals was 1.82E-02, which does not exceed the ratio of 1.0 and indicates no acute effects.

E.7.6 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.7.6.1 for vitrification and Table E.7.6.2 for calcination. The LCFs associated with representative accidents for each component of the alternative for both vitrification and calcination are summarized in Table E.7.6.3 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative for both vitrification and calcination are summarized in Table E.7.6.4. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.7.6.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences - Vitrification

Table E.7.6.2 Summary of Potential Nonradiological/Nonchemical Accident Consequences - Calcination

Table E.7.6.3 Summary of Potential Radiological Accident Consequences - Vitrification and Calcination

Table E.7.6.4 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.8.0 EX SITU EXTENSIVE SEPARATIONS ALTERNATIVE

The Ex Situ Extensive Separations alternative would separate waste into LAW and HLW streams. This alternative is very similar to the Ex Situ Intermediate Separations alternative. This section analyzes and compares the construction, and transportation risks associated with this alternative.

E.8.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the Ex Situ Extensive Separations alternative are discussed in Appendix B of the EIS. It should be noted that there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated in the following text.

The number of construction personnel to support the Ex Situ Extensive Separations alternative was estimated at an average 3.71E+04 person-years (Jacobs 1996).

The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (3.71E +04 person-years) · (9.75E+00 incidences/100 person-years) = 3.61E+03

Lost Workday Cases = (3.71E +04 person-years) · (2.45E+00 incidences/100 person-years) = 9.08E+02

Fatalities = (3.71E +04 person-years) · (3.20E-03 fatalities/100 person-years) = 1.19E+00

E.8.2 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative are:

- Transport construction material to the site;
- Transporting residual SST waste and MUST waste to vitrification facility;
- Transporting earthen material from onsite borrow site to fill tank voids;
- Transporting earthen material from onsite borrow site for Hanford Barrier; and
- Employees commuting to work each day.

E.8.2.1 Radiological Consequences

The methodology for determining radiological consequences from accidents while transporting residual SST waste and MUST waste to a vitrification facility was previously discussed in Section E.6.2.1.

The receptor dose and LCF risk resulting from the accident analysis for retrieval of MUST waste and SST residuals are presented in Table E.8.2.1 for the integrated population and Table E.8.2.2 for the MEI worker and MEI general public.

Table E.8.2.1 Integrated Radiological Impact from Retrieval Transport Accidents

Table E.8.2.2 Maximally-Exposed Individual Radiological Impact from Retrieval Transport Accidents

There would be no LCFs resulting from an accident while transporting retrieved waste onsite.

E.8.2.2 Chemical Exposure

There would be no change from the Ex Situ Intermediate Separations alternative discussed in Section 6.2.2. The general public exposure to anhydrous ammonia would exceed the ratio of exposure to ERPG-3 by 1.24E+01 and sodium hydroxide would exceed the ratio of exposure to ERPG-1 by 2.45E+00 for corrosive/irritant chemicals. Based on the magnitude of the exceedance for anhydrous ammonia, this exposure could potentially result in lethal effects.

E.8.2.3 Occupational Injuries and Fatalities

Truck and Rail Transportation

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Rail and truck transportation activities to transport materials and supplies to the site for this alternative were estimated in the Extensive Separations engineering data package (WHC 1995e) and summarized in Table E.8.2. 3 .

Table E.8.2.3 Summary of Transportation Activities for the Ex Situ Extensive Separations Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.8.2. 4 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3.

Table E.8.2.4 Distance Traveled in Population Zones for the Ex Situ Extensive Separations Alternative

The expected injuries and fatalities resulting from transportation accidents associated with the Ex Situ Extensive Separations alternative are summarized in Table E.8.2. 5 .

Table E.8.2.5 Injuries and Fatalities Resulting from Truck and Rail Transportation Accidents for the Ex Situ Extensive Separations Alternative

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, site workers and other personnel required to perform the various activities would be driving to work in their vehicles. The total person-years to perform the activities was estimated at 8.14E+04 (Jacobs 1996). Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total employee vehicle distance was therefore calculated as follows:

(8.14E +04 person-years) · (260 days/year) · (140 km/day) · (1/1.35) = 2.20E+09 km

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (2.20E+09 km) · (7.1E-07 injuries/km) = 1.57E+03

Fatalities = (2.20E+09 km) · (8.98E-09 fatalities/km) = 1.97E+01

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck and rail transport and employee vehicle accidents. The results are summarized in Table E.8.2. 6 .

Table E.8.2.6 Cumulative Fatalities and Injuries from Traffic Impacts for the Ex Situ Extensive Separations Alternative

E.8.3 OPERATION ACCIDENTS

The radiological and chemical operation accidents, consequences, and risk for the Ex Situ Extensive Separations alternative are analyzed in the following subsections.

E.8.3.1 Continued Operation Accident - Tank Waste Transfers

The dominant continued operations accident during tank waste transfer is the mispositioned jumper accident previously discussed in the No Action alternative in Section E.2.2.1 and summarized as follows:

Source-Term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The Ex Situ Extensive Separations continued operation accident was based on 26 years of operations; therefore, the probability was calculated to be 2.9E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.8.3.1.

Table E.8.3.1 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the Ex Situ Extensive Separations alternative; however, the LCF point estimate risk is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.8.3.2. The bounding scenario calculations show all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure if the accident occurred. There would be approximately seven LCFs in the noninvolved worker population and two LCFs in the general public. The nominal scenario calculations show there would be no LCFs.

Table E.8.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper are identical to those summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.00E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 2.86E-01.

E.8.3.2 Continued Operations Accident - Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and is summarized as follows:

Source-Term - The source-term resulting from the fire in Section E.2.2.2.1 was calculated to be 2.4 L (0.6 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2 was estimated to be 7.2E-03 per year. The probability of the scenario based on 26 years of operation was therefore estimated to be 1.9E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.8 are reproduced in Table E.8.3.3.

Table E.8.3.3 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.2.4 are the same for the Ex Situ Extensive Separations alternative. However, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCF and LCF risk are calculated in Table E.8.3.4.

Table E.8.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

Potential acute hazards associated with a hydrogen burn in a waste storage tank are identical to those summarized in Tables E.2.2.10 (toxic chemicals, nominal conditions), E.2.2.11 (toxic chemicals, bounding conditions), E.2.2.12 (corrosive/irritant chemicals, nominal conditions) and E.2.2.13 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impacts for Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38E+00, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio). However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100 m (330 ft) from the source area. The nearest noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100 m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 m (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82E+00 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild, reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to:

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);

- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74E+00 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 1.87E-01.

E.8.3. 3 Retrieval Accidents

The dominant retrieval operations accident is the loss of filtration accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3. 3 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3. 3 .1 was calculated to be 2.5E-01 L (6.6E-02 gal).

Probability - The frequency of a loss of filtration in Section E.6.3. 3 .2 was 8.8E-06 per year. The Ex Situ Extensive Separations retrieval activity was based on 26 years of operations; therefore, the probability was calculated to be 2.3E-04.

Radiological Consequences - The radiological consequences presented in Section 6.3. 3 .3 are reproduced in Table E.8.3. 5 .

Table E.8.3.5 Dose Consequence from Loss of Filtration

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.8.3.6 .

Table E.8.3.6 Latent Cancer Fatality Risk from Loss of Filtration

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. T he calculations show there would be less than one LCF attributed to the exposure to the noninvolved workers and the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.8 and E.6.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.10 and E.6.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.8), the cumulative acute hazard ratio for the MEI worker was less than 1.0 for all ERPGs, indicating that no adverse acute health effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio was 1.84E+00 for ERPG-1, indicating that only mild, transient acute health effects would be expected. No acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.9), the cumulative acute hazard ratio for the MEI noninvolved worker was 7.27E+01 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Uranium (approximately 48 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio);
- Mercury (approximately 13 percent of the total hazard ratio); and
- TOC (approximately 7 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100 m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population (335 workers) located 290 m (950 ft) from the source was 5.40E+00 for ERPG-2, indicating that reversible acute health effects would be expected. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Loss of Filtration

Under nominal conditions (Table E.6.3.10), the cumulative acute hazard ratio for the MEI worker was 2.11E+00 for ERPG-2, indicating that reversible corrosive/irritant effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 1.72E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 3.02E+00, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 2.47E+01 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to:

- Sodium as sodium hydroxide (approximately 82 percent of the total hazard ratio); and
- Calcium (approximately 9 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 4.38E+00 for ERPG-1, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a loss of filtration event is 2.29E-04.

E.8.3. 4 Pretreatment Accidents

The dominant pretreatment operations accident is the seismic induced line break in vault accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3. 4 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3. 4 .1 was calculated to be 7.3E-02 L (1.9E-02 gal).

Probability - The annual exceedance frequency of the seismic event in Section E.6.3. 4 .2 was 6.5 E-05 per year. The Ex Situ Extensive Separations alternative was based on 2 6 years of operations, therefore, the probability was calculated to be 1.7E-02.

Radiological Consequences - The radiological consequences presented in Section 6.3. 4 .3 are reproduced in Table E.8.3. 7 .

Table E.8.3.7 Dose Consequence from Seismic Induced Line Break in Vault

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.8.3.8 . The calculations show there would be no LCFs attributable to this exposure if the accident occurs for the bounding and nominal scenarios .

Table E.8.3.8 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.14 and E.6.3.15 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.16 and E.6.3.17 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.14), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.15), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.16), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.17), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Under both nominal and bounding conditions, the probability of a pretreatment spray release is 1.69E-02.

E.8.3. 5 Treatment Accidents

The dominant treatment operations accident is the "canister of vitrified HLW inadvertently drops and ruptures" accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.5 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3. 5 .1 was calculated to be 2.5E-06 g (8.8E-08 oz).

Probability - The frequency of the accident in Section E.6.3. 5 .2 was 6.0E-01 per year. The Ex Situ Extensive Separations alternative was based on 2 6 years of operations; therefore, the probability was calculated to be 1.0E+00.

Radiological Consequences - The radiological consequences presented in Section 6.3. 5 .3 are reproduced in Table E.8.3. 9 .

Table E.8.3.9 Dose Consequence from Breached Canister

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.8.3.10 . The calculations show there would be no LCFs attributable to this exposure if the accident occurs.

Table E.8.3.10 Latent Cancer Fatality Risk from Breached Canister

Chemical Consequences - No chemical consequences were evaluated (Shire et al. 1995 and Jacobs 1996) since the release would pass through two-stage HEPA filters that would reduce the source-term to a very small amount, well below the cumulative ratio of exposure to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.8.3.6 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.8.3.6.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference.

Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ \text{mg/m}^3) \cdot (1\ \text{g}/1{,}000\ \text{mg}) \cdot (1\ \text{L}/1{,}000\ \text{g}) \cdot (1{,}000\ \text{m}^3) \cdot (1/1.5) = 6.67\text{E-02 L } (1.8\text{E-02 gal}).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500\ \text{L}) \cdot (2.0\text{E-03}) = 5\ \text{L } (1.3\ \text{gal}) .$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500\ \text{L}) \cdot (4.0\text{E-05/hr}) \cdot (24\ \text{hr}) = 2.4\ \text{L } (0.6\text{E-01 gal}).$$

The combined source-term for the acute release is calculated as follows:

$$(6.67\text{E-02 L}) + (5.0\ \text{L}) + (2.4\ \text{L}) = 7.4\ \text{L } (2.0\ \text{gal}).$$

E.8.3.6.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 26 years of operation was therefore estimated to be 3.6E-3.

E.8.3.6.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.8.3.11.

Table E.8.3.11 Dose Consequence from Seismic Event

E.8.3.6.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.8.3.12.

Table E.8.3.12 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.8.3.6.5 Chemical Consequences from a Beyond Design Basis Earthquake

Potential acute hazards associated with a beyond design basis earthquake are identical to those summarized in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and E.2.2.19 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as described previously.

Toxic Impact from Chemical Exposure

Under nominal conditions, the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio, for the nearest noninvolved worker population consisting of 335 workers located 290 m (950 ft) away, was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+01 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within

1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.

- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects.

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild, irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs, and no acute health effects would be expected.

Under bounding conditions, the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively, for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 3.64E-03.

E.8.4 OCCUPATION INJURIES, ILLNESSES, AND FATALITIES FROM OPERATIONS

The number of operation personnel to support the Ex Situ Extensive Separations alternative was estimated (Jacobs 1996) and summarized as follows:

- Retrieval operations - 3.74E+04 person-years; and

- Vitrification operations - 6.95E+03 person-years.

The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (4.44E+04 person-years) · (2.2E+00 incidences/100 person-years) = 9.76E+02

Lost Workday Cases = (4.44E+04 person-years) · (1.1E+00 incidences/100 person-years) = 4.88E+02

Fatalities = (4.44E+04 person-years) · (3.20E-03 fatalities/100 person-years) = 1.42E+00

E.8.5 POST-REMEDIATION ACCIDENT

E.8.5.1 Deflagration in Storage Tank

After 99 percent of the tank waste has been removed from each tank, the probability of a tank generating enough hydrogen to exceed the LFL is considered to be incredible.

Consequences of Gas Building Up Under the Asphalt Barrier

If the hydrogen gas generated in the tanks was able to permeate from the tank through leaks and cracks, it could potentially build up under the asphalt layer of the Hanford Barrier if the permeation rate through the asphalt is slower than the rate in which it reaches the asphalt. Because hydrogen is highly diffusible, it is extremely unlikely that this would be the case. However, if hydrogen did build up under the asphalt layer, the worst credible consequences would result in the asphalt cracking and allowing an increased movement of the residual tank waste into the groundwater. This event could be mitigated by placing catalytic recombiners under the asphalt that would recombine hydrogen and oxygen or venting the asphalt layer.

E.8.5.2 Seismic Induced Rupture of Stabilized Tanks

As discussed in Section E.4.4.2, displacement on a fault that would increase exposure to the waste after remediation is considered incredible. The tanks would most likely crack, allowing increased infiltration to the groundwater.

E.8.6 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.8.6.1. The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.8.6.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.8.6.3. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.8.6.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.8.6.2 Summary of Potential Radiological Accident Consequences

Table E.8.6.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.9.0 EX SITU/IN SITU COMBINATION 1 ALTERNATIVE

The Ex Situ/In Situ Combination 1 alternative is a combination of the Ex Situ Intermediate Separations alternative and the In Situ Fill and Cap alternative. It would involve the ex situ treatment and disposal of some waste and in situ treatment of the remaining waste. This section analyzes and compares the construction, operation, and transportation risks associated with this alternative.

E.9.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the Ex Situ/In Situ Combination1 alternative are discussed in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated as follows.

The number of construction personnel to support the Ex Situ/In Situ Combination 1 alternative was estimated at an average of 2.07E+04 person-years (Jacobs 1996).

The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated using the incidence rates from Table E.1.2.1 of this appendix as follows:

Total Recordable Cases = (2.07E +04 person-years) · (9.75E+00 incidences/100 person-years) = 2.02E +03

Lost Workday Cases = (2.07E +04 person-years) · (2.45E+00 incidences/100 person-years) = 5.08E +02

Fatalities = (2.07E +04 person-years) · (3.20E-03 fatalities/100 person-years) = 6.63E -01

E.9.2 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative are:

- Transporting residual SST waste to a vitrification facility;
- Transporting earthen material from onsite borrow site to fill tank voids;
- Transporting earthen material from onsite borrow site for Hanford Barrier;
- Transporting construction material to the Hanford Site; and
- Employees commuting to work each day.

E.9.2.1 Radiological Consequences

The methodology for determining radiological consequences from accidents while transporting HLW onsite and offsite was previously discussed in Section E.6.2.1.

The receptor dose and LCF risk resulting from the accident analysis for retrieval of SST residuals is presented in Table E.9.2.1 for the integrated population and Table E.9.2.2 for the MEI worker and MEI general public. The MUST waste would not be retrieved in this alternative.

Table E.9.2.1 Integrated Radiological Impact from Retrieval Transport Accidents

Table E.9.2.2 Maximally-Exposed Individual Radiological Impact from Retrieval Transport Accidents

There would be no LCFs resulting from an accident while transporting retrieved waste onsite.

E.9.2.2 Chemical Exposure

The same chemicals would be transported to the Hanford Site by truck and rail as in the Ex Situ Intermediate Separations alternative. Therefore, the chemical exposure resulting from an accident would be the same as that shown in Table E.6.2. 3 for Ex Situ Intermediate Separations alternative.

However, there would be 50 percent fewer shipments, which equates to a 50 percent reduction in the probability of an accident.

The general public exposure to anhydrous ammonia would exceed the ratio of exposure to ERPG-3 by 1.24E+01 and sodium hydroxide would exceed the ratio of exposure to ERPG-1 by 2.45E+00 for corrosive/irritant chemicals. Consequently, this exposure to the MEI general public could potentially result in lethal effects.

E.9.2.3 Occupational Injuries and Fatalities

Truck and Rail Transportation

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Rail and truck transportation activities to transport material and supplies to the Site for this alternative were estimated by combining a fraction (50 percent of retrieval, 50 percent of vitrification, and 40 percent of closure) of the data values in the extensive retrieval engineering data package (WHC 1995j) with a fraction (60 percent of closure) of the data values for In Situ Fill and Cap in the in situ vitrification engineering data package (WHC 1995f). The results are summarized in Table E.9.2. 3 .

Table E.9.2.3 Summary of Transportation Activities for the Ex Situ/In Situ Combination Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.9.2. 4 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3.

Table E.9.2.4 Distance Traveled in Population Zones for the Ex Situ/In Situ Combination Alternative

The expected injuries and fatalities resulting from transportation accidents associated with the Ex Situ/In Situ Combination alternative are summarized in Table E.9.2. 5 .

Table E.9.2.5 Fatalities and Injuries Resulting from Truck and Rail Transportation Accidents for the Ex Situ/In Situ Combination Alternative

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, site workers and other personnel required to perform the various activities would be driving to the site in their vehicles. The total person-years to perform the activities was estimated at 7.32E +04. This number was estimated by combining 60 percent of the employee vehicle miles from the Ex Situ Intermediate Separations alternative with 60 percent of the employee vehicle miles from the In Situ Fill and Cap alternative.

Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). From the information listed previously the total employee vehicle distance was calculated as follows:

(7.32E +04 person-years) · (260 days/year) · (140 km/day) · (1/1.35 passengers per vehicle) =
1.97E+ 09 km (1.22E+09 mi)

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (1.97E +09 km) · (7.1E-07 injuries/km) = 1.41E +03

Fatalities = (1.97E +09 km) · (8.98E-09 fatalities/km) = 1.77E+01

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck and rail transport and employee vehicle accidents. The results are summarized in Table E.9.2. 6 .

Table E.9.2.6 Cumulative Injuries and Fatalities from Traffic Impacts for the Ex Situ/In Situ Combination Alternative

E.9.3 OPERATION ACCIDENTS

The radiological and chemical operation accidents for the Ex Situ/In Situ Combination 1 alternative are the same as the Ex Situ Intermediate Separations alternative and the In Situ Fill and Cap alternative. The radiological cancer risk and the chemical exposure would be bound by the Ex Situ Intermediate Separations alternative presented in Section E.6.3 and are summarized as follows.

E.9.3.1 Routine Operation - Mispositioned Jumper Accident - Tank Waste Transfer

The dominant routine operations accident during waste transfer is the mispositioned jumper accident previously discussed in the No Action alternative in Section E.2.2.1 and are summarized as follows:

Source-Term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The Ex Situ/In Situ Combination 1 alternative was based on 18.5 years of operations; therefore, the probability was calculated to be 2.0E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.9.3.1.

Table E.9.3.1 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the Ex Situ/In Situ Combination 1 alternative; however, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.9.3.2. The bounding scenario calculations show that all 10 would potentially receive a fatal dose and assumably die directly after exposure if the accident occurred. There would be approximately seven LCFs from the noninvolved worker population and 2 from the general public. The nominal scenario calculations show there would be no LCFs.

Table E.9.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper are identical to those summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.00E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 2.04E-01.

E.9.3.2 Continued Operations Accident - Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and is summarized as follows:

Source-Term - The source-term resulting from the fire in Section E.2.2.2.1 was calculated to be 2.4 L (0.6 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2.2 was estimated to be 7.2E-03 per year. The probability of the scenario based on 26 years of operation was therefore estimated to be 1.9E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.8 are reproduced in Table E.9.3.3.

Table E.9.3.3 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.2.4 are reproduced in Table E.9.3.4.

Table E.9.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

Potential acute hazards associated with a hydrogen burn in a waste storage tank are identical to those summarized in Tables E.2.2.10 (toxic chemicals, nominal conditions), E.2.2.11 (toxic chemicals, bounding conditions), E.2.2.12 (corrosive/irritant chemicals, nominal conditions) and E.2.2.13 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38E+00, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio) However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100 m (330 ft) from the source area. The nearest noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100 m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 m (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82E+00 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74E+00 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 1.87E-01.

E.9.3. 3 Retrieval - Loss of Filtration Accident

The dominant retrieval operations accident is the loss of filtration accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3. 3 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3. 3 .1 was calculated to be 2.5E-01 L (6.6E-02 gal).

Probability - The frequency of a loss of filtration in section E.6.3. 3 .2 was 8.8E-06 per year. The Ex Situ/In Situ Combination retrieval activity was based on 2 6 years of operations; therefore, the probability was calculated to be 2.3E-04.

Radiological Consequences - The radiological consequences presented in Section 6.3. 3 .3 are reproduced in Table E.9.3. 5 .

Table E.9.3.5 Dose Consequence from Loss of Filtration

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and are presented in Table E.9.3.6 .

Table E.9.3.6 Latent Cancer Fatality Risk from Loss of Filtration

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. T he calculations show there would be nine LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.8 and E.6.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.10 and E.6.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.8), the cumulative acute hazard ratio for the MEI worker was less than 1.0 for all ERPGs, indicating that no adverse acute health effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio was 1.84E+00 for ERPG-1, indicating that only mild, transient acute health effects would be expected. No acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.9), the cumulative acute hazard ratio for the MEI noninvolved worker was 7.27E+01 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Uranium (approximately 48 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio);
- Mercury (approximately 13 percent of the total hazard ratio); and
- TOC (approximately 7 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100 m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population (335 workers) located 290 m (950 ft) from the source was 5.40E+00 for ERPG-2, indicating that reversible acute health effects would be expected. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Loss of Filtration

Under nominal conditions (Table E.6.3.10), the cumulative acute hazard ratio for the MEI worker was 2.11E+00 for ERPG-2, indicating that reversible corrosive/irritant effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 1.72E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 3.02E+00, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 2.47E+01 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 82 percent of the total hazard ratio); and
- Calcium (approximately 9 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 4.38E+00 for ERPG-1, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a loss of filtration event in a waste storage tank is 2.29E-04.

E.9.3. 4 Pretreatment - Seismic Induced Line Break in Vault

The dominant pretreatment operations accident is the seismic-induced line break in vault accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3. 4 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3. 4 .1 was calculated to be 7.3E-02 L (1.9E-02 gal).

Probability - The annual exceedance frequency of the seismic event in Section E.6.3. 4 .2 was 6.5E-04 per year. The Ex Situ/In Situ Combination 1 alternative was based on 2 6 years of operations: therefore, the probability was calculated to be 1.7E-02.

Radiological Consequences - The radiological consequences presented in Section 6.3. 4 .3 are reproduced in Table E.9.3. 7 .

Table E.9.3.7 Dose Consequence from Seismic Induced Line Break in Vault

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.9.3.8 . The calculations show there would be no LCFs attributable to this exposure if the accident occurs for the bounding and nominal scenarios .

Table E.9.3.8 Latent Cancer Fatality Risk from Seismic-Induced Line Break in Vault

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.14 and E.6.3.15 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.16 and E.6.3.17 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.14), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.15), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.16), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.17), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Under both nominal and bounding conditions, the probability of a pretreatment spray release is 1.69E-02.

E.9.3. 5 Treatment (Ex Situ Vitrification) - Canister of Vitrified High-Level Waste Inadvertently Drops and Ruptures

The dominant immobilization operations accident is the "canister of vitrified HLW inadvertently drops and ruptures" accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.5 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3. 5 .1 was calculated to be 2.5E-06 g (8.8E-08 oz).

Probability - The frequency of the accident in Section E.6.3. 5 .2 was 6.0E-01 per year. The Ex Situ/In Situ Combination alternative was based on 2 6 years of operations; therefore, the probability was calculated to be 1.0E+00.

Radiological Consequences - The radiological consequences presented in Section 6.3. 5 .3 are reproduced in Table E.9.3. 9 .

Table E.9.3.9 Dose Consequence from Breached Canister

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.9.3.10 . The calculations show there would be no LCFs attributable to this exposure if the accident occurs for the bounding and nominal scenarios.

Table E.9.3.10 Latent Cancer Fatality Risk from Breached Canister

Chemical Consequences - No chemical consequences were evaluated (Shire et al. 1995 and Jacobs 1996) since the release would be through two-stage HEPA filters that would reduce the source-term well below the cumulative ratio of exposure to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.9.3. 6 Treatment - In Situ Fill and Cap

The dominant treatment operations accident is the tank deflagration accident resulting in a tank dome collapse previously discussed in the In Situ Fill and Cap alternative in Section E.4.3. 3 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.4.3. 3 .1 was calculated to be 7.5 L (2.0 gal).

Probability - The probability of a tank dome collapse in Section E.4.3. 3 .2 was assumed to be 1.0E-04.

Radiological Consequences - The radiological consequences presented in Section 4.3. 3 .3 are reproduced in Table E.9.3. 11 .

Table E.9.3.11 Dose Consequence from Tank Dome Collapse Due to Deflagration

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.9.3.12 .

Table E.9.3.12 Latent Cancer Fatality Risk from Tank Dome Collapse Due to Deflagration

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. The calculations show there would be 11 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.9.3. 6 .1 Chemical Consequences of Tank Dome Collapse

The chemical exposure to the receptors from the postulated accident was identical to that summarized in the exposure column in Tables E.4.3.8 and E.4.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.3.4.10 and E.3.4.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.4.3.8), the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio, for the nearest noninvolved worker population (consisting of 335 workers located 290 m [950 ft] away) was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.4.3.9), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.3.4.10), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs, and no acute health effects would be expected.

Under bounding conditions (Table E.4.3.11), the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively, for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 1.00E-04.

E.9.3.7 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.9.3.7.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ mg/m^3) \cdot (1\ g/1{,}000\ mg) \cdot (1\ L/1{,}000\ g) \cdot (1{,}000\ m^3) \cdot (1/1.5) = 6.67E\text{-}02\ L\ (1.8E\text{-}02\ gal).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500\ L) \cdot (2.0E\text{-}03) = 5.00E{+}00\ L\ (1.3\ gal).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500\ L) \cdot (4.0E\text{-}05/hr) \cdot (24\ hr) = 2.4\ L\ (0.6\ gal).$$

The combined source-term for the acute release is calculated as follows:

(6.67E-02 L) + (5.0 L) + (2.4 L) = 7.4 L (2.0 gal).

E.9.3.7.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 26 years of operation was therefore estimated to be 3.6E-3.

E.9.3.7.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.9.3.13.

Table E.9.3.13 Dose Consequence from Seismic Event

E.9.3.7.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.9.3.14

Table E.9.3.14 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.9.3.7.5 Chemical Consequences from a Beyond Design Basis Earthquake

Potential acute hazards associated with a beyond design basis earthquake are identical to those summarized in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as described previously.

Toxic Impact from Chemical Exposure

Under nominal conditions, the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population (consisting of 335 workers located 290 m [950 ft] away) was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects.

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs and no acute health effects would be expected.

Under bounding conditions, the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively, for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 3.64E-03.

E.9.3. 8 Occupation Injuries, Illnesses, and Fatalities from Operations

The number of operation personnel to support the Ex Situ/In Situ Combination 1 alternative was estimated at an average of 5.25E+04 person-years (Jacobs 1996).

The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (5.25E +04 person-years) · (2.2E+00 incidences/100 person-years) = 1.16E+03

Lost Workday Cases = (5.25E +04 person-years) · (1.1E+00 incidences/100 person-years) = 5.78E+02

Fatalities = (5.25E +04 person-years) · (3.20E-03 fatalities/100 person-years) = 1.68E+00

E.9.4 POST-REMEDIATION ACCIDENT

E.9.4.1 Deflagration in Storage Tank

The tanks that have had 99 percent of their waste removed and filled with gravel do not pose a credible risk. However, the tanks that have been saltwell pumped and filled with gravel may. After the tanks have been filled with gravel, the dome sealed off, and the Hanford Barrier placed over the tank farms, it was postulated that hydrogen builds up in the tank, reaches the LFL, and ignites. The probable sequence of events is that the tank would breach and possibly the asphalt layer in the Hanford Barrier would crack allowing an increased movement of the residual tank waste into the groundwater. An explosion that could breach the dome, displace 2 m (7 ft) of overburden, and displace an additional 5 m (15 ft) of the Hanford Barrier, is considered to be incredible.

For this event to occur, the following conditions must exist:

- Flammable gases must be generated from the waste;
- The concentration of the flammable gas must exceed the lower flammability limit;
- There must be an ignition source; and
- The deflagration would have to generate enough energy to breach the tank and crack the asphalt liner.

Generation of Flammable Gas

All 177 waste tanks produce flammable gases at the molecular level such as hydrogen, ammonia, and methane due to radiolysis, organic degradation, and corrosion.

Gas Concentration

Gases generated from the residual tank waste would diffuse and accumulate in the voids within the gravel and the tank headspace created by the waste settling under the pressure of the fill. If the hydrogen is not allowed to escape from the tank through leaks or cracks in the tank, the hydrogen concentration will continue to increase as long as the potential for radiolysis, organic degradation, or corrosion exists.

It has been shown in tank waste that hydrogen generation rates may drop by approximately one-half every 15 years. Therefore, the gas concentration potential could be reduced by allowing the tanks to vent for 100 years (during institutional controls) through vent pipes passing up through the Hanford Barrier. The vents could then be sealed off. Allowing the tanks to vent for 100 years would reduce the probability of hydrogen reaching the LFL in the tank. Hydrogen gas concentration could be retarded by placing catalytic recombiners in the tank that would recombine hydrogen and oxygen.

Ignition of Gas

If the gas concentrations in the tank manage to exceed the LFL, the ignition sources are limited. Possible ignition sources would include a lightning strike, an earthquake, or heat produced by reactions taking place in the materials remaining in the tank. If the gas was ignited, the propagation of the burn through the gravel is dependent upon the size of the voids in the gravel matrix. Flames will not propagate in a porous material if the pore size is less than a critical value.

Consequences

The probable sequence of events is that the tank would breach and possibly the asphalt layer in the Hanford Barrier would crack allowing an increased movement of the residual tank waste into the groundwater.

E.9.4.2 Seismic Induced Rupture of Stabilized Tanks

As discussed in Section E.4.4.2, displacement on a fault that would increase exposure to the waste after remediation is considered to be incredible. The tanks would most likely crack, allowing increased infiltration to the groundwater.

E.9.5 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.9.5.1. The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.9.5.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.9.5.3. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.9.5.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.9.5.2 Summary of Potential Radiological Accident Consequences

Table E.9.5.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.10.0 EX SITU/IN SITU COMBINATION 2 ALTERNATIVE

The Ex Situ/In Situ Combination 2 alternative is a combination of the Ex Situ Intermediate Separations alternative and the In Situ Fill and Cap alternative. The Ex Situ/In Situ Combination 2 alternative would involve ex situ treatment and disposal of some waste and in situ treatment of the remaining waste like Ex Situ/In Situ Combination 1, except that there would be retrieval from fewer tanks. This section analyzes and compares the construction, operation, and transportation risks associated with this alternative.

E.10.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the Ex Situ/In Situ Combination 2 alternative are discussed in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated as follows.

The number of construction personnel to support the Ex Situ/In Situ Combination 2 alternative was estimated at an average of 1.79E+04 person-years (Jacobs 1996).

The following total recordable injuries and illnesses, lost workday cases, and fatalities were calculated using the incidence rates from Table E.1.2.1:

Total Recordable Cases = (1.79E+04 person-years) · (9.75E+00 incidences/100 person-years) = 1.74E+03

Lost Workday Cases = (1.79E+04 person-years) · (2.45E+00 incidences/100 person-years) = 4.38E+02

Fatalities = (1.79E+04 person-years) · (3.20E-03 fatalities/100 person-years) =5.72E-01

E.10.2 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative are:

- Transporting residual SST waste to vitrification facility;
- Transporting earthen material from onsite borrow sites to fill tank voids;
- Transporting earthen material from onsite borrow sites for Hanford Barrier;
- Transporting construction material to the Hanford Site; and
- Employees commuting to work each day.

E.10.2.1 Radiological Consequences

The methodology for determining radiological consequences from accidents while transporting residual SST waste to the vitrification facility was previously discussed in Section E.6.2.1.

The receptor dose and LCF risk resulting from the accident analysis for retrieval of SST residuals is presented in Table E.10.2.1 for the integrated population and Table E.10.2.2 for the MEI worker and MEI general public.

Table E.10.2.1 Integrated Radiological Impact from Retrieval Transport Accidents

Table E.10.2.2 Maximally-Exposed Individual Radiological Impact from Retrieval Transport Accidents

There would be no LCFs resulting from an accident while transporting retrieved waste onsite.

E.10.2.2 Chemical Exposure

The same chemicals would be transported to the Hanford Site by truck and rail as in the Ex Situ Intermediate Separations alternative. Therefore, the chemical exposure resulting from an accident would be the same as that shown in Table E.6.2.4 for Ex Situ Intermediate Separations alternative.

However, there would be 70 percent fewer shipments, which equates to a 70 percent reduction in the probability of an accident.

The general public exposure to anhydrous ammonia would exceed the ratio of exposure to ERPG-3 by 1.24E+01 and sodium hydroxide would exceed the ratio of exposure to ERPG-1 by 2.45E+00 for corrosive/irritant chemicals. Consequently, this exposure to the MEI general public could potentially result in lethal effects.

E.10.2.3 Occupational Injuries and Fatalities

Truck and Rail Transportation

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Rail and truck transportation activities to transport material and supplies to the Site for this alternative represents 70 percent of retrieval, 70 percent of vitrification plant construction, and 60 percent of vitrification operations of the data values in the Ex Situ/In Situ Combination 1 alternative. Closure represents 16 percent of the closure data values in the extensive retrieval engineering data package (WHC 1995j) plus 84 percent of the closure data values for In Situ Fill and Cap in the in situ vitrification engineering data package (WHC 1995f). The results are summarized in Table E.10.2.3.

Table E.10.2.3 Summary of Transportation Activities for the Ex Situ/In Situ Combination 2 Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.10.2.4 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3.

Table E.10.2.4 Distance Traveled in Population Zones for the Ex Situ/In Situ Combination 2 Alternative

The expected injuries and fatalities resulting from transportation accidents associated with the ExSitu/In Situ Combination 2 alternative are summarized in Table E.10.2.5.

Table E.10.2.5 Fatalities and Injuries Resulting from Truck and Rail Transportation Accidents for the Ex Situ/In Situ Combination 2 Alternative

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, Site workers and other personnel required to perform the various activities would be driving to the Site in their vehicles. The total person-years to perform the activities was estimated at 5.36+04 (Jacobs 1996).

Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). From the information listed previously the total employee vehicle distance was calculated as follows:

$$(5.36\text{E+04 person-years}) \cdot (260 \text{ days/year}) \cdot (140 \text{ km/day}) \cdot (1/1.35 \text{ passengers per vehicle}) = 1.45\text{E+09 km } (9.02\text{E+8 mi})$$

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (1.45E+09 km) · (7.1E-07 injuries/km) = 1.03E+03

Fatalities = (1.45E+09 km) · (8.98E-09 fatalities/km) =1.30E+01

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck and rail transport and employee vehicle accidents. The results are summarized in Table E.10.2.6.

Table E.10.2.6 Cumulative Injuries and Fatalities from Traffic Impacts for the Ex Situ/In Situ Combination 2 Alternative

E.10.3 OPERATION ACCIDENTS

The radiological and chemical operation accidents for the Ex Situ/In Situ Combination 2 alternative are the same as the Ex Situ Intermediate Separations alternative and the In Situ Fill and Cap alternative. The radiological cancer risk and the chemical exposure would be bound by the Ex Situ Intermediate Separations alternative presented in Section E.6.3 and are summarized as follows.

E.10.3.1 Routine Operation - Mispositioned Jumper Accident - Tank Waste Transfers

The dominant routine operations accident during tank waste transfers is the mispositioned jumper accident previously discussed in the No Action alternative in Section E.2.2.1 and are summarized as follows:

Source-Term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The Ex Situ/In Situ Combination 2 alternative was based on 16 years of operations; therefore, the probability was calculated to be 1.8E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.10.3.1.

Table E.10.3.1 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the Ex Situ/In Situ Combination 2 alternative; however, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.10.3.2. The bounding scenario calculations show that all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure if the accident occurred. There would be approximately seven LCFs from the noninvolved worker population and two from the general public. The nominal scenario calculations show there would be no LCFs.

Table E.10.3.2 Latent Cancer Fatality Risk from Mispositioned Jumper

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper are identical to those summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.00E+00, indicating that only mild reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild, reversible irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 1.75E-01.

E.10.3.2 Continued Operations Accident - Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and is summarized as follows:

Source-Term - The source-term resulting from the fire in Section E.2.2.2.1 was calculated to be 2.4 L (0.6 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2.2 was estimated to be 7.2E-03 per year. The probability of the scenario based on 25 years of operation was therefore estimated to be 1.8E01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.8 are reproduced in Table E.10.3.3.

Table E.10.3.3 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.2.4 are reproduced in Table E.10.3.4.

Table E.10.3.4 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

Potential acute hazards associated with a hydrogen burn in a waste storage tank are identical to those summarized in Tables E.2.2.10 (toxic chemicals, nominal conditions), E.2.2.11 (toxic chemicals, bounding conditions), E.2.2.12 (corrosive/irritant chemicals, nominal conditions) and E.2.2.13 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38E+00, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio). However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100 m (330 ft) from the source area. The nearest noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100 m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above. This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 m (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82E+00 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild, reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to:

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74E+00 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 1.80E-01.

E.10.3.3 Retrieval - Loss of Filtration Accident

The dominant retrieval operations accident is the loss of filtration accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.3 and is summarized as follows.

Source-Term - The source-term resulting from the airborne release in Section E.6.3.3.1 was calculated to be 2.5E-01 L (6.6E-02 gal).

Probability - The frequency of a loss of filtration in section E.6.3.3.2 was 8.8E-06 per year. The Ex Situ/In Situ Combination 2 retrieval activity was based on 25 years of operations; therefore, the probability was calculated to be 2.2E-04.

Radiological Consequences - The radiological consequences presented in Section 6.3.3.3 are reproduced in Table E.10.3.5.

Table E.10.3.5 Dose Consequence from Loss of Filtration

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and are presented in Table E.10.3.6.

Table E.10.3.6 Latent Cancer Fatality Risk from Loss of Filtration

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure if the accident occurred. The calculations also show there would be less than one LCF attributed to the exposure to the noninvolved workers and the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.8 and E.6.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.10 and E.6.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Under nominal conditions (Table E.6.3.8), the cumulative acute hazard ratio for the MEI worker was less than 1.0 for all ERPGs, indicating that no adverse acute health effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio was 1.84E+00 for ERPG-1, indicating that only mild, transient, acute health effects would be expected. No acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.9), the cumulative acute hazard ratio for the MEI noninvolved worker was 7.27E+01 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio is primarily attributable to:

- Uranium (approximately 48 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio);
- Mercury (approximately 13 percent of the total hazard ratio); and
- TOC (approximately 7 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100 m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population (335 workers) located 290 m (950 ft) from the source was 5.40E+00 for ERPG-2, indicating that reversible acute health effects would be expected. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Loss of Filtration

Under nominal conditions (Table E.6.3.10), the cumulative acute hazard ratio for the MEI worker was 2.11E+00 for ERPG-2, indicating that reversible corrosive/irritant effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 1.72E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 3.02E+00, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 2.47E+01 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 82 percent of the total hazard ratio); and
- Calcium (approximately 9 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 4.38E+00 for ERPG-1, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a loss of filtration event in a waste storage tank is 2.20E-04.

E.10.3.4 Pretreatment - Seismic Induced Line Break in Vault

The dominant pretreatment operations accident is the seismic-induced line break in vault accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.4 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3.4.1 was calculated to be 7.3E-02

L (1.9E-02 gal).

Probability - The annual exceedance frequency of the seismic event in Section E.6.3.4.2 was 6.5E-04 per year. The Ex Situ/In Situ Combination 2 alternative was based on 25 years of operations; therefore, the probability was calculated to be 1.6E-02.

Radiological Consequences - The radiological consequences presented in Section 6.3.4.3 are reproduced in Table E.10.3.7.

Table E.10.3.7 Dose Consequence from Seismic Induced Line Break in Vault

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.10.3.8. The calculations show there would be no LCFs attributable to this exposure if the accident occurs for the bounding and nominal scenarios.

Table E.10.3.8 Latent Cancer Fatality Risk from Seismic-Induced Line Break in Vault

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.14 and E.6.3.15 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.16 and E.6.3.17 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.14), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.15), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.16), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.17), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Under both nominal and bounding conditions, the probability of a pretreatment spray release is 1.63E-02 .

E.10.3.5 Treatment (Ex Situ Vitrification) - Canister of Vitrified High-Level Waste Inadvertently Drops and Ruptures

The dominant immobilization operations accident is the "canister of vitrified HLW inadvertently drops and ruptures" accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.5 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3.5.1 was calculated to be 2.5E-06 g (8.8E-08 oz).

Probability - The frequency of the accident in Section E.6.3.5.2 was 6.0E-01 per year. The Ex Situ/In Situ Combination 2 alternative was based on 25 years of operations; therefore, the probability was calculated to be 1.0E+00.

Radiological Consequences - The radiological consequences presented in Section 6.3.5.3 are reproduced in Table E.10.3.9.

Table E.10.3.9 Dose Consequence from Breached Canister

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.10.3.10. The calculations show there would be no LCFs attributable to this exposure if the accident occurs for the bounding and nominal scenarios.

Table E.10.3.10 Latent Cancer Fatality Risk from Breached Canister

Chemical Consequences - No chemical consequences were evaluated (Shire et al. 1995 and Jacobs 1996) because the release would be through two-stage HEPA filters that would reduce the source-term well below the cumulative ratio of exposure to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.10.3.6 Treatment - In Situ Fill and Cap

The dominant treatment operations accident is the tank deflagration accident resulting in a tank dome collapse previously discussed in the In Situ Fill and Cap alternative in Section E.4.3.3 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.4.3.3.1 was calculated to be 7.5 L (2.0 gal).

Probability - The probability of a tank dome collapse in Section E.4.3.3.2 was assumed to be 1.0E-04.

Radiological Consequences - The radiological consequences presented in Section 4.3.3.3 are reproduced in Table E.10.3.11.

Table E.10.3.11 Dose Consequence from Tank Dome Collapse Due to Deflagration

Radiological Cancer Risk - All 10 workers and the MEI noninvolved worker would potentially receive a lethal dose. The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.10.3.12.

Table E.10.3.12 Latent Cancer Fatality Risk from Tank Dome Collapse Due to Deflagration

In addition to all 10 workers dying from a lethal dose, the calculations show there would be eleven LCFs attributed to the exposure to the noninvolved workers and two LCFs attributed to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.10.3.6.1 Chemical Consequences of Tank Dome Collapse

The chemical exposure to the receptors from the postulated accident was identical to that summarized in the exposure column in Tables E.4.3.8 and E.4.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.4.3.10 and E.4.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.4.3.8), the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population (consisting of 335 workers located 290 m [950 ft] away) was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.4.3.9), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.4.3.10), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects.

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs, and no acute health effects would be expected.

Under bounding conditions (Table E.4.3.11), the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 1.00E-04.

E.10.3.7 Beyond Design Basis Accident

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen. The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.10.3.7.1 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ \text{mg/m}^3) \cdot (1\ \text{g}/1{,}000\ \text{mg}) \cdot (1\ \text{L}/1{,}000\ \text{g}) \cdot (1{,}000\ \text{m}^3) \cdot (1/1.5) = 6.67\text{E-}02\ \text{L}\ (1.8\text{E-}02\ \text{gal}).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500\ \text{L}) \cdot (2.0\text{E-}03) = 5.0\ \text{L}\ (1.3\ \text{gal}).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500\ \text{L}) \cdot (4.0\text{E-}05/\text{hr}) \cdot (24\ \text{hr}) = 2.4\ \text{L}\ (0.6\ \text{gal}).$$

The combined source-term for the acute release is calculated as follows:

(6.67E-02 L) + (5.0 L) + (2.4 L) = 7.4 L (2.0 gal).

E.10.3.7.2 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 25 years of operation was therefore estimated to be 3.5E-03.

E.10.3.7.3 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.10.3.13.

Table E.10.3.13 Dose Consequence from Seismic Event

E.10.3.7.4 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.10.3.14.

Table E.10.3.14 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.10.3.7.5 Chemical Consequences from a Beyond Design Basis Earthquake

Potential acute hazards associated with a beyond design basis earthquake are identical to those summarized in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and E.2.2.18 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as described previously.

Toxic Impact from Chemical Exposure

Under nominal conditions, the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population (consisting of 335 workers located 290 m [950 ft] away) was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.17), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m away) were 2.15E+03 and 7.80 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.18), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects.

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs and no acute health effects would be expected.

Under bounding conditions, the cumulative acute hazard ratios for the MEI noninvolved worker, and nearest noninvolved worker (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively, for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatening health effects.

For the next nearest noninvolved worker and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00, respectively for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 3.50E-03.

E.10.3.8 Occupation Injuries, Illnesses, and Fatalities from Operations

The number of operation personnel to support the Ex Situ/In Situ Combination 2 alternative was estimated at an average of 3.58E+04 person-years (Jacobs 1996).

The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (3.58E+04 person-years) · (2.2E+00 incidences/100 person-years) = 7.87E+02

Lost Workday Cases = (3.58E+04 person-years) · (1.1E+00 incidences/100 person-years) = 3.93E+02

Fatalities = (3.58E+04 person-years) · (3.20E-03 fatalities/100 person-years) = 1.14E+00

E.10.4 POST-REMEDIATION ACCIDENT

E.10.4.1 Deflagration in Storage Tank

The tanks that have had 99 percent of their waste removed and filled with gravel do not pose a credible risk. However, the tanks that have been saltwell pumped and filled with gravel may. After the tanks have been filled with gravel, the dome sealed off, and the Hanford Barrier placed over the tank farms, it was postulated that hydrogen builds up in the tank, reaches the LFL, and ignites. The probable sequence of events is that the tank would breach and possibly the asphalt layer in the Hanford Barrier would crack allowing an increased movement of the residual tank waste into the groundwater. An explosion that could breach the dome, displace 2 m (7 ft) of overburden, and displace an additional 5 m (15 ft) of the Hanford Barrier, is considered to be incredible.

For this event to occur, the following conditions must exist:

- Flammable gases must be generated from the waste;
- The concentration of the flammable gas must exceed the lower flammability limit;
- There must be an ignition source; and
- The deflagration would have to generate enough energy to breach the tank and crack the asphalt liner.

Generation of Flammable Gas

All 177 waste tanks produce flammable gases at the molecular level such as hydrogen, ammonia, and methane due to radiolysis, organic degradation, and corrosion.

Gas Concentration

Gases generated from the residual tank waste would diffuse and accumulate in the voids within the gravel and the tank headspace created by the waste settling under the pressure of the fill. If the hydrogen is not allowed to escape from the tank through leaks or cracks in the tank, the hydrogen concentration will continqe to increase as long as the potential for radiolysis, organic degradation, or corrosion exists.

It has been shown in tank waste that hydrogen generation rates may drop by approximately one-half every 15 years. Therefore, the gas concentration potential could be reduced by allowing the tanks to vent for 100 years (during institutional controls) through vent pipes passing up through the Hanford Barrier. The vents could then be sealed off. Allowing the tanks to vent for 100 years would reduce the probability of hydrogen reaching the LFL in the tank. Hydrogen gas concentration could be retarded by placing catalytic recombiners in the tank that would recombine hydrogen and oxygen.

Ignition of Gas

If the gas concentrations in the tank manage to exceed the LFL, the ignition sources are limited. Possible ignition sources would include a lightning strike, an earthquake, or heat produced by reactions taking place in the materials remaining in the tank. If the gas was ignited, the propagation of the burn through the gravel is dependent upon the size of the voids in the gravel matrix. Flames will not propagate in a porous material if the pore size is less than a critical value.

Consequences

The probable sequence of events is that the tank would breach and possibly the asphalt layer in the Hanford Barrier would crack allowing an increased movement of the residual tank waste into the groundwater.

E.10.4.2 Seismic Induced Rupture of Stabilized Tanks

As discussed in Section E.4.4.2, displacement on a fault that would increase exposure to the waste after remediation is considered to be incredible. The tanks would most likely crack, allowing increased infiltration to the groundwater.

E.10.5 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.10.5.1. The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.10.5.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.10.5.3. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.10.5.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.10.5.2 Summary of Potential Radiological Accident Consequences

Table E.10.5.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.11.0 PHASED IMPLEMENTATION ALTERNATIVE

The Phased Implementation alternative includes remediating the tank waste in a two-phase process. The first phase would be a commercial demonstration of the separations and immobilization processes for selected tank waste. The second step would involve scaling-up the demonstration processes to treat the remaining tank waste and construction of larger treatment facilities. The phased implementation approach could be applied to any of the tank waste alternatives involving ex situ waste treatment; however, for the purposes of analysis the Ex Situ Intermediate Separations alternative, with some additional separations, was selected as the representative alternative. The Phased Implementation alternative is presented in two parts, Phase 1 first, then Phase 2.

E.11.1 PHASE 1

Phase 1 would consist of one LAW treatment facility and one LAW and HLW facility using vitrification to produce a stabilized waste form to specification. This alternative would involve constructing and operating vitrification and support facilities, and transfer lines from the tank farms and T Plant to the vitrification facilities. This alternative would also involve vehicle traffic of the personnel required to support the alternative. This section analyzes the construction, operation, and transportation risks associated with this alternative.

E.11.1.1 Construction Accidents

The potential exists for accidents resulting from construction activities. The construction activities are outlined in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated as follows.

The number of construction personnel was estimated at an average 1.07E+04 person-years (Jacobs 1996). The number of total recordable injuries and illnesses, lost workday cases, and fatalities during construction were calculated using the incidence rates from Table E.1.2.1 as follows:

Total Recordable Cases = (1.07E+04 person-years) · (9.75E+00 incidences/100 person-years) = 1.04E+03

Lost Workday Cases = (1.07E+04 person-years) · (2.45E+00 incidences/100 person-years) = 2.62E+02

Fatalities = (1.07E+04 person-years) · (3.2E-03 fatalities/100 person-years) = 3.42E-01

E.11.1.2 Transportation Accidents

Transportation activities associated with this alternative are:

- Transporting construction material to the Hanford Site;
- Transporting earthen material from onsite borrow sites;
- Transporting process material from offsite to the vitrification facilities;
- Transporting vitrified and unvitrified LAW and HLW to the Canister Storage Building (CSB);
- Transporting contaminated waste from decommissioned facilities to low-level waste burial ground;
- Transporting noncontaminated waste from decommissioned facilities to regulated landfill; and
- Employees commuting to work each day.

E.11.1.2.1 Radiological Cancer Risk from Transportation

Canisters of Cs and technetium would be transported to the CSB by truck. The radiological cancer risk from this activity was compared to a similar activity in Section E.14.2.1. Section E.14.2.1 evaluated the radiological cancer risk from transporting Cs and Sr capsules from WESF to an onsite vitrification facility. The radiological cancer risk from transporting 1.93E+03 of Cs and Sr capsules to the vitrification facility was analyzed (Green 1995) and summarized in Section E.14.2.1 of this appendix. The estimated number of LCFs in an integrated population, resulting from an accident, was 1.2E-05. Approximately half as many Cs and technetium canisters would be transported to the CSB in the Phase 1, therefore 1.2E-05 LCFs would be reduced by a factor of two resulting in approximately 6.0E-06 LCFs for the Phased Implementation alternative.

E.11.1.2.2 Chemical Exposure from Transportation Accidents

The chemical exposure from transportation accidents would be bound by the analysis preformed in Section 6.2.2. The chemical exposure and frequency of the integrated accident was reproduced in Table E.11.1.1. The comparison of exposure concentration from postulated chemical released to exposure limits was reproduced in Table E .11.1.2.

Table E.11.1.1 Chemical Releases from Postulated Accidents for Phase 1

Table E.11.1.2 Comparison of Chemical Concentrations to Corrosive/Irritant Concentration Limits for Phase 1

For the MEI general public the ratio of exposure to ERPG-3 values for corrosive/irritant chemicals was 1.24E+01, which exceed the acceptable criterion of 1.0 and is indicative of potential lethal effects. This acute hazard index is primarily attributable to anhydrous ammonia (over 99.9 percent of the total hazard).

E.11.1.2.3 Occupational Injuries and Fatalities

Truck and Rail Transportation

Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Rail and truck transportation activities to transport materials and supplies to the Site for this alternative were estimated (WHC 1995j) and are summarized in Table E.11.1.3.

Table E.11.1.3 Summary of Transportation Activities for the Phase 1 Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.11.1.4 by the appropriate unit risk factors shown in Table E.1.3.1. The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3. The expected injuries and fatalities resulting from transportation accidents associated with Phase 1 are summarized in Table E.11.1.5.

Table E.11.1.4 Distance Traveled in Population Zones for Phase 1

Table E.11.1.5 Injuries and Fatalities Resulting from Truck and Rail Transportation Accidents for Phase 1

Employee Traffic

In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, Site workers and other personnel required to perform the various activities would be driving to the site in their vehicles. The total person-years to perform the activities was estimated at 1.76E +04.

Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total employee vehicle distance was therefore calculated as follows:

(1.76E+ 04 person-years) · (260 days/year) · (140 km/day) · (1/1.35 passengers per vehicle) = 4.76E+08 km (2.96E+08 mi)

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (4.76E+08 km) · (7.1E-07 injuries/km) = 3.40E+02

Fatalities = (4.76E+08 km) · (8.98E-09 fatalities/km) = 4.27E+00

Cumulative Transportation Injuries and Fatalities

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck and rail transport and employee vehicle accidents. The results are summarized in Table E.11.1.6.

Table E.11.1.6 Cumulative Injuries and Fatalities from Traffic Impacts for Phase 1

E.1 1 .1.3 Operation Accidents

Operations are discussed in Appendix B. The radiological and chemical operation accidents, consequences, and risk for Phase 1 are summarized in the following text.

E.11.1.3.1 Continued Operation Accidents - Mispositioned Jumper Accident - Tank waste Transfer

The dominant continued operations accident during tank waste transfer is the mispositioned jumper accident previously discussed in the No Action alternative in Section E.2.2.1 and summarized as follows:

Source-Term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The probability of the No Action alternative was based upon 10 years of waste transfers. Phase 1 is based on 10 years of operations; therefore, the probability would be the same 1.1E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E. 11.1.7.

Table E.11.1.7 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for Phase 1 and are reproduced in Table E.11.1.8. The bounding scenario calculations show that all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure if the accident occurred.

Table E.11.1.8 Latent Cancer Fatality Risk from Mispositioned Jumper

There would be approximately seven LCFs from the noninvolved worker population and two from the general public. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper are identical to those summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.00E+00, indicating that only mild, reversible, irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild, reversible, irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 1.10E-01.

E .11.1.3.2 Pretreatment Accidents

The dominant pretreatment operations accident is the seismic induced line break in vault accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3. 4 and is summarized as follows:

Source-Term - The source-term resulting from the airborne release in Section E.6.3. 4 .1 was calculated to be 7.3E-02 L (6.6E-02 gal).

Probability - The annual excedance frequency of the seismic event in Section E.6.3. 4 .2 was 6.5 E-0 4 per year. Phase 1 was based on 10 years of operations; therefore, the probability was calculated to be 6. 5 E-0 3 .

Radiological Consequences - The radiological consequences presented in Section 6.3. 4 .3 are reproduced in Table E.11.1.9.

Table E.11.1.9 Dose Consequence from Seismic Induced Line Break in Vault

Radiological Cancer Risk - The LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.11.1.10. The calculations show that there would be no LCFs attributable to this exposure if the accident occurs for the bounding and nominal scenarios .

Table E.11.1.10 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.14 and E.6.3.15 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.16 and E.6.3.17 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.14), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.15), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.16), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.17), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Under both nominal and bounding conditions, the probability of a pretreatment spray release is 6.50E-03.

E.11.1.3.3 Treatment Accidents

The dominant treatment operations accident is a crushed Cs canister. It was postulated that the Cs canister is breached when a heavy object falls on the canister. The source-term, probability, and dose consequences were taken from (WHC 1995k) and summarized in the following text.

Scenario and Source-Term Development

It was assumed that the initial shock of the drop of a heavy object on the canister would spill the entire canister contents and loft a fraction of 1.0E-03 of the activity by free-fall. This would be resuspended for 8 hours at 4.0E-06 per hour and released from the facility through two stage HEPA filters that would provide a LPF of 2.0E-06. The source-term would be 8.0E-05 Ci.

Probability

The scenario was considered to be unlikely with a frequency range of 1.0E-02 per year to 1.0E-04 per year. For conservatism, a frequency of 1.0E-02 per year was used for calculating risk. Based on a separations operation of 10 years, the probability was calculated to be 1.0E-01.

Radiological Consequences

The radiological dose to the receptors from the accident scenario was calculated using the methodology previously discussed in Section 1.1.6. The results are summarized in Table E.11.1.11. Dose consequences for the worker was not evaluated since the accident was assumed to take place in a vault and would result in a filtered stack release.

Table E.11.1.11 Dose Consequence from Crushed Cesium Canister

Radiological Cancer Risk

Based on a dose-to-risk conversion factor of 4.0E-04 LCF per person-rem for the workers and noninvolved workers and 5.0E-04 LCF per person-rem for the general public, the LCFs and the LCF point estimate risk were calculated for the receptors and presented in Table E.11.1.12 . The calculations show there would be no LCFs attributable to this exposure if the accident occurs.

Table E.11.1.12 Latent Cancer Fatality Risk from Crushed Cesium Canister

Chemical Exposure

Chemical exposure was not evaluated since there would essentially be no other chemical in the canister other than Cs which was evaluated under Radiological consequences.

E.11.1.3.4 Disposal/Storage Accidents

No DBA accidents resulting in a radiological or chemical consequences to the receptors were identified. This is largely due to the vitrified waste form of the material and the engineered structural packaging of the vitrified LAW and vitrified HLW in shipping containers.

E.11.1.3.5 Occupational Injuries and Fatalities

The number of operation personnel to support Phase 1 was estimated at 6.93E+03 (Jacobs 1996). The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (6.93E+03 person-years) · (2.2E+00 incidences/100 person-years) = 1.52E+02

Lost Workday Cases = (6.93E+03 person-years) · (1.1E+00 incidences/100 person-years) = 7.62E+01

Fatalities = (6.93E+03 person-years) · (3.2E-03 fatalities/100 person-years) = 2.22E-01

E.11.2 TOTAL ALTERNATIVE

The Total alternative for tank waste would involve constructing and operating vitrification and support facilities, low-activity vitrified waste burial vaults, and transfer lines from the tank farms and T Plant to the vitrification facilities. This alternative would also involve transporting retrieved tank waste to a vitrification facility, and vehicle traffic of the personnel required to support the alternative. This section analyzes the construction, operation, and transportation risks associated with this alternative.

E.11.2.1 Construction Accidents

The potential exists for accidents resulting from construction activities. The construction activities are outlined in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated as follows.

The number of construction personnel was estimated at an average 4.82E+04 person-years (Jacobs 1996). The number of total recordable injuries and illnesses, lost workday cases, and fatalities during construction were calculated using the incidence rates from Table E.1.2.1 as follows:

Total Recordable Cases = (4.82E +04 person-years) · (9.75E+00 incidences/100 person-years) = 4.70E+03

Lost Workday Cases = (4.82E +04 person-years) · (2.45E+00 incidences/100 person-years) = 1.18E+03

Fatalities = (4.82E +04 person-years) · (3.2E-03 fatalities/100 person-years) = 1.54E+00

E.11.2.2 Transportation Accidents

Under the Total alternative, Hanford Site tank waste would be stabilized by vitrification. The residual SST waste and MUST waste would be transported to a vitrification facility. In addition to transporting the waste, construction materials and process chemicals would be transported to the Hanford Site by truck and rail. This alternative would also be supported by a work force of employees that would commute to work each day.

E.11.2.2.1 Radiological Cancer Risk

The radiological cancer risk would be the same as that previously discussed in Section E.6.2.1. for truck transport of retrieved tank waste to the vitrification facility.

The receptor dose, LCFs, and LCF risk resulting from a truck transport accident during retrieval of MUST waste and SST residuals for the integrated population and for the MEI worker and MEI general public was evaluated in Section E.6.2.1.1. These are reproduced in Tables E.11.2.1 and E.11.2.2.

Table E.11.2.1 Integrated Radiological Impact from Retrieval Transport Accidents

Table E.11.2.2 Maximally-Exposed Individual Radiological Impact from Retrieval Transport Accidents

There would be no LCFs resulting from an accident while transporting retrieved waste on site.

E.11.2.2.2 Chemical Exposure

Chemicals transported to the Hanford Site to support the pretreatment and vitrification processes would have the greatest chemical impact. The impacts were previously analyzed in Section E.6.2.2. The evaluation showed the general public exposure to anhydrous ammonia would exceed the ratio of exposure to ERPG-3 by 1.24E+01 and sodium hydroxide would exceed the ratio of exposure to ERPG-1 by 2.45E+00 for corrosive/irritant chemicals. The magnitude of the anhydrous ammonia exceedance indicates potential lethal effects for the MEI general public.

E.11.2.2.3 Occupational Injuries and Fatalities

Truck and Rail Transportation - Injuries and fatalities resulting from direct impact of transportation accidents are analyzed in this subsection. Rail and truck transportation activities to transport materials and supplies to the Site for this alternative were estimated (WHC 1995j) and are summarized in Table E.11.2.3.

Table E.11.2.3 Summary of Transportation Activities for the Total Alternative

The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.11.2.4 by the appropriate unit risk factors shown in Table E.1.3.1.

Table E.11.2.4 Distance Traveled in Population Zones for the Total Alternative

The distance traveled in the population zones were calculated using the methodology previously discussed in Section E.1.3. The expected injuries and fatalities resulting from transportation accidents associated with the Total alternative are summarized in Table E.11.2.5.

Table E.11.2.5 Injuries and Fatalities Resulting from Truck and Rail Transportation Accidents for the Total Alternative

Employee Traffic - In addition to transporting materials and supplies to and from the Hanford Site by truck and rail, Site workers and other personnel required to perform the various activities would be driving to the site in their vehicles. The total person-years to perform the activities was estimated at 1.32E+05 (Jacobs 1996).

Each person was assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area was estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total employee vehicle distance was therefore calculated as follows:

$$(1.32E+05 \text{ person-years}) \cdot (260 \text{ days/year}) \cdot (140 \text{ km/day}) \cdot (1/1.35) = 3.56\ E+09 \text{ km } (2.21\ E+09 \text{ mi}).$$

To calculate the expected number of injuries and fatalities resulting from vehicle accidents, the injury/fatality rates discussed in Section E.1.3 were used. The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

$$\text{Injuries} = (3.56E+09 \text{ km}) \cdot (7.1E\text{-}07 \text{ injuries/km}) = 2.54E+03$$

Fatalities = (3.56E +09 km) · (8.98E-09 fatalities/km) = 3.19E +01

Cumulative Transportation Injuries and Fatalities - The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are the sum of the truck and rail transport and employee vehicle accidents. The results are summarized in Table E.11.2.6.

Table E.11.2.6 Cumulative Injuries and Fatalities from Traffic Impacts for the Total Alternative

E.11.2.3 Operation Accidents

Operation accidents would be the same as those analyzed in Section E.6.3.

E.11.2.3.1 Routine Operation Accidents - Tank Waste Transfers

The dominant routine operations accident during tank waste transfers is the mispositioned jumper accident previously discussed in the No Action alternative in Section E.2.2.1 and summarized as follows:

Source-Term - The source-term resulting from a spray release in Section E.2.2.1.1 was calculated to be 52 L (14 gal).

Probability - The frequency of a mispositioned jumper in Section E.2.2.1.2 was 1.1E-02 per year. The Ex Situ Intermediate Separations alternative was based on 27.5 years of operations; therefore, the probability was calculated to be 3.0E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.11.2.7.

Table E.11.2.7 Dose Consequence from Mispositioned Jumper

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.1.4 are the same for the Total alternative. However, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.11.2.8. The bounding scenario calculations show that all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure if the accident occured. There would be approximately seven LCFs from the noninvolved worker population and two from the general public. The nominal scenario calculations show there would be no LCFs.

Chemical Consequences

Potential acute hazards associated with a mispositioned jumper are identical to those summarized in Tables E.2.2.4 (toxic chemicals, nominal conditions), E.2.2.5 (toxic chemicals, bounding conditions), E.2.2.6 (corrosive/irritant chemicals, nominal conditions) and E.2.2.7 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Table E.11.2.8 Latent Cancer Fatality Risk from Mispositioned Jumper

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.4), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.2.2.5), the MEI worker was not evaluated because death would occur from exposure to radionuclides. The cumulative acute hazard ratio for the MEI noninvolved worker was 5.36E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to mercury (approximately 89 percent of the overall hazard ratio). No adverse acute health effects were predicted for the MEI general public under bounding conditions.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.6), the cumulative acute hazard ratio for the MEI worker was 2.70E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio was almost entirely attributable to sodium assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 3.00E+00, indicating that only mild, reversible, irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions. Under bounding conditions (Table E.2.2.7), the MEI worker was not evaluated because death would occur from exposure to radionuclides. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-1 was 4.36E+00, indicating that only mild, reversible, irritant effects would be expected. No acute health impacts were predicted for the MEI general public under bounding conditions.

Under both nominal and bounding conditions, the probability of a mispositioned jumper is 3.03E-01.

E.11.2.3.2 Continued Operations Accidents - Waste Storage Tanks

The dominant accident is a hydrogen deflagration in a waste storage tank previously discussed in the No Action alternative in Section E.2.2.2.1 and is summarized as follows.

Source-Term - The source-term resulting from the fire in Section E.2.2.2.1 was calculated to be 2.5E-01 L (6.6E-02 gal).

Probability - The frequency of the hydrogen deflagration in a waste storage tank in Section E.2.2.2.2 was estimated to be 7.2E-03 per year. The probability of the scenario based on 31 years of operation was therefore estimated to be 2.23E-01.

Radiological Consequences - The radiological consequences presented in Table E.2.2.8 are reproduced in Table E.11.2.9.

Table E.11.2.9 Dose Consequence from Hydrogen Deflagration in Waste Storage Tank

Radiological Cancer Risk - The LCFs calculated in Section E.2.2.2.4 are the same for the Total alternative. However, the LCF risk (point estimate) is not the same due to the difference in probabilities. The LCR and the LCF risk are calculated in Table E.11.2.10.

In the bounding scenario all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and 2 LCFs to the general public if the accident occurred. The nominal scenario calculations show that there would be no LCFs.

Table E.11.2.10 Latent Cancer Fatality Risk from Hydrogen Deflagration in Waste Storage Tank

Chemical Consequences

Potential acute hazards associated with a hydrogen burn in a waste storage tank are identical to those summarized in Tables E.2.2.10 (toxic chemicals, nominal conditions), E.2.2.11 (toxic chemicals, bounding conditions), E.2.2.12 (corrosive/irritant chemicals, nominal conditions) and E.2.2.13 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.10), the cumulative acute hazard ratio for the MEI worker was 1.57E+00 for ERPG-2, indicating that reversible acute health effects would be expected. This acute hazard ratio was primarily attributable to TOC (approximately 87 percent of the overall ERPG-2 ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 9.38E+00, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was also primarily attributable to TOC (approximately 90 percent of the overall ERPG-3 ratio) However, the MEI noninvolved worker is a hypothetical worker assumed to be located 100 m (330 ft) from the source area. The nearest noninvolved worker population is located 290 m (950 ft) from the source area and had no cumulative acute hazard ratios greater than 1.0 for any of the ERPGs, indicating that no acute health effects would be expected for the nearest noninvolved worker population. Likewise, no acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 4.54E+02 for ERPG-3, indicating the potential for irreversible health effects that could be life-threatening. This acute hazard ratio is primarily attributable to:

- Oxalate (approximately 37 percent of the total hazard ratio);
- Beryllium (approximately 13 percent of the total hazard ratio);
- Cadmium (approximately 14 percent of the total hazard ratio);
- Uranium (approximately 12 percent of the total hazard ratio); and
- TOC (approximately 8 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100 m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population located 290 m (950 ft) from the source was 1.65E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening for 335 workers. This hazard ratio was attributable to the same toxic chemicals listed above.

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The next nearest noninvolved worker population is located 1,780 m (5,840 ft) from the source and contains 1,500 workers. The cumulative acute hazard ratio was less than 1.0 for all ERPGs, indicating that no acute health effects would be expected for this population of workers. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.12), the cumulative acute hazard ratio for the MEI worker was 3.82E+00 for ERPG-3, indicating the potential for irreversible corrosive/irritant effects that could be life threatening. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 7.89E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 1.38E+01, indicating that only mild, reversible effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.2.2.13), the cumulative acute hazard ratio for the MEI noninvolved worker was 1.91E+02 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 75 percent of the total hazard ratio);
- Chromium (approximately 14 percent of the total hazard ratio); and
- Calcium (approximately 6 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 1.74E+00 for ERPG-2, indicating that reversible acute effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a hydrogen deflagration event in a waste storage tank is 2.23E-01.

E.11.2.3.3 Retrieval Accidents

The dominant routine operations accident is the loss of filtration accident previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3. 3 and summarized as follows:

Source-Term - The source-term resulting from a loss of filtration in Section E.6.3. 3 .1 was calculated to be 2.5E-01 L (6.6E-02 gal).

Probability - The frequency of a loss of filtration in Section E.6.3. 3 .2 was 8.8E-06 per year. The Total alternative retrieval activity was based on 31 years of operation, therefore the probability was calculated to be 2.7E-04.

Radiological Consequence - The radiological consequences presented in Section E.6.3.3 are reproduced in Table E.11.2.11.

Table E.11.2.11 Dose Consequence for Loss of Filtration

Radiological Cancer Risk - The LCFs calculated in Section E.6.3. 3 .4 are reproduced in Table E.11.2.12. Aside from all 10 workers dying from a lethal dose, the calculations show that there would be no LCFs attributed to the exposure to the noninvolved workers and the general public if the accident occurred.

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.8 and E.6.3.9 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.10 and E.6.3.11 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section 1.1.7.

Table E.11.2.12 Latent Cancer Fatality Risk from Loss of Filtration

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as discussed previously.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.8), the cumulative acute hazard ratio for the MEI worker was less than 1.0 for all ERPGs, indicating that no adverse acute health effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio was 1.84E+00 for ERPG-1, indicating that only mild, transient acute health effects would be expected. No acute health effects were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.9), the cumulative acute hazard ratio for the MEI noninvolved worker was 7.27E+01 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio is primarily attributable to:

- Uranium (approximately 48 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio);
- Mercury (approximately 13 percent of the total hazard ratio); and
- TOC (approximately 7 percent of the total hazard ratio).

As discussed previously, this is a hypothetical receptor located 100 m (330 ft) from the source. The cumulative acute hazard ratio for the nearest noninvolved worker population (335 workers) located 290 m (950 ft) from the source was 5.40E+00 for ERPG-2, indicating that reversible acute health effects would be expected. No acute health impacts were predicted for the MEI general public.

Corrosive/Irritant Impact from Loss of Filtration

Under nominal conditions (Table E.6.3.10), the cumulative acute hazard ratio for the MEI worker was 2.11E+00 for ERPG-2, indicating that reversible corrosive/irritant effects would be expected. For the MEI noninvolved worker, the cumulative acute hazard ratio for ERPG-3 was 1.72E+01 and would indicate irreversible corrosive/irritant effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to sodium, which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects. For the nearest noninvolved worker population (290 m) composed of 335 workers, the cumulative acute hazard ratio for ERPG-1 was 3.02E+00, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under bounding conditions (Table E.6.3.11), the cumulative acute hazard ratio for the MEI noninvolved worker was 2.47E+01 for ERPG-3, indicating irreversible health effects that could be life threatening for this hypothetical receptor. This hazard ratio was primarily attributable to :

- Sodium as sodium hydroxide (approximately 82 percent of the total hazard ratio); and
- Calcium (approximately 9 percent of the total hazard ratio).

For the nearest noninvolved worker population (290 m [950 ft]) composed of 335 workers, the cumulative acute hazard ratio was 4.38E+00 for ERPG-1, indicating that only mild, transient irritant effects would be expected. No acute health impacts were predicted for the MEI general public under nominal conditions.

Under both nominal and bounding conditions, the probability of a loss of filtration event in a waste storage tank is 2.73E-04 for the MEI worker, MEI noninvolved worker, and MEI general public.

E.11.2.3.4 Pretreatment

The dominant pretreatment operations accident was the line break within a vault due to an earthquake previously discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.4 and summarized as follows:

Source-Term - The source-term resulting from a line break in a vault in Section E.6.3.4.1 was calculated to be 7.3E-02 L (1.9E-02 gal).

Probability - The probability of a seismic induced line break in Section E.6.3.4.2 was calculated to be 2.02E-02.

Radiological Consequences - The radiological consequences presented in Section E.6.3.4.3 are reproduced in Table E.11.2.13.

Table E.11.2.13 Dose Consequence for Seismic Induced Line Break

Radiological Cancer Risk - The LCFs calculated in Section E.6.3.3.4 are reproduced in Table E.11.2.14 . The calculations show that there would be no LCFs attributable to this exposure if the accident occurs for the bounding and nominal scenarios .

Chemical Consequences

The chemical exposure to the receptors from the postulated accident was calculated in Appendix A of the accident data package (Shire et al. 1995 and Jacobs 1996) and summarized in the exposure column in Tables E.6.3.14 and E.6.3.15 for the nominal and bounding toxic effects, respectively, and Tables E.6.3.16 and E.6.3.17 for the nominal and bounding corrosive/irritant effects, respectively. The tables compare the concentration of postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section E.1.1.7.

Toxic Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.14), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.15), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Table E.11.2.14 Latent Cancer Fatality Risk from Seismic Induced Line Break in Vault

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.6.3.16), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors. Under bounding conditions (Table E.6.3.17), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker, and MEI general public were less than 1.0, indicating that no adverse acute health effects would be expected for these three receptors.

Under both nominal and bounding conditions, the probability of a pretreatment spray release is 2.02E-02 .

E.11.2.3.5 Treatment Accidents

The dominant routine operations accident is an inadvertent HLW canister drop discussed in the Ex Situ Intermediate Separations alternative in Section E.6.3.4 and summarized as follows:

Source-Term from Breached Canister - The source-term in Section E.6.3. 5 .1 was 2.5E-06 grams (8.8E-08 ounces).

Probability - The probability of dropping a canister in Section E.6.3. 5 .3 was calculated to be 1.0E+00.

Radiological Consequences - The radiological consequences presented in Section E.6.3.5.4 are reproduced in Table E.11.2.15

Table E.11.2.15 Dose Consequence from Breached Canister

Radiological Cancer Risk - The LCFs calculated in Section 6.3. 5 .4 are reproduced in Table E.11.2.16. The calculations show there would be no LCFs attributable to this exposure for bounding and nominal scenarios .

Chemical Consequences - No chemical consequences were evaluated in (Shire et al. 1995 and Jacobs 1996) since the release would first pass through two-stage HEPA filters that would reduce the source-term to a very small amount, well below the cumulative ratio of exposure to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.11.2.3.6 Disposal/Storage Accidents

No DBA accidents resulting in radiological or chemical consequences to the receptors were identified. This is largely due to the vitrified waste form of the material and the engineered structural packaging of the vitrified LAW in burial vaults and vitrified HLW in shipping containers.

TableE.11.2.16 Latent Cancer Fatality Risk from Breached Canister

E.11.2.3.7 Beyond Design Basis Accidents

The beyond design basis accident is a seismic event resulting in the collapse of a SST. In the event of a 0.43 g earthquake, a SST could potentially collapse (LANL 1995). This event is not dependent on the remediation alternative but has the same annual frequency regardless of the alternative that is chosen.

The length of time unremediated waste would remain in tanks that have not been backfilled would vary depending on the alternative and would affect the probability of the event. The probability of the event is the product of the annual frequency of the earthquake and the number of years the waste remains untreated in the unstabilized tanks.

At smaller annual frequencies, larger earthquakes could occur resulting in greater destruction and larger numbers of LCF to the onsite and offsite populations. In addition to population exposures from the collapsed SSTs, the impact to other Hanford Site facilities and operations would potentially add to the chemical and radiological risk. This would be a severe earthquake that would cause catastrophic structural damage in the Tri-Cities and the Hanford Site with expected extensive loss of life. There would be injuries and fatalities resulting from collapsed buildings and homes, fires, and traffic accidents. However, this section evaluates the radiological and chemical impacts resulting from the collapse of one SST.

E.11.2.3.8 Source-Term Development

It was conservatively assumed that the radiological and chemical contaminants in the headspace are available for release. The collapse of a portion of the dome and overburden compresses the vapor in the headspace as it descends, enhancing the vapor release rate by a sudden pressure difference. Assuming for each tank a respirable concentration of contaminants in the headspace of 100 mg/m^3, a liquid SpG of 1.5, and a headspace volume of 1,000 m^3 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution from the headspace release was calculated as follows:

$$(100\ \text{mg/m}^3) \cdot (1\ \text{g}/1{,}000\ \text{mg}) \cdot (1\ \text{L}/1{,}000\ \text{g}) \cdot (1{,}000\ \text{m}^3) \cdot (1/1.5) = 6.67\text{E-}02\ \text{L}\ (1.8\text{E-}02\ \text{gal}).$$

It was conservatively assumed that the liquids had been pumped from the tanks so that the tanks contained only solids and the MAR was 2,500 L (660 gal) for each tank. It was postulated that the fall of the dome and overburden generated an air movement sufficient to suspend a fraction the MAR. Assuming the respirable release fraction to be 2.0E-03 (Shire et al. 1995 and Jacobs 1996), the potential source-term contribution was calculated as follows:

$$(2{,}500\ \text{L}) \cdot (2.0\text{E-}03) = 5\ \text{L}\ (1.3\ \text{gal}).$$

It was postulated that prevailing winds resuspend a respirable fraction of the MAR (2,500 L [660 gal]). A respirable release fraction of 4.0E-05/hr for 24 hours was assumed. The potential source-term contribution from resuspension was calculated as follows:

$$(2{,}500\ \text{L}) \cdot (4.0\text{E-}05/\text{hr}) \cdot (24\ \text{hr}) = 2.4\ \text{L}\ (0.6\ \text{gal}).$$

The combined source-term for the acute release is calculated as follows:

$$(6.67\text{E-}02\ \text{L}) + (5.0\ \text{L}) + (2.4\ \text{L}) = 7.4\ \text{L}\ (2.0\ \text{gal}).$$

E.11.2.3.9 Probability of a Beyond Design Basis Earthquake

This earthquake has a calculated annual exceedance frequency of approximately 1.40E-04 (WHC 1996b). The probability for this scenario based on 31 years of operation was therefore estimated to be 4.3E-03.

E.11.2.3.10 Radiological Consequences from a Beyond Design Basis Earthquake

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6. The results are presented in Table E.11.2.17.

E.11.2.3.11 Radiological Cancer Risk from a Beyond Design Basis Earthquake

The LCFs and LCF point estimate risk are presented in Table E.11.2.18.

Table E.11.2.17 Dose Consequence from Seismic Event

Table E.11.2.18 Latent Cancer Fatality Risk from Seismic Event

In the bounding scenario, all 10 workers would potentially receive a fatal dose and assumably die directly after the exposure. There would also be 10 LCFs attributed to the exposure to the noninvolved workers and two LCFs to the general public if the accident occurred. The nominal scenario calculations show there would be no LCFs.

E.11.2.3.12 Chemical Consequences from a Beyond Design Basis Earthquake

Potential acute hazards associated with a beyond design basis earthquake are identical to those summarized in Tables E.2.2.16 (toxic chemicals, nominal conditions), E.2.2.17 (toxic chemicals, bounding conditions), E.2.2.18 (corrosive/irritant chemicals, nominal conditions) and E.2.2.19 (corrosive/irritant chemicals, bounding conditions) for the No Action alternative.

Under bounding conditions, chemical impacts were not evaluated for the MEI worker because all workers would receive a lethal radiation dose, as described previously.

Toxic Impact from Chemical Exposure

Under nominal conditions, the cumulative acute hazard ratio for the MEI worker was 2.64E+00 for ERPG-1, indicating that only mild transient effects would be expected. For the MEI noninvolved worker, the cumulative acute health hazard was 2.59E+00 for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. This acute hazard ratio was primarily attributable to TOC (approximately 84 percent of the total hazard ratio). The TOC is assumed to be equivalent in toxicity to tributylphosphate, which is the most acutely toxic constituent of the organic analytes identified. Tributylphosphate was used as a surrogate because an inventory of the various chemicals that make up the TOC class is not available. The cumulative acute hazard ratio for the nearest noninvolved worker population (consisting of 335 workers located 290 m [950 ft] away) was less than 1.0 for all ERPGs, suggesting that no acute health effects would be expected.

Under bounding conditions (Table E.2.2.16), the cumulative hazard ratios for the MEI and nearest noninvolved worker (335 workers located 290 m [950 ft] away) were 2.15E+03 and 7.80E+00 for ERPG-3, respectively. These ratios were primarily attributable to:

- Uranium (approximately 47 percent of the total hazard ratio);
- Oxalate (approximately 24 percent of the total hazard ratio); and
- Mercury (approximately 13 percent of the total hazard ratio).

This exceedance of the ERPG-3 criterion for the nearest noninvolved worker population would not be expected to result in irreversible health effects or place these workers in a life-threatening situation for the following reasons.

- ERPG-3 is defined as a concentration in which a receptor can be exposed for 1 hour without irreversible health effects. Because the Hanford Site has an in-place emergency response plan designed to evacuate workers within 1 hour of an accident, workers would be expected to evacuate their location and move to an area where potential exposures would be well below ERPG-3. Therefore, this worker population would not be exposed to airborne concentrations that would be either life threatening or result in irreversible health effects.
- The estimated air concentrations of chemicals as a result of this accident were based on very conservative meteorology, which results in movement of a plume directly toward the worker population at a relatively slow rate with minimal wind dispersion. If less conservative meteorological parameters were used, wind dispersion would cause the estimated air concentrations of chemicals to be substantially less, and the ERPG-3 criterion would not be exceeded.
- Only the bounding toxic chemical evaluation exceeded ERPG-3, while the nominal evaluation was well below 1.00E+00 for ERPG-3, suggesting that the noninvolved worker population would not receive an exposure that would result in any permanent health effects.

The cumulative acute hazard ratio for the next nearest noninvolved worker population, composed of 1,500 people and located 1,780 m (5,840 ft) away, was 2.15E+00 for ERPG-2, indicating that reversible acute health effects would be expected. The cumulative acute hazard ratio for the MEI general public was 1.76E+00 for ERPG-2, indicating that reversible, acute health effects would be expected.

Corrosive/Irritant Impact from Chemical Exposure

Under nominal conditions (Table E.2.2.17), the cumulative acute hazard ratios for the MEI worker, MEI noninvolved worker and nearest noninvolved worker population (335 workers at 290 m [950 ft]) were 2.47E+01, 5.10E+02 and 1.85E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These ratios were almost entirely attributable to sodium which was assumed to be equivalent to sodium hydroxide in corrosive/irritant effects.

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatining health effects.

For the next nearest noninvolved worker population (1,500 workers at 1,780 m [5,840 ft]), the cumulative acute hazard ratio was 1.20E+00 for ERPG-1, indicating that only mild irreversible irritant effects would be anticipated. For the MEI general public, the cumulative acute hazard ratio was less than 1.0 for all ERPGs and no acute health effects would be expected.

Under bounding conditions, the cumulative acute hazard ratios for the MEI noninvolved worker and nearest noninvolved worker population (335 workers at 290 m [950 ft]) were 7.31E+02 and 2.65E+00, respectively for ERPG-3, indicating the potential for irreversible health effects that could be life threatening. These acute hazard ratios were primarily attributable to:

- Sodium (approximately 83 percent of the total hazard ratio); and
- Calcium (approximately 10 percent of the total hazard ratio).

As discussed previously, this exceedance of the ERPG-3 criterion would not be expected to result in irreversible or life threatining health effects.

For the next nearest noninvolved worker, and MEI general public, the cumulative acute hazard ratios were 1.74E+00 and 1.42E+00 respectively for ERPG-1, indicating that only mild, transient irritant effects would be expected.

Under both nominal and bounding conditions, the probability of a seismic event is 4.34E-03.

E.11.2.3.13 Occupational Injuries and Fatalities

The number of operation person-years to support the Ex Situ Intermediate Separations alternative was estimated to be 8.37E +04 (Jacobs 1996). The total recordable injuries and illnesses, lost workday cases, and fatalities were calculated as follows:

Total Recordable Cases = (8.37 E+04 person-years) · (2.2E+00 incidences/100 person-years) = 1.84E+03

Lost Workday Cases = (8.37E +04 person-years) · (1.1E+00 incidences/100 person-years) = 9.20E+02

Fatalities = (8.37E +04 person-years) · 3.2E-03 fatalities/100 person-years) = 2.68E +00

E.11.3 POST-REMEDIATION ACCIDENT

E.11.3.1 Deflagration in Storage Tank

After 99 percent of the tank waste has been removed from each tank, the probability of a tank generating enough hydrogen to exceed the LFL is considered to be incredible.

E.11.3.2 Seismic Induced Rupture of Stabilized Tanks

As discussed in Section E.4.4.2, displacement on a fault that would increase exposure to the waste after remediation is considered incredible. The tanks would most likely crack, allowing increased infiltration to the groundwater.

E.11.4 SUMMARY OF ACCIDENTS

The potential consequences from nonradiological and nonchemical accidents that include occupational and transportation impacts are summarized in Table E.11.4.1. The LCFs associated with representative accidents for each component of the alternative are summarized in Table E.11.4.2 along with the probability of the accident. The chemical hazards associated with representative accidents for each component of the alternative are summarized in Table E.11.4.3. The chemical hazard is expressed as an exceedance of the ERPG threshold values.

Table E.11.4.1 Summary of Potential Nonradiological/Nonchemical Accident Consequences

Table E.11.4.2 Summary of Potential Radiological Accident Consequences

Table E.11.4.3 Chemical Exposures Resulting from Potential Operations and Transportation Accidents

E.12.0 NO ACTION ALTERNATIVE (CAPSULES)

The No Action alternative for Cs and Sr capsules would involve the continued operation of Waste Encapsulation and Storage Facility (WESF) for 10 years. This section analyzes potential operation and transportation risks resulting from accidents associated with this alternative. Because there would be no construction, accidents associated with construction were not analyzed.

E.12.1 TRANSPORTATION ACCIDENTS

Employee Vehicles

Personnel required to support the various activities would drive to the site in their vehicles. The total person-years to support the alternative for 10 years was calculated to be 1.00E+03 (Jacobs 1996). Each person is assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area is estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total personnel vehicle distance was therefore calculated as follows:

(1.00E+03 person-years) · (260 days/year) · (140 km/day) · (1/1.35 person) = 2.70E+07 km (1.68E+07 mi)

The expected numbers of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (2.70E+07 km) · (7.14E-07 injuries/km) = 1.93E+01

Fatalities = (2.70E+07 km) · (8.98E-09 fatalities/km) = 2.42E-01

E.12.2 OPERATION ACCIDENTS

The potential exists for accidents resulting from operation activities, which are discussed in Appendix B. The potential accidents were identified in the document entitled Potential Accidents for Storage and Disposition of Cesium and Strontium Capsules for the Tank Waste Remediation System-EIS (WHC 1995k). The data package provided a range of potential accidents, probability of the accidents, and the consequences of the accidents. These accidents are summarized in the Accident Screening Table (Table E.12.2.1). The dominant accident scenario analyzed in the following subsection was selected from the table.

E.12.2.1 Pool Cell Storage Accident at the Waste Encapsulation and Storage Facility

Types of potential accidents associated with pool cell storage at WESF are leaks, direct exposure, fires, mechanical impacts, and explosions. From Table E.12.2.1 , the DBA accident identified as having the highest risk would be an earthquake that would result in the combination of Accident 3.1.2 "loss of shielding in a single pool cell," and Accident 3.1.1, "strontium capsule leak."

E.12.2.1.1 Scenario and Source-Term Development for Pool Cell Storage Accident

It was postulated that the earthquake results in the roof of the building collapsing breaching 40 Sr capsules. The pool cell is also breached and all the water drained from the cell. The source-term resulting from the breached canisters for the noninvolved worker receptor as calculated in the capsule data package (WHC 1995k) would be 1.2E-01 Ci based on 8 hours exposure. The general public was calculated to be 3.5E-01 Ci based on 24 hours exposure. In addition to the source-term, the loss of the water shielding the capsules would result in high direct radiation doses to the receptors. It was assumed that all workers would die in the building from the collapsed roof.

Table E.12.2.1 Accident Screening Table for the No Action Alternative (Capsules)

E.12.2.1.2 Probability of Pool Cell Storage Accident

The initiating event is a beyond design basis earthquake with an annual exceedance frequency of 2.5E-04 per year. Based on an operation duration of 10 years, the probability of the event would be 2.5E-03.

E.12.2.1.3 Radiological Consequence of Pool Cell Storage Accident

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section E.1.1.6.

The direct radiation dose to the receptors from the accident scenario was calculated using the Monte Carlo Neutron Photon (MCNP) computer code. Because the pools are belowground, the primary source of dose rates to people outside the facility would be due to radiation scattering (often referred to as shine) from the air. The results, which are taken from the potential accident data package for the capsules (WHC 1995k), are summarized in Table E.12.2.2.

TableE.12.2.2 Dose Consequence for Pool Cell Storage Accident

E.12.2.1.4 Radiological Cancer Risk for Pool Cell Accident

To calculate the LCFs and the LCF risk (point estimate) for the receptors, a dose-to-risk conversion factor of 4.0E-04 LCF per person-rem for the noninvolved worker and MEI noninvolved worker and 5.0E-04 for the general public and MEI general public was used. The results are presented in Table E.12.2.3. Aside from the 10 workers dying from the collapsed roof, the calculations show there would be no fatal cancer.

E.12.2.1.5 Chemical Consequences for Pool Cell Accident

Chemical consequences were not evaluated in (WHC 1995k) since the small quantity of nonradiological constituents in the capsules would result in an exposure to all receptors well below the cumulative ratio of 1.0 to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.12.2.2 Occupational Fatalities and Injuries

Table E.12.2.3 Latent Cancer Fatality Risk from Pool Cell Accident

The number of operation personnel was estimated at approximately 1.00E+03 person-years (Jacobs 1996). The number of injuries, illnesses, and fatalities for the 10 years of operation are calculated as follows:

Total Recordable Cases = (1.00E+03 person-years) · (2.2E+00 incidences/100 person-years) = 2.2E+01

Lost Workday Cases = (1.00E+03 person-years) · (1.1E+00 incidences/100 person-years) = 1.1E+01

Fatalities = (1.00E+03 person-years) · (3.2E-03 fatalities/100 person-years) = 3.2E-02

E.13.0 ONSITE DISPOSAL ALTERNATIVE

The Onsite Disposal alternative for Cs and Sr capsules would involve the continued operation of WESF until the disposal facility was completed. The capsules would then be removed from the basin, placed in overpack canisters, and transferred to storage for disposal where they would remain. This section analyzes potential construction, operation, and transportation risks resulting from accidents associated with this alternative.

E.13.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the Onsite Disposal alternative are discussed in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from construction accidents are calculated in the following text.

The number of construction personnel was estimated at 2.10E+02 person-years (Jacobs 1996). The number of total recordable injuries and illnesses, lost workday cases, and fatalities for the 8 years of construction are calculated using the incidents rates from Table E.1.2.1 as follows:

Total Recordable Cases = (2.10E+02 person-years) · (9.75E+00 incidences/100 person-years) = 2.05E+01

Lost Workday Cases = (2.10E+02 person-years) · (2.45E+00 incidences/100 person-years) = 5.15E+00

Fatalities = (2.10E+02 person-years) · (3.2E-03 fatalities/100 person-years) = 6.72E-03

E.13.2 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative include:

- Transporting construction material from offsite by truck to support WESF modifications;
- Transporting fill material from an onsite borrow site to support drywell construction;
- Transporting the overpacked capsules from WESF to drywell disposal; and
- Employees commuting to work each day.

E.13.2.1 Radiological Cancer Risk

Radiological exposures resulting from accidents during transport of the capsules to the Drywell Disposal Facility were analyzed (Green 1995), and the methodology of this analysis is discussed in Section E.1.1.6. The results of the analysis are summarized in Tables E.1 3 .2.1 and E.1 3 .2.2. The calculations show there would be no fatal cancers attributable to this exposure.

Table E.13.2.1 Integrated Radiological Impact from Accidents for the Onsite Dry Storage Alternative

Table E.13.2.2 Maximum Individual Radiological Impact from Accidents for the Onsite Dry Storage Alternative

E.13.2.2 Chemical Exposure

Because chemicals other than small amounts of common chemicals (e.g., lubricants) are required to implement in this alternative, essentially no chemical exposure would occur.

E.13.2.3 Occupational Fatalities and Injuries

Truck Transport

WESF would be modified to support overpacking operations. Construction material would be transported by truck from the Tri-Cities area 70 km (43 mi) away. This would require an estimated 200 trips.

The area of land that would be graded is 1.8E+03 m^2 (2.2E+03 yd^2). Drywells (672) would be bored with a drywell encasement placed on center in the drywell. The encasement would be backfilled with sand and covered with a sandplug after placement of the capsule in the encasement. One hundred loads of sand would be trucked from a borrow site 5 km (3 mi) away. The 672 encasement pipes would be transported by truck from the Portland or Seattle area 400 km (249 mi) away. The encasement pipe would require an estimated 14 trips.

The 1,929 capsules would be transported by truck to drywell disposal. Capsule transport would require 184 trips. Table E.13.2.3 provides a summary of the expected distance to be traveled by truck in support of the construction and capsule transport activities. The number of injuries and fatalities are calculated by multiplying the total distance traveled in each zone, shown in Table E.13.2.4 , by the appropriate unit risk factors shown in Table E.1.3.1. The expected injuries and fatalities resulting from transportation accidents associated with the alternative are summarized in Table E.13.2.5.

Table E.13.2.3 Summary of Transportation Activities for the Onsite Disposal Alternative

Table E.13.2.4 Distance Traveled in Population Zones for the Onsite Disposal Alternative

Table E.13.2.5 Injuries/Fatalities Resulting from Truck Accidents for the Onsite Disposal Alternative

Employee Vehicles

In addition to transporting materials and supplies to and from the Hanford Site by truck, site workers and other personnel required to support the various activities will be driving to the site in their vehicles.

The total person-years to support the alternative for an estimated 88 years was calculated to be 1,294 (Jacobs 1996). Each person is assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area is estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a). The total personnel vehicle distance was therefore calculated as follows:

(1.29E+03 person-years) · (260 days/year) · (140 km/day) · (1/1.35 person) = 3.49E+07 km (2.2E+07 mi)

The expected numbers of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (3.49E+07 km) · (7.14E-07 injuries/km) = 2.49E+01

Fatalities = (3.49E+07 km) · (8.98E-09 fatalities/km) = 3.13E-01

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are summarized in Table E.13.2.6. It is most likely there would be 25 injuries and no fatalities resulting from traffic accidents.

Table E.13.2.6 Cumulative Injuries and Fatalities from Traffic Impacts for the Onsite Disposal Alternative

E.13.3 OPERATION ACCIDENTS

The potential exists for accidents resulting from operation activities. The operations are discussed in Appendix B. This analysis separates and analyzes the operations according to the following modes of operation:

- Pool cell storage at WESF - Cs and Sr capsules would remain stored in water-filled basins until they are transported to drywell disposal.

- Capsule overpacking at WESF - Cs and Sr capsules would be removed from the basin and sealed in overpack canisters.
- Transport of overpacked capsules to drywell disposal.
- Storage of capsules in drywells - Cs and Sr capsules are stored in drywells for an indefinite length of time.

The potential accidents were identified in the document entitled Potential Accidents for Storage and Disposition of Cesium and Strontium Capsules for the Tank Waste Remediation System (WHC 1995k). The data package provided a range of potential accidents, probability of the accidents, and the consequences of the accidents. These accidents are summarized in the Accident Screening Table (Table E.13.3.1). The dominant accident scenarios analyzed in the following subsections were selected from the table, whose methodology was previously discussed in Section E.1.1.2.

Table E.13.3.1 Accident Screening Table for the Onsite Disposal Alternative

E.13.3.1 Pool Cell Storage Accident at the Waste Encapsulation and Storage Facility

The dominant pool cell storage accident at WESF is the earthquake previously discussed in the No Action alternative in Section E.12.2.1 and is summarized in the following.

Source-Term - The source-term presented in Section E.12.1.1 resulting from the breached canisters for the noninvolved worker receptor was 1.2E-01 Ci based on 8 hours exposure. The general public was calculated to be 3.5E-01 Ci based on 24 hours exposure. In addition to the source-term, the loss of the water shielding the capsules would result in high direct radiation doses to the receptors. It was assumed that all the workers would die in the building from the collapsed roof.

Probability - The annual exceedance frequency of the earthquake in Section E.12.2.1.2 was 2.5E-04 per year. The Onsite Disposal alternative was based on 19 years of operations; therefore, the probability was calculated to be 4.8E-03.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.13.3.2 .

Radiological Cancer Risk - The LCFs calculated in Section E.12.2.1.4 are the same for the Onsite Disposal alternative; however, the LCF point estimate risk is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.13.3.3. Aside from the 10 workers dying from the collapsed roof, the calculations show there would be no fatal cancers.

Chemical Consequences - Chemical consequences presented in Section E.12.2.1.5 concluded there would be no exposure that would exceed the cumulative ratio of 1.0 to ERPG-1 values for toxic or corrosive/irritant chemicals.

Table E.13.3.2 Dose Consequence for Pool Cell Storage Accident

Table E.13.3.3 Latent Cancer Fatality Risk from Pool Cell Accident

E.13.3.2 Overpacking and Drywell Disposal Accident

Types of potential accidents associated with overpacking and drywell disposal are leaks and mechanical impacts. From Table E.13.3.1 , the DBA accident identified as having the highest risk is Accident 3.2.1, "Sr Capsule Crushed in Overpacking or Dry Storage." It was postulated that during overpacking a Sr capsule was breached when a heavy object falls on the canister.

E.13.3.2.1 Scenario and Source-Term Development for Crushed Strontium Capsule

It was assumed that the initial shock of the drop of a heavy object on the capsule would spill the entire capsule contents and loft a fraction of 1.0E-03 of the activity by free-fall. This would be resuspended for 8 hours at 4.0E-06 per hour. The source-term would be 38.5 Ci.

E.13.3.2.2 Probability of Crushed Strontium Capsule

This scenario was considered to be unlikely with a frequency range of 1.0E-02 per year to 1.0E-04 per year. For conservatism, a frequency of 1.0E-02 per year is used for calculating risk. Based on a packaging operation of 19 years, the probability was calculated to be 1.9E-01.

E.13.3.2.3 Radiological Consequence from Crushed Strontium Capsule

The radiological dose to the receptors from the accident scenario was calculated by the GENII computer code (Napier et al. 1988) using the methodology previously discussed in Section 1.1.6. The results, taken from the potential accident data package for the capsules (WHC 1995k), are summarized in Table E.13.3.4.

Table E.13.3.4 Dose Consequence from Crushed Strontium Capsule

E.13.3.2.4 Radiological Cancer Risk from Crushed Strontium Capsule

Based on a dose-to-risk conversion factor of 4.0E-04 LCF per person-rem for the worker/noninvolved worker and 5.0E-04 LCF per person-rem for the general public, the LCF risk is calculated for the receptors in Table E.13.3.5.

For the bounding scenario the calculations show there would be no fatal cancers attributable to this exposure.

The BDBA represents an unmitigated release (the HEPA filters fail). For the BDBA the calculations show all 10 workers would receive a lethal dose, there would be 1.2E+03 LCF in the noninvolved worker population, and 6.20E+02 LCFs in the general public.

E.13.3.2.5 Chemical Consequences from Crushed Strontium Capsule

Chemical consequences were not evaluated in (WHC 1995k) since the small quantity of nonradiological constituents in a capsule would result in an exposure to all receptors well below the cumulative ratio of 1.0 to ERPG-1 values for toxic corrosive/irritant chemicals.

E.13.3.3 Occupational Fatalities and Injuries

The number of operation personnel was estimated at approximately 1.08E+03 person-years (Jacobs 1996). The number of injuries, illnesses, and fatalities for the 88 years of operation are calculated as follows:

Total Recordable Cases = (1.08E+03 person-years) · (2.2E+00 incidences/100 person-years) = 2.38E+01

Lost Workday Cases = (1.08E+03 person-years) · (1.1E+00 incidences/100 person-years) = 1.19E+01

Fatalities = (1.08E+03 person-years) · (3.2E-03 fatalities/100 person-years) = 3.47E-02

TableE.13.3.5 Latent Cancer Fatality Risk from Crushed Strontium Capsule

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E.14.0 OVERPACK AND SHIP ALTERNATIVE

The Overpack and Ship alternative for Cs and Sr capsules would involve the continued storage of the capsules in the WESF water basin with final disposal in the potential geologic repository. The capsules would not be removed from the WESF pools until a repository became available. The capsules would be removed from the pools and placed in overpacks prior to shipment. The capsules would be transported by rail to the potential geologic repository.

E.14.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the Overpack and Ship alternative are discussed in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from construction accidents are calculated in the following text.

The number of construction personnel was estimated at 1.0E+02 person-years (Jacobs 1996). The number of total recordable injuries and illnesses, lost workday cases, and fatalities for the 8 years of construction are calculated using the incidence rates from Table E.1.2.1 of this appendix as follows:

Total Recordable Cases = (1.00E+02 person-years) · (9.75E+00 incidences/100 person-years) = 9.75E+00

Lost Workday Cases = (1.00E+02 person-years) · (2.45E+00 incidences/100 person-years) = 2.45E+00

Fatalities = (1.00E+02 person-years) · (3.2E-03 fatalities/100 person-years) = 3.20E-03

There would be an estimated 10 total recordable cases, two to three lost workday case, and no fatalities resulting from construction.

E.14.2 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative are:

- Transporting construction material from offsite by truck to support WESF modification;
- Transporting overpacked capsules by rail from WESF the potential geologic repository; and
- Employees commuting to work each day.

E.14.2.1 Radiological Cancer Risk

Radiological exposures resulting from accidents while transporting the capsules to an offsite potential geologic repository were analyzed (Green 1995). The methodology of the analysis was previously discussed in Section E.1.1.6. The results of the analysis are summarized in Tables E.14.2.1 and E.14.2.2. The calculations show there would be no fatal cancers attributed to this exposure.

Table E.14.2.1 Integrated Radiological Impact from Accidents for the Overpack and Ship Alternative

Table E.14.2.2 Maximum Individual Radiological Impact from Accidents for the Overpack and Ship Alternative

E.14.2.2 Chemical Exposure

Only small amounts of chemicals (e.g., lubricants) would be required under this alternative so only very minor chemical exposure would be expected to occur.

E.14.2.3 Occupational Fatalities and Injuries

Table E.14.2.3 provides a summary of the expected distances to be traveled by truck and rail to support construction and capsule transport activities.

Table E.14.2.3 Summary of Transportation Activities for the Overpack and Ship Alternative

Construction Transport

There would be modifications to WESF to support overpacking operations. Construction material would be transported by truck from the Tri-Cities area 70 km (43 mi) away. This would require an estimated 200 trips.

Capsule Transport

It would require 5 rail shipments to transport the capsules to an offsite potential geologic repository 1,465 km (910 mi) away (Green 1995).

The number of injuries and fatalities are calculated by multiplying the total distance traveled in each zone, shown in Table E.14.2.4 , by the appropriate unit risk factors shown in Table E.1.3.1.

In addition to transporting materials and supplies to and from the Hanford Site, site workers and other personnel required to support the various activities would be driving to the site in their vehicles. The total person-years to support the alternative for an estimated 39 years was calculated to be 241 (Jacobs 1996). Each person is assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area is estimated at 140 km (87 mi), with an estimated 1.35 passengers per vehicle (DOE 1994a). The total personnel vehicle distance was therefore calculated as follows:

(241 person-years) · (260 days/year) · (140 km/day) · (1/1.35 person) = 6.50E+06 km (4.0E+06 mi)

Table E.14.2.4 Distance Traveled in Population Zones for the Overpack and Ship Alternative

The expected injuries and fatalities resulting from transportation accidents associated with the Overpack and Ship alternative are summarized in Table E.14.2.5.

The expected number of injuries and fatalities resulting from employee vehicle accidents were calculated as follows:

Injuries = (6.50E+06 km) · (7.14E-07 injuries/km) = 4.64E+00

Fatalities = (6.50E+06 km) · (8.98E-09 fatalities/km) = 5.84E-02

Table E.14.2.5 Injuries/Fatalities Resulting from Transportation Accidents for the Overpack and Ship Alternative

The cumulative nonradiological and nontoxicological injuries and fatalities incurred as a direct result of traffic accident impacts are summarized in Table E.14.2.6. It is mostly likely there would be 4 injuries and no fatalities resulting from traffic accidents.

Table E.14.2.6 Cumulative Injuries and Fatalities from Traffic Impacts for the Overpack and Ship Alternative

E.14.3 OPERATION ACCIDENTS

The potential exists for accidents resulting from operation activities. These operations are discussed in Appendix B. The operations are separated and analyzed according to the following modes of operation:

- Pool cell storage at WESF - Cs and Sr capsules would remain stored in water-filled basins until they are transported to drywell disposal.
- Capsule overpacking at WESF - Cs and Sr capsules would be removed from the basin and sealed in overpack canisters, and stored for shipment to a potential geologic repository.

E.14.3.1 Pool Cell Storage Accident at the Waste Encapsulation and Storage Facility

The dominant pool cell storage accident at WESF is the earthquake, which was previously discussed in the No Action alternative in Section E.12.2.1 and is summarized in the following.

Source-Term - The source-term presented in Section E.12.2.1.1 resulting from the breached canisters for the noninvolved worker receptor was 1.2E-01 Ci, based on 8 hours exposure. The general public was calculated to be 3.5E-01 Ci, based on 24 hours exposure. In addition to the source-term, the loss of water shielding the capsules would result in high direct radiation doses to the receptors. It was assumed that all of the workers would die in the building from the collapsed roof.

Probability - The annual exceedance frequency of the earthquake (Section E.12.2.1.2) was 2.5E-04 per year. The Overpack and Ship alternative was based on 19 years of operations; therefore, the probability was calculated to be 4.8E-03.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.14.3.1.

Table E.14.3.1 Dose Consequence for Pool Cell Storage Accident

Radiological Cancer Risk - The LCFs calculated in Section E.12.2.1.4 are the same for the Onsite Disposal alternative; however, the LCF point estimate risk is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in TableE.14.3.2. Except for the 10 workers dying from the collapsed roof, the calculations show there would be no fatal cancers.

Table E.14.3.2 Latent Cancer Fatality Risk from Pool Cell Accident

Chemical Consequences - Chemical consequences presented in Section E.12.2.1.5 concluded there would be no exposure that would exceed the cumulative ratio of 1.0 to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.14.3.2 Overpacking Accident

The dominant overpacking accident at WESF was the crushed Sr capsule previously discussed in the Onsite Disposal alternative in Section E.13.3.2 and is summarized as follows:

Source-Term - The source-term presented in Section E.13.3.2.1 resulting from the breached canisters was 38.5 Ci.

Probability - The frequency of the accident in Section E.13.3.2.2 was 1.0E-02 per year. The Overpack and Ship alternative was based on 19 years of operations; therefore, the probability was calculated to be 1.9E-01.

Radiological Consequences - The radiological consequences presented in Section E.13.3.2.3 are reproduced in Table E.14.3.3.

Radiological Cancer Risk - The LCFs calculated in Section E.13.3.2.4 are the same for the Overpack and Ship alternative and are reproduced in Table E.14.3.4.

Chemical Consequences - Chemical consequences presented in Section E.13.3.2.5 concluded there would be no exposure that would exceed the cumulative ratio of 1.0 to ERPG-1 values for toxic or corrosive/irritant chemicals.

Table E.14.3.3 Dose Consequence from Crushed Strontium Capsule

TableE.14.3.4 Latent Cancer Fatality Risk from Crushed Strontium Capsule

E.14.3.3 Occupational Injuries and Fatalities

The number of operation personnel was estimated at approximately 1.41E+02 person-years (Jacobs 1996). The number total recordable injuries and illnesses, lost workday cases, and fatalities are calculated as follows:

Total Recordable Cases = (1.41E+02 person-years) · (2.2E+00 incidences/100 person-years) = 3.10E+00

Lost Workday Cases = (1.41E+02 person-years) · (1.1E+00 incidences/100 person-years) = 1.55E+00

Fatalities = (1.41E+02 person-years) · (3.2E-03 fatalities/100 person-years) = 4.51E-03

E.15.0 VITRIFY WITH TANK WASTE ALTERNATIVE

The Vitrify With Tank Waste alternative for Cs and Sr capsules would involve the continued operation of WESF until a HLW vitrification facility was completed. The capsules would then be removed from the basin, placed in overpacks, and transferred by truck to the HLW vitrification facility where they would be cut up and blended with the HLW from the tank farms. This section analyzes potential construction, operation, and transportation risks resulting from accidents associated with this alternative.

E.15.1 CONSTRUCTION ACCIDENTS

The construction activities associated with the Vitrify with Tank Waste alternative are discussed in Appendix B of the EIS. It should be noted there are no radiological or chemical consequences associated with construction accidents. Occupational injuries, illnesses, and fatalities resulting from potential construction accidents are calculated in the following text.

The number of construction personnel was estimated at 1.00E+02 person-years (Jacobs 1996). The number of total recordable injuries and illnesses, lost workday cases, and fatalities for the 8 years of construction are calculated using the incidence rates from Table E.1.2.1 of this Appendix as follows:

Total Recordable Cases = (1.00E+02 person-years) · (9.75E+00 incidences/100 person-years) = 9.75E+00

Lost Workday Cases = (1.00E+02 person-years) · (2.45E+00 incidences/100 person-years) = 2.45E+00

Fatalities = (1.00E+02 person-years) · (3.2E-03 fatalities/100 person-years) = 3.20E-03

E.15.2 TRANSPORTATION ACCIDENTS

Transportation activities associated with this alternative are:

- Transporting construction material from offsite to modify WESF;
- Transporting the overpacked capsules from WESF to the HLW vitrification facility;
- Transporting vitrified HLW to a national HLW repository; and
- Employees commuting to work each day.

E.15.2.1 Radiological Cancer Risk

Radiological exposures resulting from accidents during transport of the capsules to the HLW vitrification facility were analyzed (Green 1995), the methodology of the analysis is discussed in Section E.6.2.1. The results of the analysis are summarized in Tables E.15.2.1 and E.15.2.2.

It is most likely there would be no fatal cancers attributable to this exposure.

TableE.15.2.1 Integrated Radiological Impact from Accidents for the Vitrify with Tank Waste Alternative

Table E.15.2.2 Maximum Individual Radiological Impact from Accidents for Vitrify with Tank Waste Alternative

The receptor dose and LCF risk resulting from the accident analysis for transporting vitrified HLW to an offsite geologic repository is presented tn Table E.15.2.3 for the integrated population and urban population. Since the capsules could be mixed and vitrified with any of the ex situ tank remediation alternatives, Table E.15.2.3 presents the

LCF Risk for each of the alternatives.

Table E.15.2.3 Radiological Impact from Transport Accident While Transporting Vitrified HLW to a National HLW Repository

E.15.2.2 Chemical Exposure

Chemicals would be transported to the Hanford Site in support of vitrifying the Cs and Sr capsules with the tank waste. An analysis was performed to identify the hazardous chemicals that could result in the largest toxicological impacts and evaluate the toxicological impacts of the bounding scenario accidents involving the highest hazard chemicals (Green 1995). A preliminary screening analysis was performed to identify the chemicals representing the highest potential toxicological hazard. The highest hazard chemicals in terms of toxicity were determined to be nitric acid and sulfuric acid. The chemical concentrations resulting from the bounding case scenario accident at 100 m (330 ft) (3.28E+02 ft) and the frequency of the accidents as postulated (Green 1995) are summarized in Table E.15.2.4.

Table E.15.2.4 Comparison of Chemical Concentrations to Corrosive/Irritant Concentration Limits for the Capsules Alternative

Table E.15.2.5 compares the respirable concentration of the postulated chemical releases to acute exposure criteria (ERPGs) discussed in Section E.1.1.7. For the MEI general public, no ERPGs would be exceeded.

Table E.15.2.5 Comparison of Exposed Chemical Concentrations to Concentration Limits for the Vitrify with Tank Waste Alternative

E.15.2.3 Occupational Fatalities and Injuries

Table E.15.2.6 provides a summary of the expected distance to be traveled by truck to support the construction and capsule transport activities.

Table E.15.2.6 Summary of Transportation Activities for the Vitrify with Tank Waste Alternative

Construction Material Transport

There would be modifications to WESF to support overpacking operations. Construction materials would be transported by truck from the Tri Cities 70 km (43 mi) and would require an estimated 200 trips.

Capsule Transport

The 1,929 capsules would be transported by truck to the HLW vitrification facility. Capsule transport would require 184 trips. The number of injuries and fatalities are calculated by multiplying the total distance traveled in each zone, shown in Table E.15.2.7 , by the appropriate unit risk factors shown in Table E.1.3.1.

Table E.15.2.7 Distance Traveled in Population Zones for the Vitrify with Tank Waste Alternative

The expected injuries and fatalities resulting from transportation accidents associated with the Vitrify With Tank Waste alternative are summarized in Table E.15.2.8.

Table E.15.2.8 Injuries and Fatalities Resulting from Truck Accidents for the Vitrify with Tank Waste Alternative

In addition to transporting materials and supplies to and from the Hanford Site by truck, site workers and other personnel required to support the various activities will be driving to the site in their vehicles. The total person-years to support the alternative was calculated to be 241 (Jacobs 1996). Each person is assumed to work 260 days of the year. The round-trip distance traveled to work from the Tri-Cities area is estimated at 140 km (87 mi) with an estimated 1.35 passengers per vehicle (DOE 1994a).

The total personnel vehicle distance was therefore calculated as follows:

(241 person-years) · (260 days/year) · (140 km/day) · (1/1.35 person) = 6.50E+06 km (4.0E+06 mi)

The expected number of injuries and fatalities resulting from employee vehicle accidents was calculated as follows:

Injuries = (6.50E+06 km) · (7.14E-07 injuries/km) = 4.66E+00

Fatalities = (6.50E+06 km) · (8.98E-09 fatalities/km) = 5.97E-02

The cumulative noncancer injuries and fatalities incurred as a direct result of traffic accident impacts are summarized in Table E.15.2.9. It is most likely there would be four injuries and no fatalities resulting from traffic accidents.

Table E.15.2.9 Cumulative Injuries and Fatalities from Traffic Impacts for the Vitrify with Tank Waste Alternative

E.15.3 OPERATION ACCIDENTS

The potential exists for accidents resulting from operation activities. These operations are discussed in Appendix B. The operations are separated and analyzed according to the following modes of operation:

- Pool cell storage at WESF - Cs and Sr capsules would remain stored in water-filled basins until they are transported to HLW vitrification facility.
- Capsule overpacking at WESF - Cs and Sr capsules would be removed from the basin and placed in overpacks.
- Vitrification preparation - Cs and Sr capsules would be cut up and blended into the HLW from tank farms.

E.15.3.1 Pool Cell Storage Accident at the Waste Encapsulation and Storage Facility

The dominant pool cell storage accident at WESF is the earthquake previously discussed in the No Action alternative in Section E.12.2.1 and is summarized as follows:

Source-Term - The source-term presented in Section E.12.2.1.1 resulting from the breached canisters for the non-involved worker receptor was 1.2E-01 Ci based on 8 hours exposure. The general public was calculated to be 3.5E-01 Ci based on 24 hours exposure. In addition to the source-term the loss of the water shielding the capsules would result in high direct radiation doses to the receptors. It was assumed that all the workers would die in the building from the collapsed roof.

Probability - The annual exceedance frequency of the earthquake in Section E.12.2.1.2 was 2.5E-04 per year. The Vitrify with Tank Waste alternative was based on 19 years of operations; therefore, the probability was calculated to be 4.8E-03.

Radiological Consequences - The radiological consequences presented in Table E.2.2.2 are reproduced in Table E.15.3.1.

TableE.15.3.1 Dose Consequence for Pool Cell Storage Accident

Radiological Cancer Risk - The LCFs calculated in Section E.12.2.1.4 are the same for the Vitrify with Tank Waste alternative; however, the LCF point estimate risk is not the same due to the difference in probabilities. The LCFs and the LCF risk are calculated in Table E.15.3.2. Aside from the 10 workers dying from the collapsed roof, the calculations show there would be no fatal cancers.

Table E.15.3.2 Latent Cancer Fatality Risk from Pool Cell Accident

Chemical Consequences - Chemical consequences presented in Section E.12.2.1.5 concluded there would be no exposure that would exceed the cumulative ratio of 1.0 to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.15.3.2 Overpacking Accident

The dominant overpacking accident at WESF is the crushed Sr capsule previously discussed in the Onsite Disposal alternative in Section E.13.3.2 and is summarized as follows:

Source-Term - The source-term presented in Section E.13.3.2.1 resulting from the breached canisters was 38.5 Ci.

Probability - The frequency of the accident in Section E.13.3.2.2 was 1.0E-02 per year. The Vitrify with Tank Waste alternative was based on 19 years of operations; therefore, the probability was calculated to be 1.9E-01.

Radiological Consequences - The radiological consequences presented in Section E.13.3.2.3 are reproduced in Table E.15.3.3.

TableE.15.3.3 Dose Consequence from Crushed Strontium Capsule

Radiological Cancer Risk - The LCFs calculated in Section E.13.3.2.4 are the same for the Vitrify with Tank Waste alternative and are reproduced in Table E.15.3.4.

Table E.15.3.4 Latent Cancer Fatality Risk from Crushed Strontium Capsule

Chemical Consequences - Chemical consequences presented in Section E.13.3.2.5 concluded there would be no exposure that would exceed the cumulative ratio of 1.0 to ERPG-1 values for toxic or corrosive/irritant chemicals.

E.15.3.3 Vitrification Preparation Accident

Types of potential accidents associated with vitrification preparation include sprays, spills, leaks, and explosions. The DBA accident identified in Table E.15.3.5 as having the highest risk is Accident 3.3.3.1 "Cs ion exchange column explosion". It was postulated that a fully loaded ion exchange column over pressurizes and explodes.

Table E.15.3.5 Accident Screening Table for the Vitrify with Tank Waste Alternative

E.15.3.3.1 Scenario and Source-Term Development for Cesium Ion Exchange Column Explosion

It was postulated that after the column was loaded with Cs, undiluted nitric acid was inadvertently used to dilute the Cs from the column instead of diluted nitric acid. The nitric acid reacts with the resin giving off gas and heat. The gas over pressurizes the column and explodes. A 10 percent airborne release fraction was assumed. It is also assumed that the facility in which the ion exchange would be performed would be equipped with two stages of high-efficiency particulate filters with a LPF of 2.0E-06. The source-term was calculated to be 1.27E+06 Ci.

E.15.3.3.2 Probability of Cesium Ion Exchange Column Explosion

This was considered to be an unlikely event with a frequency range of 1.0E-02 per year to 1.0E-04 per year. For conservatism the frequency of 1.0E-02 was assumed for calculating risk. Based on 19 years of operation the probability was calculated to be 1.9E-01.

E.15.3.3.3 Radiological Consequence from Cesium Ion Exchange Column Explosion

The radiological dose to the receptors from the previous source-term was calculated by the GENII computer program using the methodology previously discussed in Section E.1.1.6. The results are summarized in Table E.15.3.6 (WHC 1995k).

Table E.15.3.6 Dose Consequence from Cesium Ion Exchange Column Explosion

E.15.3.3.4 Radiological Cancer Risk from Cesium Ion Exchange Column Explosion

Based on a dose-to-risk conversion factor of 4.0E-04 LCF per person-rem for the worker and noninvolved worker and 5.0E-04 LCF per person-rem for the general public, the LCF risk is calculated for the receptors in Table E.15.3.7.

TableE.15.3.7 Latent Cancer Fatality Risk from Cesium Ion Exchange Column Explosion

The calculations show there would be no fatal cancers attributable to this exposure. Because the accident would occur in a canyon and the release would be from the stack, the workers would not receive a dose.

E.15.3.3.5 Chemical Consequences from Cesium Ion Exchange Column Explosion

Chemical exposures resulting from accidents at the vitrification facility are addressed in the Ex Situ Intermediate Separations alternative in Section E.6.

E.15.3.4 Occupational Fatalities and Injuries

The number of operation personnel was estimated at approximately 1.41E+02 person-years (Jacobs 1996). The number of total recordable injuries and illnesses, lost workday cases, and fatalities are calculated as follows:

Total Recordable Cases = (1.41E+02 person-years) · (2.2E+00 incidences/100 person-years) = 3.10E+00

Lost Workday Cases = (1.41E+02 person-years) · (1.1E+00 incidences/per 100 person-years) = 1.55E+00

Fatalities = (1.41E+02 person-years) · (3.2E-03 fatalities/100 person-years) = 4.51E-03

E.16.0 VITRIFIED HLW TRANSPORT TO THE POTENTIAL GEOLOGIC REPOSITORY

Under the ex situ treatment alternatives the HLW streams would be vitrified or calcined and eventually shipped to a geologic repository assumed to be located 2,140 km (1,330 mi) offsite by a dedicated train of 10 railcars per train. The nonradiological and radiological transportation impacts associated with this activity are evaluated in this section.

E.16.1 NONRADIOLOGICAL TRANSPORTATION IMPACTS

The nonradiololgical impacts are injuries and fatalities resulting from rail accidents. The number of injuries and fatalities were calculated by multiplying the total distance traveled in each zone shown in Table E.16.1.1 by the appropriate unit risk factors shown in Table E.1.3.1. The expected injuries and fatalities resulting from transportation accidents associated with each ex situ stabilization alternative are summarized in Table E.16.1.2.

Table E.16.1.1 Distance Traveled in Population Zones

Table E.16.1.2 Injuries and Fatalities from Rail Transportation Accidents

E.16.2 RADIOLOGICAL CONSEQUENCES

Radiological exposures resulting from routine exposures and accidents while the waste is in transit were analyzed using RADTRAN 4 (Neuhauser-Kanipe 1992).

Travel fractions and population densities for the offsite rail shipments were determined using a computer code (Peterson 1985, Green 1995). For shipments to the geologic repository in the western United States, the following travel fractions were used:

- Rural population zones - The population density was assumed to be 3.4 persons/km^2 (8.8 persons/mi^2). The fraction of the route spent in rural zones was 0.936 (i.e., nearly 94 percent of the route would be rural);
- Suburban population zone - The population density was assumed to be 406 person/km^2 (1,051 persons/mi^2). The fraction of the route spent in suburban zones was 0.055; and
- Urban population zone - The population density was assumed to be 1,959 persons/km^2 (5,074 persons/mi^2). The fraction of the route spent in urban zones was 0.009.

For routine risk, the key variable in the code was the dose rate from the vehicle package. The radioactive shipments in this analysis were assumed to be less than the regulatory maximum dose rate of 10 mrem per hour at 1 m (3.3 FT) (Jacobs 1996).

For accidents, the population doses calculated by RADTRAN 4 were dependent on the accident probability, release quantities, atmospheric dispersion parameters, population distribution parameters, human uptake, and dosimetry models (Jacobs 1996).

The routine exposures were addressed as onsite population LCF risk and offsite population LCF risk. The analysis addressed radiological accident impacts as both integrated population LCF risk (i.e., accident frequencies times consequences integrated over the entire shipping campaign) and urban population LCF risk. The routine and accident LCF risks resulting from transporting vitrified or calcined HLW to a potential geologic repository are presented in Table E.16.2.1 for each of the ex situ treatment alternatives.

A main uncertainty associated with calculating the radiological doses resulting from transporting HLW to a potential geologic repository is the location of the repository. The analysis was based on the assumption that the waste would be transported to Yucca Mountain, should that site be shown to be acceptable and approved as a potential geologic repository. If Yucca Mountain should not be approved, the LCF risks could increase or decrease depending on the distance and population pathways of the alternative site.

Other uncertainties that would impact the LCF risk is the percent of the waste by weight that could be mixed with the glass matrix. To demonstrate these uncertainties, a sample scenario for the Ex Situ Intermediate Separations alternative is presented in Table E.16.2.2. The baseline analysis used in the EIS assumed a 20 weight percent waste loading. A range from the base line from as little as 15 weight percent to as much as 40 weight percent are used in the uncertainty evaluation (Jacobs 1996).

Table E.16.2.1 LCF Risk from Routine and Accident Radiological Exposures While Shipping Vitrified or Calcined HLW By Rail To A Proposed Geologic Repository

Table E.16.2.2 Uncertainty Evaluation for HLW Glass Transport - Ex Situ Intermediate Separations Alternative

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APPENDIX F

GROUNDWATER MODELING

ACRONYMS AND ABBREVIATIONS

AOI	area of interest
CFEST	Coupled Fluid, Energy, and Solute Transport
DOE	U.S. Department of Energy
DST	double-shell tank
EIS	Environmental Impact Statement
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
GIS	ARC/INFO Geographic Information System
HLW	high-level waste
K_d	distribution coefficient
LAW	low-activity waste
PEIS	Programmatic Environmental Impact Statement

PNL	Pacific Northwest National Laboratory
PUREX	Plutonium-Uranium Extraction
SALDS	State-approved land disposal site
SST	single-shell tank
TWRS	Tank Waste Remediation System
WESF	Waste Encapsulation and Storage Facility
2-D	two-dimensional

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length

cm	centimeter
ft	foot
in	inch
km	kilometer
m	meter
mi	mile

Area

ac	acre
ft^2	square foot
ha	hectare
km^2	square kilometer
mi^2	square mile

Volume

cm^3	cubic centimeter
ft^3	cubic foot
gal	gallon
L	liter
m^3	cubic meter
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard

Mass

g	gram
kg	kilogram
lb	pound
mg	milligram
mt	metric ton

Radioactivity

Ci	curie
MCi	megacurie (1.0E+06)
mCi	millicurie (1.0E-03 Ci)
µCi	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

Electricity/Energy

A	ampere
J	joule
kV	kilovolt
kW	kilowatt
MeV	million electron volts
MW	megawatt
V	volt
W	watt

Temperature

C	degrees centigrade
F	degrees Fahrenheit

F.4.0 FLOW AND TRANSPORT MODEL

The vadose zone and groundwater modeling effort used VAM2D to predict contaminant migration through the vadose zone and groundwater. VAM2D has been previously used for flow and transport assessments at the Hanford Site. The model formulation used in the code is a descendant of that used in the SATURN code presented by Huyakorn et al. (Huyakorn et al. 1984, 1985) and was developed by HydroGeoLogic Inc. (Huyakorn et al. 1991).

The approach used for this modeling effort relies as much as possible on extensive previous work completed at the Hanford Site (e.g., hydrogeological investigations and modeling studies). Understanding and being able to predict changes in the hydraulic head of the unconfined aquifer is in an advanced stage at the Hanford Site. However, contaminant transport in the unconfined aquifer and flow and contaminant transport in the vadose zone are still in relatively early stages of understanding and development. The modeling approach was as follows:

- A combined groundwater flow and transport code (VAM2D) was used.
- Hydrogeologic and contaminant transport parameters from previous studies, including Wood et al. (Wood et al. 1995), Kincaid et al. (Kincaid et al. 1993), and Wurstner and Devary (Wurstner-Devary 1993) were used in this modeling effort.
- The VAM2D flow model of the unconfined aquifer at the Hanford Site was developed based on a previously published Sitewide calibrated groundwater flow model developed with the CFEST code (Wurstner-Devary 1993). The VAM2D flow model of the unconfined aquifer was then benchmarked against these results.

Details of the approach used to test the model are provided in the following sections.

F.4.1 FEATURES OF THE VAM2D FLOW AND TRANSPORT CODE

VAM2D is a 2-D, finite element model developed for simulating saturated and unsaturated flow and transport. Using a single model code for both vadose zone and groundwater modeling simplified the combined modeling effort. VAM2D is capable of performing flow and transport simulations in vertical cross-sections as well as horizontal orientations.

The capabilities of VAM2D applicable to the TWRS EIS modeling effort include the following:

- Simulates flow and transport in saturated and unsaturated zones;
- Solves flow and transport simultaneously or sequentially;
- Accommodates a wide range of field conditions;
- Computes hysteretic effects on flow because of wetting and drying cycles; and
- Computes the effects of variable anisotropic hydraulic conductivities on flow in stratified media.

F.4.2 LIMITATIONS OF THE TRANSPORT MODEL

Limitations of VAM2D specified in the user's manual (Huyakorn et al. 1991) include the following:

- Does not simulate three-dimensional flow. However, a 2-D analysis is appropriate for the site in that there is a lower confirming bed in the Ringold Formation, and sufficient data to develop a three-dimensional flow and transport model may not be available;
- In performing variably saturated flow, the code handles only single-phase flow (i.e., water) and ignores the flow of a second phase (i.e., air or other nonaqueous phase). This is not a concern as aqueous phase liquids are not reported in site inventory;
- The code does not address kinetic sorption effects and/or reversible chemical reactions; and
- The groundwater flow portion of the model was executed for steady-state conditions. This did not allow simulation of the decay of the groundwater mounds associated with waste disposal activities.

F.4.3 RELIABILITY TESTING OF CALCULATED RESULTS

Several tests may be performed to demonstrate a model's ability to reasonably predict flow and contaminant transport. These include:

- Verification - Comparing the numerical solutions generated by the model with one or more analytical solution or with other solutions.
- Benchmarking - Testing the model solution against the solution of other models for the same problem.
- Calibration - Establishing that the model can reproduce field-measured conditions.
- Validation - Comparing model results with detailed field data.
- Parameter Sensitivity - Quantifying the uncertainty in the calibrated model caused by uncertainty in the estimates of the parameters used.

The following sections describe reliability testing performed on VAM2D for the Hanford Site.

F.4.3.1 Verification

A number of tests were performed to ensure reliability of the code on the computer platform used for the modeling effort (IBM RS/6000 workstation) and to compare results with known analytical solutions. These included the following:

- Initially verifying the model against sample problem 1 in the VAM2D User's Manual;
- Verifying results for saturated flow against an analytical solution (Dupuit solution) (Fetter 1994); and
- Verifying results for saturated transport against an analytical solution (Domenico solution [Domenico 1985]).

The sample problem results matched the results published in the VAM2D User's Manual for head, saturated value, and x-velocity. Y-velocity values differed slightly, however the differences were less than 2.0E-13. The results published in the user's manual were for VAM2D Version 5.2; Version 5.3 was used for this modeling effort.

For the flow problem to be solved with the Dupuit solution, a simple model was constructed and solved for unconfined flow with fixed head boundaries at each end and fixed across a transect. The analytical solution was calculated for several points and compared to the model results. VAM2D model results very closely matched the Dupuit solution. Results calculated by VAM2D compared to the analytical solution are provided as follows.

Distance from Left Boundry	Head Calculated by VAM2D	Head Calculated by Dupuit Solutions
12.5 m	5.844 m	5.846 m
37.5 m	4.90 m	4.981 m

For the transport problem to be solved with the Domenico solution, a simple 2-D model was constructed and solved for transient transport. A contaminant was input at one grid node and a transient model run was performed to predict contaminant concentrations for several node points at a specified point in time (300,000 days). Concentrations based on the Domenico solution were calculated for several points and compared to the model results. VAM2D model results very closely matched the Domenico solution. Results calculated by VAM2D compared to the analytical solution are provided as follows.

Grid Location		Concentration Calculated	Concentration Calculated
Delta X	Delta Y	by VAM2D	by Domenico Solution
10 m	0 m	453.3 mg/L	455.71mg/L
20 m	5 m	85.08 mg/L	83.15 mg/L

30 m	0 m	270.5 mg/L	273.13.73 mg/L71mg/L
40 m	10 m	14.60 mg/L	

F.4.3.2 Benchmarking

The groundwater flow model effort was developed and benchmarked as follows:

- Unconfined aquifer flow parameters and boundary conditions used to set up the VAM2D model were developed from published groundwater flow modeling work using CFEST (Wurstner-Devary 1993). This effort has undergone verification, calibration, and quasi-validation efforts, which were initiated in the mid-1960's.
- VAM2D predictions of hydraulic head were compared to these published CFEST results (Wurstner-Devary 1993). Basic differences in the model input requirements and the grid used required minor adjustments, primarily to boundary discretization, to obtain a closer match.

Figure F.4.3.1 shows both the published results from prior model development and the hydraulic heads calculated with the VAM2D model. As expected, this figure indicates good agreement between the VAM2D results and the previously published results.

F.4.3.3 Calibration

Calibration of a groundwater model consists of comparing its results to an independent standard. Changing flow conditions at the Hanford Site make an absolute calibration infeasible. However, a qualitative calibration can be performed. This qualitative calibration begins by examining the geometry of a tritium plume that is present on the Hanford Site and estimating tritium travel times from the 200 East Area to the Columbia River. Contaminants originating from the 200 East Area are estimated to take approximately 20 to 25 years to reach the Columbia River. The estimated travel time is based on site operations beginning in the 1940's and detection of contaminants in springs and groundwater in the 1970's.

In this qualitative calibration effort, the VAM2D model was used to simulate a contaminant concentration of 200,000 mg/L source originating from B Pond in the 200 East Area. Discharge fluid fluxes were based on 1979 data, and the transient transport simulation was based on the steady-state field (also based on 1979 data). Figure F.4.3.2 provides estimates of tritium levels observed in groundwater based on 1977 environmental monitoring (Meyers 1978). Figure F.4.3.3 provides the 300 mg/L isoconcentration lines for tritium at 10, 20, and 30 years, assuming this constant discharge rate. Figure F.4.3.3 demonstrates that the travel times calculated by VAM2D correspond well with the assumed 20- to 25-year travel time. Additionally, the plume geometry for the tritium plume originating from the 200 East Area (Figure F.4.3.2) is similar to the predicted plume geometry (Figure F.4.3.3). An exact match between these two plumes should be not expected because discharge amounts varied substantially over time, and the observed tritium plume (Figure F.4.3.2) was created by multiple sources. However, similarities between the two plume geometries indicate that the VAM2D results are reasonable.

F.4.3.4 Validation

Validating a groundwater model consists of comparing model results with detailed field data. However, rigorous validation requires accurate historic data on effluent discharges as a function of time.

Although data are available on flow and transport within the unconfined aquifer, the data set is not sufficient to perform a detailed model validation. Flow conditions have changed dramatically since the early 1940's, primarily as the result of changes in wastewater discharges. Historic records of effluent amounts and water quality have not been maintained since that time in sufficient detail to perform a rigorous validation of flow and transport in the unconfined aquifer.

F.4.3.5 Parameter Sensitivity

Parameter sensitivity was investigated for the following areas:

- The effect of higher glass surface areas for the In Situ Vitrification alternative;
- The effect of changing the performance period of the Hanford Barrier from 1,000 to 500 years;
- The effect of the decay of the potentiometric head resulting from groundwater mounding due to discharge to the Hanford Site ponds;
- The effect of variations in filtration rate; and
- The effect of variations in distribution coefficient (K_d).

The approach and conclusion from these investigations are provided in Volume Five, Appendix K.

F.4.4 MODELING ASSUMPTIONS AND UNCERTAINTIES

This appendix provides the basis of potential groundwater impacts associated with each of the TWRS alternatives. Developing the groundwater assessments provided in this appendix required several assumptions to uncertainties of some of the data. The major assumptions and uncertainties are related to either the natural system (i.e., an understanding and ability to assign vadose zone and aquifer parameter values) or uncertainties inherent to the assessment approach.

The most important assumptions and uncertainties are as follows:

- The rates of infiltration into natural ground and through a cap;
- Distribution coefficient (K_d) of contaminants;
- Uncertainty in future groundwater flow direction due to decay of groundwater mounds onsite;
- Uncertainty in future groundwater flow direction and vadose zone thickness due to climate change;
- Uncertainty in vadose zone transport due to use of one-dimensional flow and transport simulation; and
- Uncertainty due to calculation of releases during retrieval.

The basis for these assumptions and their potential impact on the alternatives is provided in Volume Five, Appendix K.

F.4.5 CONCEPTUAL GROUNDWATER CUMULATIVE IMPACTS

This section addresses potential cumulative groundwater impacts of other past and projected future waste disposal activities. The activities that may have a cumulative impact on the TWRS alternatives are as follows :

- Past-practice waste disposed of to the ground as liquid;
- Past leaks from waste tanks;
- Past-practice waste disposed of to the ground as solid;
- Solid low-level radioactive waste to be disposed of in the Environmental Restoration Disposal Facility (ERDF);
- Solid low-level radioactive waste to be disposed of in the 200 West Area burial grounds; and
- Solid low-level radioactive waste to be disposed of in the US Ecology burial grounds.

These activities result in both near-term and long-term groundwater impacts. The near-term impacts are in response to past-practice liquid waste disposal to the ground. Large volumes, over 1.29E+12 L (3.40E+11 gal) in the 200 Areas, containing radionuclides and hazardous chemicals have been discharged to the ground surface or subsurface since 1944 (Wodrich 1991). Long-term groundwater impacts are associated with 1) leaching of solid waste disposed of to the ground in the 200 Areas and on the Central Plateau (Wood et al. 1995), and with 2) the relatively low-volume leaks from the waste tanks, as compared with volumes discharged to cribs and ponds. It is assumed that all of these disposal activities, except for the past-practice liquid disposal, would have some cumulative impact with respect to the TWRS activities. Quantitative information, such as would be developed for a performance assessment, on the fate of current contaminant plumes resulting from past-practice liquid waste disposal is not available; however, the following discussion suggests these contaminants will not interact with groundwater contaminant plumes associated with the TWRS alternatives.

Potential cumulative impacts with respect to contaminants C-14, I-129, Tc-99, and uranium are provided in the following sections for each of the solid waste disposal facilities. These contaminants were chosen for comparison because they have high mobility in the Hanford vadose zone and groundwater, have been routinely monitored in the groundwater, and have been identified as contributing much of the tank waste-related risk.

F.4.5.1 Past-Practice Liquid Waste Disposal

Liquid waste disposal has resulted in extensive groundwater contamination in the 200 Areas as well as downgradient toward the Columbia River. Information on specific contaminants disposed of to ground surface or subsurface is limited to only a few key constituents including nitrate and radionuclides with half-lives greater than 10 years and in quantities large enough to be of concern in waste disposal and cleanup (Wodrich 1991). These radionuclides are Sr-90/Y-90, Cs-137, Tc-99, I-129, uranium, Am-241, and plutonium. Table F.4.5.1 provides a comparison of the inventories estimated for the past-practice liquid and solid waste disposal, past waste tank leaks, and TWRS tank waste. Quantitative estimates of contaminant concentration in groundwater with an acceptable degree of uncertainty from past-practice liquid waste disposal activities are not possible using available information. Key information that is not available includes definition of the multiple source terms (e.g., waste volume, contaminant concentration, release duration) and residual waste remaining in the vadose zone. A semi-quantitative approach coupled with some qualitative assumptions is used because of these limitations.

The past-practice liquid waste disposal impacts on groundwater are believed to be ongoing and would be greatly reduced by the time the TWRS alternatives would potentially impact groundwater. Thus, they are considered near-term impacts. These conclusions are based on several assumptions and on observations of groundwater contaminant concentration trends discussed later in this section. The assumptions are as follows:

- Present groundwater contaminants, concentration levels, and distribution in the 200 Areas and downgradient are a result of the past-practice liquid disposal in the 200 Areas.
- All liquid waste disposal to the ground at previously used waste disposal facilities (e.g., cribs, trenches, drains, and reverse wells) has been stopped or will be stopped by the year 2000.
- There will be no new ground disposal of radioactive or hazardous chemical-containing liquids, except for tritium.
- The remediation alternative for the past-practice liquid waste disposal sites will be installation of caps by the year 2005.
- Less mobile contaminants in the past-practice liquid waste may contribute to the cumulative impact but are not considered at this time.

Given these assumptions, the present concentrations of highly mobile contaminants in groundwater such as tritium, Tc-99, I-129, nitrate, and to a lesser extent, uranium currently would be experiencing a large reduction in concentration that would continue for less than 10 years, followed by many years where the contaminant concentration in groundwater diminishes at a much slower rate. Change in uranium concentrations in well 299-W19-18 is an example of this process. This well is located in the 200 West Area adjacent to the inactive 216-U-1 and 216-U-2 cribs. The uranium concentration in this well has reduced at a uniform rate of approximately 3,000 µg/L for a 2 to 3-year period since remediation of the cribs in 1988 (Woodruff-Hanf 1993). By the end of 1992, the uranium concentration in this well was approximately 750 µg/L and the rate of reduction had dropped to approximately 80 ug/L/yr. The rate of concentration reduction is expected to continue to decline but at a very slow rate such that the uranium concentration at this well would appear to become constant at some low level. This level is not known and is assumed to be inconsequential by the time contaminants from the tanks arrive at the groundwater. This early reduction in concentration also is observed for tritium in observation well 699-24-33 (Woodruff-Hanf 1993).

In the performance assessment for the low-level waste burial grounds in the 200 West Area (Wood et al. 1995), it is concluded that mixing of the present day plume with that from the burial grounds is unlikely. These burial grounds include disposal sites with and without caps, thus times to peak groundwater contaminant concentrations range from approximately 125 to 1,000 years from present. The performance assessment presents the following discussion to support this conclusion. First, the particle velocity in the unconfined aquifer, on the order of 10 m/yr, would result in the migration of the present plume a few hundred meters over a few decades (Wood et al. 1995). Secondly, additional plume generation is unlikely because liquid discharge nearly has ceased, and it is likely that only very small quantities of the mobile radionuclides such as Tc-99, C-14, and I-129 remain in the present soil column. Other less mobile radionuclides are present in the soil column. They are believed to be short-lived (Wood et al. 1995) and would decay to inconsequential quantities before reaching the unconfined aquifer.

Of all the TWRS alternatives, the No Action and Long-Term Management alternatives have the earliest potential groundwater impact. First arrival of contaminants to the groundwater has been estimated to occur at about 140 years for these alternatives. Estimated first arrival of contaminants to groundwater for the other alternatives ranges from approximately 1,070 years for the ex situ alternatives to 2,330 years for the in situ alternatives. Cumulative impacts with respect to past-practice liquid disposal likely would be very low for the ex situ and in situ alternatives and, with a larger degree of uncertainty, is assumed to be very low for the No Action and Long-Term Management alternatives.

F.4.5.2 Past Leaks From the Single-Shell Tanks

Liquid waste from past tank leaks has resulted in vadose zone contamination beneath the leaking tanks and may be impacting the groundwater in the vicinity of the tanks. Potential groundwater impacts are currently being investigated as part of Resource Conservation and Recovery Act (RCRA) Groundwater Assessments for the T Farm Waste Management Area and will be ongoing soon for the S-SX and B-BX-BY Waste Management Areas.

Past SST tank leaks are considered to result in long-term groundwater impacts (compared to impacts from liquid waste disposal discussed in Section F.4.5.1) because the leak volume was, for the most part, insufficient to immediately flush the contaminants all the way through the vadose zone and into the underlying groundwater. Under current conditions (e.g., no cap over the tanks), impacts to the underlying groundwater are expected to occur over a period similar to that predicted for the No Action alternative, which is approximately 300 years. Groundwater impacts from past tank leaks would be expected to begin soon and may already be occurring because contaminants from the leaks are likely distributed vertically in the vadose zone from the tank bottoms to near the water table. A bounding approach is used to the extent practicable to estimate potential impacts from past waste tank leaks. The leak volume is taken as the upper range of the cumulative leak volume as provided in the inventory and surveillance reports (Hanlon 1996). The release to the groundwater is assumed to be analogous to release to the groundwater in the No Action alternative. Provided in the following discussion are the estimated leak volume, radioisotope content of the leaks, and the potential impact of the leaks on groundwater.

Leak monitoring is ongoing for the 177 waste tanks, and reports on waste inventory and surveillance are released monthly and quarterly. The report for the month ending February 29, 1996 (Hanlon 1996) indicates that 67 of the 149 SSTs are assumed leakers. There are no reported leaks from the 28 DSTs. The tank identification number, date tank was declared leaker, estimated leak volume, estimated activity of leak, and date the tank was stabilized are provided in Table F.4.5.2. The range of leak volume is from approximately 1,300 L (350 gal) from tank 241-C-204 in the 200 East Area to 436,000 L (115,000 gal) from tank 241-T-106 in the 200 West Area. Total leak volume from all 67 assumed leakers ranges from 2.30E+06 to 3.4E+06 L (600,000 to 900,000 gal). Interim stabilization has been completed on all but five assumed leaking tanks.

The monthly tank waste and surveillance reports (Hanlon 1996) provide a estimated range of Cs-137 associated with the waste tank leaks. However, quantitative estimates of radioisotopes such as Tc-99, C-14, I-129, and U-238 in the liquids that leaked from the waste tanks are not available. The activities of Tc-99 and uranium (assumed to be U-238) isotopes that would have been released with the tank leaks were estimated based on the total and isotopic activity of liquid waste disposal in the 200 Areas (including waste tank leaks) (Wodrich 1991). These estimates, provided in Table F.4.5.2, include an upward adjustment to account for the upper bound of leak volume of 3.4E+06 L (900,000 gal). (Hanlon 1996). The amount or activity of nitrate and C-14, respectively, was estimated based on the 3.4E+06 L (900,000 gal) cumulative leak volume and the concentration of each contaminant in the tanks as shown on Table F.2.2.14. Nitrate is assumed to have a concentration of 3.6E+02 g/L in all the tanks. The concentration of C-14 varies from tank to tank, therefore, the maximum concentration in any one SST source area was used, which was 6.74E-05 g/L in source area 2ESS. The estimated past leak quantities for these constituents are provided in Table F.4.5.2.

The potential impacts to groundwater are provided for waste tank leaks in terms of maximum potential concentration of four critical isotopes. These estimated values are provided in Table F.4.5.3. The estimated maximum concentrations of the selected contaminants in groundwater range from approximately 1 percent (for nitrate) to 25 percent (for U-238) of the maximum predicted values for the No Action alternative.

F.4.5.3 Past-Practice Solid Waste Disposal

Quantitative estimates of contaminant concentration in groundwater with an acceptable degree of uncertainty from past-practice solid waste disposal activities is not possible with the present available information. As with past-practice liquid waste disposal, key information not available includes definition of the multiple source terms (e.g., waste volume, contaminant concentration, release duration). A semi-quantitative approach is used because of these limitations.

The approach is based on the premise that the potential impacts from the In Situ Fill and Cap alternative can be used as an analog for estimating impacts from past-practice solid waste disposal. This estimate is conservative given the following major assumptions.

- The remediation alternative for the past-practice solid waste disposal sites will be installation of caps by the year 2005.
- The inventory of past-practice solid waste is in proportion to the distribution of waste in the tanks.

Contaminants from past-practice solid waste disposal would be expected to reach the groundwater at approximately the same time as contaminants from the In Situ Fill and Cap alternative, given the previous assumptions. Based on the ratio of estimated past-practice solid waste disposed to waste in tanks for C-14 and uranium (Table F.4.5.2), a factor of 1.2 is used to adjust the calculated groundwater concentrations upward from the In Situ Fill and Cap alternative. This is a semi-quantitative approximation of the potential impacts of the past-practice solid waste disposal. Table F.4.5.3 provides the potential maximum groundwater concentrations for Tc-99, I-129, C-14, and uranium. Maximum groundwater impacts of the past-practice solid waste disposal activities would occur at approximately 5,000 years based on the In Situ Fill and Cap alternative analog.

F.4.5.4 Solid Low-Level Radioactive Waste Disposal in the Environmental Restoration Disposal Facility

The proposed ERDF is a deep-lined trench disposal facility for the waste generated by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 cleanup activities. The ERDF will be located adjacent to the southwest corner of the 200 West Area. The waste will be disposed of primarily in bulk noncontainerized form and is anticipated to consist primarily of contaminated soils and concrete rubble (Wood et al. 1995a). There are currently two principal documents that provide calculated groundwater dose information: the Remedial Investigation and Feasibility Report for the Environmental Restoration Disposal Facility (DOE 1994h) and the Environmental Restoration Disposal Facility Performance Assessment (Wood et al. 1995a). The performance assessment (PA) was used herein as the basis for potential ERDF inventory and groundwater contaminant concentrations because the approach taken in the PA is similar to that used to calculate groundwater impacts from the TWRS waste tanks.

The projected ERDF inventory for Tc-99, I-129, C-14, and uranium is provided in Table F.4.5.2 (Wood et al. 1995a). The PA provides calculated groundwater drinking dose estimates for these radionuclides based on consumption of 730 L/yr (193 gal/yr). The maximum groundwater concentration for these radionuclides is calculated from the maximum dose using the drinking water consumption rate assumed in the PA and the DOE internal dose factor (Wood et al. 1995a).

Using Tc-99 as an example, the maximum groundwater concentration is calculated as follows. The reported maximum drinking water dose is 0.007 mrem/yr (Wood et al. 1995a) and the DOE internal dose factor for Tc-99 is 1.3E-06 mrem/pCi (Wood et al. 1995a). The maximum groundwater concentration of Tc-99 is calculated by dividing the reported maximum dose of 0.007 mrem/yr by the consumption rate of 730 L/yr (193 gal/yr) and the internal dose factor of 1.3E-06 mrem/pCi. This results in a maximum Tc-99 concentration in groundwater of 7.38 pCi/L. This maximum concentration would occur at approximately 1,500 years from present, assuming a K of zero and d

infiltration rate of 0.5 cm/yr (0.2 in./yr) (Wood et al. 1995a). Calculated maximum groundwater concentrations for Tc-99, I-129, C-14, and uranium are provided in Table F.4.5.3.

F.4.5.5 Solid Low-Level Radioactive Waste Disposal in the 200 West Burial Grounds

The 200 West low-level waste burial grounds consist of shallow (5 to 10 m deep [16 to 33 ft]), unlined trenches of variable widths (3 to 10 m wide [10 to 33 ft]), and lengths (50 to 100 m long [160 to 330 ft]). Potential groundwater impacts have been calculated in the Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds (Wood et al. 1995). This performance assessment examines the potential groundwater impacts from disposal of waste in two different facility types. The first, called a Category 1 waste facility, is assumed to have no functional barriers (e.g., cap) and is intended to contain very low concentrations of radionuclides. The other facility is called a Category 3 waste facility and is assumed to have a cap that controls infiltration to the same degree as the natural soil and vegetative system (Wood et al. 1995). Radionuclide inventory for each waste category is provided in Table F.4.5.2.

The maximum groundwater contaminant concentration for Tc-99, I-129, C-14, and uranium was calculated as described in Section F.4.5.3 and is provided in Table F.4.5.3.

F.4.5.6 Solid Low-Level Radioactive Waste Disposal in the US Ecology Burial Grounds

The US Ecology Burial Grounds is a commercial low-level waste disposal facility located on the Central Plateau just southwest of the 200 East Area and approximately 4 km (2.5 mi) east of the 200 West Area. Radionuclide inventory and maximum groundwater concentrations for Tc-99, I-129, C-14, and uranium were estimated for the US Ecology site at closure (Jacobs 1996). These values are based on preliminary estimates of future solid radioactive waste emplacement at the site. The estimates assume closure of the facility in about the year 2063. The inventory and maximum groundwater concentrations are provided in Tables F.4.5.2. and F.4.5.3, respectively.

F.4.6 Groundwater Impacts for Nominal Case

The preparation of the groundwater impacts assessment required numerous assumptions concerning not only the subsurface conditions that affect fate and transport through the vadose zone and unconfined aquifer but also the contents of the waste tanks and the release of waste during remediation. Bounding assumptions were used that would result in calculations of impacts than would be conservative compared to impact results based on average or nominal assumptions. This section provides calculated groundwater impacts for nominal estimates of waste tank releases for a scenario modified from the Ex Situ Intermediate Separations alternative. All other approaches and assumptions relative to fate and transport in the vadose zone and groundwater are the same as were used for calculating the groundwater impacts for the Ex Situ Intermediate Separation alternative summarized in Section F.3.5.

F.4.6.1 Nominal Case Source Term

The source term for this scenario is a result of releases from SSTs during waste retrieval, releases from the residuals in SSTs and DSTs, and releases from the LAW vaults. Only the long-term mobile risk contributing contaminants are considered for this scenario. These contaminants are I-129, C-14, Tc-99, and U-238. The grouping of these contaminants is the same for the base case Ex Situ Intermediate alternative scenario except for Np-237. The base-case Ex Situ Intermediate Separations alternative includes Np-237 with the above group of long-term mobile risk contributing contaminants. There is a large uncertainty surrounding the mobility of Np-237 in the Hanford Site vadose zone and unconfined aquifer and for the bounding impact analyses, it was conservatively placed in K_d group 1 (K_d = 0), which means that Np-237 would move at the same rate as the water in the vadose zone and underlying aquifer. For the nominal case scenario, Np-237 is assumed to have a K_d of 1 mL/g. In the following, a discussion of each of the three potential sources for the nominal case scenario is provided.

Released During Waste Retrieval

As with the bounding scenario for the Ex Situ Intermediate Separations alternative, retrieval releases only occur from the SSTs. The DSTs are assumed to have no releases during retrieval. Retrieval occurs over a 15-year period and the work is assumed to be ongoing at all eight of the source areas during this period. The infiltration scenario is the same as that assumed for the Ex Situ Intermediate Separations alternative, where it would decrease to 0.5 cm/yr (1.36E-05 m/day) for a 29-year period (15-year period of waste retrieval followed by a construction period or 14-years) from 5.0 cm/yr (1.36E-04 m/day). Infiltration through the Hanford Barrier at the end of construction is assumed to be 0.05 cm/yr (1.36E-06 m/day) for a 1,000-year period. It is assumed to double to 0.10 cm/yr (2.74E-06 m/day) after the 1,000-year period and remain at that level for the remainder of the period of interest.

The assumed release volume of 15,000 L (4,000 gal) per SST is retained for this scenario. For the nominal case, the contaminant concentration in the retrieval releases is two-thirds of the concentrations assumed for the Ex Situ Intermediate Separations alternative. The contaminants released during retrieval, their estimated mass and concentrations are provided in Tables F.4.6.1 and F.4.6.2. For this analysis, only the long-term risk contributors Tc-99, I-129, C-14, and U-238 are considered.

Releases from Waste Tank Residuals

The bounding scenario for the Ex Situ Intermediate Separations alternative incorporates an assumption that 1 percent of initial total tank waste remains after retrieval as a residual. This assumption does not account for recovery of the more soluble constituents during hydraulic retrieval. For the nominal case scenario, mobile soluble constituents in the residual inventory for the base case Ex Situ Intermediate Separations alternative are reduced, based on sludge wash factors reported in WHC-EP-0616. The residual inventory, concentration, and duration of release for the long-term risk contributors are provided in Table F.4.6.3, F.4.6.4, and F.4.6.5, respectively.

Releases from the LAW vaults

The releases from the LAW vaults for this scenario have not been modified from the bounding Ex Situ Intermediate Separations alternative because their contribution to overall risk in very small. The LAW vault inventory and initial contaminant concentrations are provided in Table F.2.2.6 and F.2.2.19, respectively.

F.4.6.2 Calculated Impacts for the Nominal Case Scenario

The calculated maximum contaminant concentrations from tank sources (i.e., waste released during retrieval from SSTs and residual waste released from SSTs and DSTs) are provided in Table F.4.6.5. Maximum calculated contaminant concentrations from the LAW vault sources are the same as were calculated for the Ex Situ Intermediate Separation Alternative LAW vault sources (Table 3.5.2).

The calculated concentrations from tank sources are lower than calculated concentrations for the Ex Situ Intermediate Separations alternative tank sources (Table F.3.5.1), as would be expected. Absent from this scenario is the impact of Np-237 because with a K_d of 1 mL/g, its movement in the vadose zone is sufficiently retarded such that it does not reach the unconfined aquifer within the 10,000-year period of interest. Provided in Volume Three, Appendix D, are the calculated risk values based on the nominal case groundwater concentrations.

FIGURES:

TABLES:

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APPENDIX G

AIR MODELING

ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
DST	double-shell tank
EPA	U.S. Environmental Protection Agency
HLW	high-level waste
ISC2	Industrial Source Complex Model
ISCLT2	long-term ISC2
ISCST2	short-term ISC2
LAW	low-activity waste
TWRS	Tank Waste Remediation System
WAC	Washington Administrative Code
WESF	Waste Encapsulation and Storage Facility

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length

cm	centimeter
ft	foot
in	inch
km	kilometer
m	meter
mi	mile

Area

ac	acre
ft^2	square foot
ha	hectare
km^2	square kilometer
mi^2	square mile

Volume

cm^3	cubic centimeter
ft^3	cubic foot
gal	gallon
L	liter
m^3	cubic meter
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard

Mass

g	gram
kg	kilogram
lb	pound
mg	milligram
mt	metric ton

Radioactivity

Ci	curie
MCi	megacurie (1.0E+06 Ci)
mCi	millicurie (1.0E-03 Ci)
Ci	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

Electricity/Energy

A	ampere
J	joule
kV	kilovolt
kW	kilowatt
MeV	million electron volts
MW	megawatt
V	volt
W	watt

Temperature

C degrees centigrade

F degrees Fahrenheit

G.1.0 INTRODUCTION

This appendix describes the air dispersion modeling that was performed to assess the impacts on air quality resulting from normal operations associated with the various Tank Waste Remediation System (TWRS) alternatives. The analyses were conducted to accomplish the following objectives:

- Compare the analyzed impacts of potential criteria pollutant releases against National Ambient Air Quality Standards and applicable Washington State regulations;
- Compare the analyzed impacts of emissions of toxic and hazardous air pollutants against applicable Washington State regulations; and
- Compare the analyzed impacts of emissions of radionuclides against applicable Washington State and Federal standards.

The following sections describe the proposed Hanford Site TWRS alternatives and discuss the dispersion models used in the analyses. The remaining sections describe the methodology of the modeling approach, the data used as input to the model (meteorology, source, and receptor parameters), and the results of the modeling effort.

G.2.0 DESCRIPTION OF ALTERNATIVES

The remedial alternatives are broadly separated into those activities related to remediating the tank waste, and those activities involving remediation of the cesium (Cs) and strontium (Sr) capsules. The following alternatives were studied:

- Tanks Waste Alternatives
  - No Action - The waste would be maintained in the existing tanks.
  - Long-Term Management - The double-shell tank (DST) waste would be transferred to newly constructed DSTs. The tanks would be replaced twice, at 50-year intervals.
  - In Situ Fill and Cap - Waste would be disposed of in situ by filling the tanks with gravel and placing a Hanford Barrier over them to inhibit infiltration of rain water or human intrusion.
  - In Situ Vitrification - The waste contained in the existing storage tanks would be vitrified in-place.
  - Ex Situ Intermediate Separations - The tank waste would be separated into high-level waste (HLW) and low-activity waste (LAW) and the waste vitrified. The LAW would be disposed of onsite in subsurface vaults, and the HLW would be shipped offsite for disposal at the potential geologic repository.
  - Ex Situ No Separations - Under the vitrification option, the waste would be immobilized as glass cullet. Under the calcination option, the waste would be treated at temperatures below those required for vitrification, with a resulting dry-powder waste form. All of the treated waste would be shipped offsite for disposal at the potential geologic repository.
  - Ex Situ Extensive Separations - This is an extension of the Ex Situ Intermediate Separations alternative. The difference is that waste would undergo a more extensive series of processing steps that would result in a smaller volume of HLW and a larger volume of LAW. Vitrification and disposal activities would be similar to those in the Ex Situ Intermediate Separations alternative.

- Ex Situ/In Situ Combination 1 and 2 - These alternatives are a combination of the Ex Situ Intermediate Separations alternative and the In Situ Fill and Cap alternative. Waste would be retrieved from 70 tanks (Combination 1) or 25 tanks (Combination 2) , separated into LAW and HLW, and vitrified. The LAW would be disposed of onsite in LAW vaults, and the HLW would be shipped offsite for disposal at the potential geologic repository. The remainder of the tanks (107 under Combination 1 and 152 under Combination 2) would undergo fill and cap, as described for the In Situ Fill and Cap alternative.
- Phased Implementation - For the first phase of this alternative, two demonstration vitrification facilities would be built and operated. One facility would treat LAW, while the other would separate and treat LAW and HLW streams. For the second phase of this alternative, the facilities from the first phase would continue to operate and large-scale facilities would be built to separate the tank waste into HLW and LAW. The LAW would be disposed of onsite in subsurface vaults, and the HLW would be shipped offsite for disposal at the potential geologic repository.

- Cesium and Strontium Capsules Alternatives
  - No Action - The capsules would be maintained in the Waste Encapsulation and Storage Facility (WESF).
  - Onsite Disposal - The capsules would be transferred from their existing location to a newly constructed drywell storage facility.
  - Overpack and Ship - The capsules would be retrieved from their existing location, transferred to a newly constructed repackaging facility, repackaged, and transferred to a storage location pending future disposal at the potential geologic repository.
  - Vitrify with Tank Waste - The capsules would be retrieved, and the contents would be vitrified along with the HLW.

G.2.1 SOURCE IDENTIFICATION AND CHARACTERIZATION

Reviewing available data resulted in identifying several locations and processes expected to emit air pollutants (WHC 1995c, j, n, and Jacobs 1996). The following discussion describes the location and nature of each of these sources. Section G.2.2 details the manner in which these sources were grouped to analyze each alternative. Section G.3.1.2 discusses the emission rates assigned to each source for each alternative.

Pollutant emitting activities were depicted as either area sources or point sources in the dispersion models. Area sources are used for simulating emissions that exist in a known area of activity, especially if the exact source locations are unknown or are expected to move from time to time. In other words, the emissions occurring within the area need not be uniform over space or time. Area sources are defined in the model as square areas and are assigned an areal emission rate (typically specified as grams per square meter per second [$g/m^2/s$]). In this study, the area sources were chosen to include the area in which most of the emissions from a particular operation or grouping of sources would be expected to occur.

Point sources are used for simulating the emissions from sources that are expected to remain in a fixed location and are vented through a stack. The models consider the effects of elevated release heights, building downwash, release temperature, and release velocity when calculating predicted concentrations from point sources. Figure G.2.1.1 shows the source locations used in the modeling scenarios.

Tank Farms

Area sources were used to represent logical groupings of tanks and tank farms. Locations of all sources for all alternatives are shown in Volume Two, Appendix B. Eleven such groupings (identified as TF1E through TF11E) were assigned to tanks in the 200 East Area, while six groupings (TF1W through TF6W) were assigned to the tanks in the 200 West Area. Air emissions that are assumed to occur in these areas include:

- Vehicular emissions associated with construction activities at these sites; and
- Emissions of radiological and nonradiological components from the tanks for all alternatives during continued operations, retrieval, and gravel filling operations.

Waste Retrieval Annex Areas

As part of the ex situ alternatives, the Ex Situ/In Situ Combination 1 and 2 alternatives, and the Phased Implementation alternative, waste transfer annexes would be constructed to collect and distribute the waste retrieved from the tanks. Two such facilities (identified as TA1E and TA2E) are expected to be constructed in the 200 East Area, while three facilities (TA1W, TA2W, and TA3W) would be constructed in the 200 West Area. All annexes would be the same size, except the facility identified as TA2W, which would be larger and also serve as a waste sampling facility.

Although no emissions would be expected to result from operating these facilities, vehicular emissions and fugitive dust would be produced during their construction. These sources were depicted as area sources in the dispersion models.

Concrete Batch Plant

A concrete batch plant would be constructed to support construction activities. For each model scenario, the batch plant was assumed to have sufficient capacity to support the remediation activities. For the purpose of impact assessment, this batch plant was assumed to be located between the 200 Areas. The emissions from this process were modeled as an area source (identified as BTCH).

Figure G.2.1.1 Emission Source Locations

Process Facilities and Tank Farm Construction

Emissions from constructing the processing facilities related to the ex situ and Ex Situ/In Situ Combination 1 and 2 alternatives would include vehicle exhaust emissions and fugitive dust released during earthmoving operations. A single area source (identified as PROC) centered on and equal in size to the disturbed area (80 hectares [ha] [200 acres (ac)]) expected for constructing the process facilities for the Ex Situ Intermediate Separations alternative was used to model these emissions. Bounding case construction emissions related to constructing retrieval equipment at the tank farm locations were modeled as an area source at the tank farm designated TF6W.

For the first phase of the Phased Implementation alternative, two processing facilities would be constructed. Emissions associated with this activity would include vehicle and heavy equipment exhaust emissions and fugitive dust releases. A single area source (FCPI), which encompasses the locations of both plants, was used to model these emissions. In addition, particulate matter emissions from the Pit 30 site (BTCH) would occur.

During the second phase of this alternative, large-scale facilities would be constructed to treat the remainder of the tank waste. Emissions would come from constructing the five waste transfer annexes, process facilities, and a concrete batch plant. Emissions from erecting retrieval equipment at the tank farms would occur simultaneously.

Borrow Site Excavation

For the In Situ Fill and Cap alternative, particulate matter emissions would result from the use of heavy equipment to excavate and transport borrow materials from Pit 30, which is located between the 200 East and 200 West Areas at the same location as the concrete batch plant (BTCH).

For all tank waste alternatives except the No Action alternative, excavation of borrow materials from the Vernita Quarry and McGee Ranch would result in similar particulate matter emissions. These emissions would be associated with installing post-closure barriers over the tank farms. Because of a lack of data concerning these operations, specific emissions estimates and modeling were not performed. However, any such operations would include appropriate control measures (such as using surfactants and water spray procedures) that would result in compliance with Federal and State air quality standards.

Process Facilities Operation

Essentially all the emissions during the processing operations for the ex situ alternatives and the Ex Situ/In Situ

Combination 1 and 2 alternatives would occur through the main processing facility stacks. The LAW and HLW processing facilities stacks for the Ex Situ Intermediate Separations alternative were designated as ST-L and ST-H, respectively. The Ex Situ No Separations alternative would have one stack, identified as SMIN. Although two plants would operate in the Ex Situ Extensive Separations alternative scenario, emissions from both plants would be routed through a common stack, designated as ESEP. Processing facilities for the Ex Situ/In Situ Combination 1 and 2 alternatives would be similar to, but with less capacity than, facilities for the Ex Situ Intermediate Separations alternative. Because stack locations and release parameters are expected to be similar, these stacks were modeled using sources ST-L and ST-H. All stacks were modeled as point sources.

Emissions from the vitrification processing facilities that would be constructed for the Phased Implementation alternative would be routed through stacks. The stack for the Phase 1 LAW processing facility was designated as SSPI, while the Phase 1 combined LAW/HLW processing facility stack was designated as NSPI. The stacks for the Phase 2 full-scale LAW processing facilities were designated as ST-L1 and ST-L2. The full-scale processing facility stack was designated as ST-H. All stacks were modeled as point sources.

In Situ Vitrification Process Stacks

During vitrification operations for the In Situ Vitrification alternative, off-gases would be treated and released through one process stack per tank farm. Although two tanks from a single tank farm would be vitrified simultaneously, it was assumed that emissions from both vitrified tanks would be discharged from a single stack. The facility location that would produce the highest impact (in association with the construction emissions) was identified to be at the tank farm location known as TF6W. A point source (identified as IS6W) was used to model emissions from the process stack.

Drywell Storage Facility

A Drywell storage facility would be constructed as part of the Onsite Disposal alternative for the Cs and Sr capsules. The emissions resulting from the construction of this facility are represented as an area source identified as DWSF. No emissions were assumed to result from the operations phase of this alternative.

Capsule Packaging Facility

The capsules Overpack and Ship alternative would involve emissions resulting from constructing and operating a Capsule Packaging Facility (CPF). These emissions are represented by an area source identified as CPF.

Waste Encapsulation and Storage Facility

Routine radiological emissions from the WESF were analyzed for all alternatives. These emissions would occur through a stack, and were modeled as a point source (WESF).

Evaporator

Operating an evaporator during continued operations and waste processing operations is expected to release radiological and nonradiological components. These emissions would occur through a stack, and were modeled as a point source (EVAP).

W-314 Project

This project potentially involves the replacement of various transfer lines located in the 200 East and 200 West Areas. The data available for this project indicate that construction activities would be spread out over various areas and would be of relatively low intensity compared to construction activities associated with other TWRS alternatives. In addition, dust-control measures would be employed that would minimize emissions from these activities. Because substantial emissions are not anticipated, the emissions from the W-314 Project were not separately analyzed.

G.2.2 MODEL SCENARIOS

The various alternatives would involve emissions from one or several of the sources described previously. Implementing alternatives would involve an initial phase of facility construction followed by a phase during which the treatment, transfer, or repackaging processes would occur. Consequently, each alternative could have different phases in which the emissions and analyzed impacts were distinctly different. Therefore, the emissions and analyzed impacts resulting from each phase were calculated and are reported separately for each alternative. The following sections discuss each proposed TWRS alternative and describe the associated emissions sources.

G.2.2.1 Tank Waste Alternatives

No Action Alternative (Tank Waste)

The No Action alternative would involve routine radiological and nonradiological emissions from continued operation of the storage tanks, and continued operation of the evaporator as a waste management activity. In addition, routine radiological releases from WESF would occur and are considered. No construction activities would be associated with this alternative.

The emissions from the continued operations of tank farms would also occur during the construction and operation phases of the alternatives, and are included in the analysis of these alternatives.

Long-Term Management Alternative

The Long-Term Management alternative would involve two phases having air emissions, each of which was analyzed separately. The first phase would involve transferring waste from existing DSTs to newly constructed DSTs 50 years in the future. Waste from the SSTs would not be retanked. The new tanks would be constructed in the same area as the process facility that would be built for the Ex Situ Intermediate Separations, Ex Situ No Separations, and Ex Situ Extensive Separations alternatives; the construction emissions were modeled by assigning them to the location PROC. In addition, continued tank and evaporator emissions would occur simultaneously at the tank farms and the evaporator locations. Increased emissions would be expected from tanks undergoing retrieval. These increased emissions were modeled by assigning the highest increased emission rate for each pollutant to the TF6W Tank Farm, which was identified as the tank farm location producing the highest impacts. The actual emissions for every chemical would not necessarily be the highest at TF6W.

The emissions from the tank farms during retrieval operations would be the same as would be expected for retrieval activities associated with the operational phases of the Ex Situ (Intermediate Separations, No Separations, and Extensive Separations) alternatives. These impacts have been included with the analysis of these alternatives.

The second phase (replacement of the tanks 100 years in the future) is similar to the first phase, except that the routine and increased tank emissions would occur within the PROC area, as well as the construction emissions.

In Situ Fill and Cap Alternative

Implementing this alternative would involve construction and gravel-filling operations at the tank farm locations, as well as gravel removal from Pit 30.

For the purposes of the analysis, construction activities are assumed to occur simultaneously with the filling operations and routine emissions from the continued operation of the tank farms. The following text summarizes the pollutant emitting activities and sources for this alternative.

- Particulate matter emissions are expected as a result of gravel handling operations at Pit 30 (BTCH).
- Construction equipment emissions are expected at the tank farm location. To provide a conservative approach, emissions from construction activities were assigned to the bounding case location (TF6W).
- Gravel handling operations are assumed to occur at a location central to several tank farms; the corresponding emissions were assigned to location TF5W.
- Increased tank emissions during filling operations are expected. To ensure a conservative approach, the increased

tank emissions were assigned to location TF6W in a similar manner as was done for retrieval operations.

The emissions from the tank farms during gravel filling operations would be the same as would be expected during the in situ portion of the Ex Situ/In Situ Combination 1 and 2 alternatives and have been included in the analysis of that alternative.

In Situ Vitrification Alternative

Implementing this alternative would involve constructing a tank farm confinement facility and an off-gas treatment facility at each tank farm. Construction of one confinement facility would occur while vitrification processes were occurring at an adjacent tank farm. For potential air quality impacts, the bounding case location for construction was identified as TF6W, and the impacts described are for this bounding case scenario.

Operations associated with this alternative would release pollutants that would be treated in an off-gas treatment facility. The emissions from the off-gas treatment facility would be from a vertical stack. The bounding case location for this operation was shown to be adjacent to TF6W. Although construction and operations activities would not occur at the same time and at the same tank farm location, the operational emissions were assigned to this location (IS6W) to provide a bounding case analysis.

Ex Situ Intermediate Separations Alternative

The construction phase would involve vehicular and fugitive dust emissions from constructing five waste transfer annexes and two waste processing facilities and constructing and operating a concrete batch plant to support these operations. Additionally, vehicular emissions associated with constructing tank waste retrieval equipment at the tank farms would occur during this time.

According to the estimated construction schedule, work would not be expected to occur at more than two tank farms at a time. An analysis was conducted to determine the two locations that would produce the highest impact when construction activities occurred simultaneously. It identified the TF5W and TF6W areas as having the highest combined impacts. Accordingly, the impacts of these activities were analyzed by assuming simultaneous construction operations at:

- The process facility locations;
- The concrete batch plant;
- The five transfer annex areas (TA1W, TA2W, TA3W, TA1E, TA2E); and
- Two tank farm locations (TF5W and TF6W).

The operational phase of the Ex Situ Intermediate Separations alternative would involve separating the waste into HLW and LAW streams and processing the waste at separate facilities. HLW vitrification processing would occur over a 12-year period while LAW processing would occur over a 19-year period. Additionally, retrieval equipment would operate at no more than two tank farm locations at a time during the course of the processing. Therefore, the impacts of the operations phase of the alternative were calculated by evaluating the simultaneous operation of both processing facilities (ST-L and ST-H) and the two tank farm locations (i.e., TF5W and TF6W) producing the highest impacts.

Ex Situ No Separations Alternative

The emission scenario for the Ex Situ No Separations alternative differs from the Ex Situ Intermediate Separations alternative because the tank waste would not be separated into LAW and HLW components and only one processing plant with one process stack (as opposed to two) would be operated. Two options (vitrification and calcination) were analyzed for this alternative. The sources and emission rates associated with the calcination option are identical to those of the vitrification alternative, with the exception of the emission rates of nitrogen oxides and carbon-14 (C-14) (Jacobs 1996).

The construction phase would involve vehicular and fugitive dust emissions from constructing the five waste transfer annexes and the process facilities, and from constructing and operating a concrete batch plant to support these operations. Additionally, vehicular emissions from erecting the retrieval equipment at the tank farms would occur during this time. These emissions were assigned in the same manner as described for the Ex Situ Intermediate Separations alternative construction phase, although emission rates would differ.

Operational processes for the Ex Situ No Separations alternative would occur over a 14-year period, beginning after completion of the construction phase. Emissions would occur through the main process stack at the vitrification facility. Additionally, installing and operating retrieval equipment would occur at only two tank farm locations at a time during processing. Therefore, the impacts of the operations phase of the alternative were calculated by evaluating the simultaneous operation of the process facility and the two tank farm locations (i.e., TF5W and TF6W) producing the highest combined impacts.

Ex Situ Extensive Separations Alternative

The construction phase would involve vehicular and fugitive dust emissions from constructing the five waste transfer annexes and the process facilities, and from constructing and operating a concrete batch plant to support these operations. Additionally, vehicular emissions from erecting the retrieval equipment at the tank farms would occur during this time. These emissions were assigned in the same manner as described for the Ex Situ Intermediate Separations alternative construction phase, although emission rates would differ.

The operational phase of this alternative would involve separating the tank waste into HLW and LAW streams and processing the waste at separate facilities. HLW and LAW processing vitrification processing would occur over a 21-year period. The off-gas emissions from these two processes would be combined and routed through a common stack (ESEP). In addition, retrieval equipment would be operated at only two tank farm locations at a time during processing. Therefore, the impacts of the operations phase of the alternative were calculated by evaluating the simultaneous operation of the process facilities (ESEP) and the two tank farm locations (i.e., TF5W and TF6W) producing the highest combined impacts.

Ex Situ/In Situ Combination 1 and 2 Alternative s

Implementing the in situ portion of these alternative s would involve the same source locations and emissions scenarios as described for the In Situ Fill and Cap alternative, although lower emission rates would be expected. These emissions would occur simultaneously with those associated with the operational phase of the ex situ portion of the alternative s .

The construction phase s would involve vehicular and fugitive dust emissions from constructing the waste transfer annexes and the process facilities, and from constructing and operating a concrete batch plant to support these operations. Additionally, vehicular emissions from erecting the retrieval equipment at the tank farms would occur during this time. These emissions were assigned in the same manner as described for the Ex Situ Intermediate Separations alternative construction phase, although emission rates would differ.

The operational phase of the ex situ vitrification portion of the alternative s would involve separating the HLW and LAW streams and processing the waste at separate facilities. Retrieval and ex situ vitrification operations would be expected to occur over a 21-year period for Combination 1, and over a 20-year period for Combination 2. Additionally, retrieval equipment would be expected to operate at no more than two tank farm locations at a time during processing. Therefore, the impacts of the operational phase of these alternative s were calculated by evaluating the simultaneous operation of both process facilities (ST-L and ST-H) and the two tank farm locations (i.e., TF5W and TF6W) producing the highest impacts.

Phased Implementation Alternative

Phase 1

Implementation of the first phase of this alternative would involve a construction period, during which two vitrification facilities would be constructed. Because construction on both facilities would occur simultaneously, the construction emissions were assigned to a single area source (FCPI) that would encompass the expected disturbed area.

Following completion of construction, operation of the two facilities would commence. Emissions from the vitrification processes would be released through two stacks -- one located at the combined LAW/HLW facility (NSPI), and one located at the LAW facility (SSPI). LAW operations at both plants would occur over a 10-year period; HLW operations at the combined plant would occur for 6 years. The impacts from these activities were calculated by using the peak hourly emission rates from all processes simultaneously.

Phase 2

In the second phase of this alternative, large-scale facilities would be constructed to treat the remainder of the tank waste. Emissions would come from constructing the five waste transfer annexes (TA1W, TA2W, TA3W, TA1E, TA2E), process facilities, and a concrete batch plant (BTCH). Emissions from erecting retrieval equipment at the tank farms producing the highest impacts (TF5W, TF6W) would occur simultaneously. These emissions were assessed in the same manner as described for the Ex Situ Intermediate Separations alternative.

Total Alternative

Impacts from the operation of the total Phased Implementation alternative are analyzed in the same manner as for the Ex Situ Intermediate Separations alternative. This involves the simultaneous operation of the two facilities discussed under Phase 1 (NSPI and SSPI), the large-scale facilities (ST-L 1, ST-L2 and ST-H), and the two tank farm locations producing the highest impacts (TF5W and TF6W).

G.2.2.2 Cesium and Strontium Capsule Alternatives

No Action Alternative (Capsules)

This alternative would involve maintaining the capsules at WESF. Routine radiological emissions from WESF were analyzed for this alternative and were included in the analysis of all other alternatives. These emissions were modeled as a point source (WESF). No other impacts are expected from this alternative.

Onsite Disposal Alternative

This alternative would involve transferring the existing capsules to a newly constructed Drywell storage facility. Constructing the Drywell storage facility would result in emissions from construction. These construction emissions were assigned to the source identified as DWSF. There would be no emissions during operations for this alternative. No airborne emissions are anticipated from the sealed Cs and Sr capsules while they are in storage. The only operational activities would be facility monitoring.

Overpack and Ship Alternative

This alternative would involve recovering the capsules from WESF, repackaging them, and shipping them to the potential geologic repository. A repackaging facility would be built as part of this alternative. Construction emissions and minor operational emissions would occur. These emissions were assigned to the area source identified as CPF.

Vitrify with Tank Waste Alternative

This alternative would involve recovering the Cs and Sr capsules from WESF, removing the contents, and vitrifying the capsule contents along with tank waste. Because the emissions occurring under this alternative are combined with emissions from remediating tank waste, no separate air quality impacts were analyzed.

G.3.0 MODEL SELECTION AND METHODOLOGY

Version two of the U.S. Environmental Protection Agency (EPA) Industrial Source Complex Model (ISC2) was selected to perform the air-dispersion modeling (EPA 1992a). The ISC2 model is a Gaussian dispersion model capable of simulating emissions from diverse source types. In a Gaussian dispersion model, pollutant concentrations are assumed to be distributed normally (i.e., bell-shaped curve) about the centerline of the plume, a relationship that has been observed to occur for releases of gases and small particles from many types of sources. ISC2 is a guideline air quality model (i.e., it is accepted by EPA for regulatory applications [40 CFR Part 51]). It is also routinely recommended for performing screening and refined analyses for remedial actions at Resource Conservation and Recovery Act and Superfund sites (EPA 1989a). This model was selected based on its widespread acceptability and versatility.

The ISC2 consists of two models: a short-term version (ISCST2) appropriate for predicting concentrations averages of 1 to 24 hours, and a long-term version (ISCLT2) for predicting seasonal and yearly concentrations. Both models were incorporated in this study. ISCLT2 was used to generate annual average predicted concentrations for comparison with annual average ambient air quality standards and target levels. ISCST2 was executed in a screening mode to predict short-term ambient air concentrations for comparisons to 1 to 24 hour average air quality standards and other target levels (EPA 1992b).

G.3.1 MODEL OPTIONS AND INPUTS

ISC2 requires the input of source and meteorological data as well as receptor coordinates (i.e., locations for which the model computes a concentration). The model must also be configured properly by the selection of various options. The following discussions document the inputs and model configuration.

G.3.1.1 Model Options

The models were run using the standard rural dispersion coefficients. These were selected based on the nature of the land use in the vicinity of the emission sources. Standard EPA procedures were followed in making this determination (40 CFR Part 51).

The regulatory default option was selected, which implemented the following model options:

- Final plume rise;
- Buoyancy-induced dispersion;
- Default wind profile exponents;
- Default vertical potential temperature gradients; and
- Upper bound values for supersquat buildings.

G.3.1.2 Source Data

The manner in which sources were grouped for each alternative is discussed in Section G.2.2. Source- related model input data are shown on Table G.3.1.1. Please note that all tables are located at the end of Appendix G. The chemical pollutant emission rates for each phase of the alternatives are shown in Tables G.3.1.2 through G.3.1.1 9 . Tables G.3.1. 20 through G.3.1. 31 contain the radiological emission rates. When appropriate, construction and operational emissions from the alternatives were analyzed separately, and separate emissions data for construction and operational activities are reported. In other cases, construction and operational processes would occur simultaneously, and the emission rates reported represent the combined emissions from construction and operational activities.

The primary sources of data used for the emission rates were the engineering data packages for the various alternatives, which were prepared by the Hanford Site Management and Operations contractor (WHC 1995 a, b, c, d, e, f, g, h, i, n) and the TWRS EIS contractor (Jacobs 1996). The following discussion describes the protocol used for calculating model emission rates from the available data.

Routine Emissions from Tank Farms and the Waste Encapsulation and Storage Facility

Routine emissions of radiological and nonradiological components from continued operations of the tank farms and

WESF are shown for the No Action alternative (Tank Waste) in Tables G.3.1.2 and G.3.1. 20 . Emissions are reported separately for each tank farm location (Jacobs 1996). Similar emissions are expected to occur and were analyzed for all alternatives. However, during retrieval operations (and during gravel filling operations associated with the In Situ Fill and Cap alternative), the routine emissions rates would be expected to increase at the affected tank farm location. In these situations, the increased emission rates were analyzed in the following manner: the highest routine emission rate for each pollutant was assigned to source TF6W to provide a bounding case scenario and increased by the appropriate factor to represent retrieval or gravel filling operations.

In Situ Vitrification Emission Data

Data contained in the engineering data packages for this alternative were analyzed to generate tables of radiological and nonradiological emissions for this alternative (Jacobs 1996). Separate emissions data for the construction and operational phases for the alternative were created. Annual construction emissions were converted to peak hourly emissions based on an assumed schedule of construction activities. The peak hourly emission rate of each pollutant for the vitrification process was used for the model input.

Process Facility Stack Emissions Data

Process flow diagrams and mass balance data contained in the engineering data packages were analyzed to generate tables of average annual emissions, maximum daily emissions, and peak hourly emissions from the vitrification facility process stacks for the Ex Situ Intermediate Separations, Ex Situ No Separations, and Ex Situ Extensive Separations alternatives, including the Ex Situ/In Situ Combination 1 and 2 and the Phased Implementation alternatives (Jacobs 1996). The peak hourly emissions for pollutants listed in these tables were used to generate emission rates for the process stacks.

Construction Activities Emission Data

The primary sources of construction activity emission data were the engineering data packages for the various alternatives. In some cases, data concerning the construction emissions were not given explicitly in the data package. Calculations were performed to estimate the emissions given the scope of the construction activity (Jacobs 1996). Annual emissions were converted to hourly emissions based on an assumed schedule for construction activities.

G.3.1.3 Meteorological Data

Long-Term Meteorological Data

The meteorological data used for the ISCLT2 model consisted of a joint frequency distribution, also referred to as a stability array (STAR) of wind speed, wind direction, and stability class compiled for each of 5 years (1989 to 1993). The stability arrays are shown in Tables G.3.1.33 through G.3.1.37. These data were based on measurements collected at the Hanford Meteorological Station located between the 200 East Area and 200 West Area (PNL 1994g). The general wind direction is to the southeast.

Additional meteorological data, such as the annual mean temperature and mixing heights, were obtained from the Hanford Climatological Data Summary (PNL 1994g) and a standard summary document of morning and afternoon mixing heights (Holzworth 1972). The protocol for assigning these values was taken from the ISC2 User's Manual (EPA 1992a). As outlined in the user's manual, the average annual maximum daily temperature (18 C [65 F]) was used for the A, B, and C stability classes; the average minimum daily temperature (5 C [42 F]) was used for the stability classes E and F; and the average annual temperature (12 C [53 F]) was used for the D stability class. Mixing height values were assigned as follows: 1.5 times the average afternoon mixing height of 1,500 m (4,900 ft) was used for stability class A and the average afternoon mixing height was used for stability classes B, C, and D. Because ISCLT2 in the rural mode assumes that there is no restriction in vertical mixing in the E and F stability classes, 1.5 times the average afternoon mixing height was considered to be appropriate for these stability classes.

Short-Term Meteorological Data

ISCST2 requires hourly meteorological data. Typically, for refined and regulatory modeling, a full year of sequential hourly records are input to the model. Because data in this format for the Hanford Site were unavailable and a refined level of modeling was not considered necessary given the preliminary nature of the design data, the ISCST2 model was executed in a screening mode. This required inputting a range of possible meteorological conditions which might reasonably occur at this site. This screening meteorological file was prepared according to procedures outlined in EPA's SCREEN2 Model User's Guide (EPA 1992c).

For each of 36 wind directions, 54 possible combinations of stability class and wind speed were input (i.e., 1,944 hourly records). A matrix of windspeed and stability classes is shown in Table G.3.1. 32 .

Atmospheric mixing heights were assigned to stability classes A, B, C, and D using the mechanical mixing height (Z_m) and calculated using the following formula taken from Section 3.2 of the SCREEN2 Model User's Guide:

Where:

Z_m = mechanical mixing height (m)
u_{10} = wind speed at 10 m elevation (m/s)

To allow for unlimited mixing, heights of 10,000 m (32,800 ft) were assigned to stability classes E and F, in keeping with the scheme outlined in the SCREEN2 User's Manual. Ambient temperatures for each stability class were assigned in the same manner as the ISCLT2 model inputs.

G.3.1.4 Receptor Locations

Three receptor sets were used for the study. The first set was used to predict concentrations for comparison with Washington State and Federal ambient air quality standards and target levels for nonradionuclide impacts, and for comparison with the Washington State ambient air quality standard for radionuclides. These receptor locations were placed to correspond to areas that might be considered to be ambient air (i.e., areas where the general public could be exposed). Because of the potential release of the Fitzner Eberhardt Arid Lands Ecology portion of the Hanford Site, the public would have access to land southwest of State Route 240, and it was selected to represent the southern boundary of the facility. For the same reason, the Columbia River was selected to define the northern and eastern facility boundaries. A total of 614 receptors were placed along the Columbia River, State Route 240, and the Hanford Site boundary line north of the Columbia River. Because of the size of the Hanford Site, most offsite receptors are quite distant from the sources and were placed with a 2-km (1.2-mi) spacing. To ensure that the areas of maximum impact were identified, receptors were placed at 500-m (1,650-ft) intervals along sections of State Route 240 to ensure adequate coverage.

The second set of receptors was used to assess compliance with the Federal standard for radionuclide release impacts contained in 40 Code of Regulations [CFR] Part 61. Compliance with this standard is calculated at the nearest residence, rather than at the nearest ambient air location. Although the distance from the source locations to the nearest residence in all directions is not known, available data indicate that no residence lies within 24 km (15 mi) of the 200 West area, or 16 km (10 mi) of the 200 East Area (DOE 1994d). Thus, a circular set of 72 receptors, centered on the 200 West Area and with a radius of 24 km (15 mi), was established to assess compliance with this standard. This circular grid encompasses all locations within 16 km (10 mi) of the 200 East Area.

A rectangular grid of 834 receptors, which encompasses the entire Hanford Site, was used to generate isopleths of radionuclide impacts.

ISC2 is designed to model simple terrain (i.e., terrain less than or equal to stack height). Terrain elevation is relevant for modeling point sources. Concentration predictions from area source emissions are not affected by terrain. Elevations for all receptor locations were obtained from a Geographic Information System database of the Hanford

Site and U.S. Geological Survey topographical maps of the surrounding area.

G.3.2 MODEL OUTPUT

The model output consisted of ground level average concentration values. ISCLT2 produced annual average concentrations for each of the 5 years (1989 to 1993) of meteorological input data. The predicted concentrations reported are from the year producing the highest impact. ISCST2 was executed to determine the maximum 1-hour average concentrations resulting from inputting a range of possible meteorological conditions. The 1-hour averages were multiplied by various correction factors for predictions of 3-, 8-, and 24-hour average concentrations. The following sections provide more details on the concentration calculations.

G.3.2.1 Normalized Concentrations

To provide efficiency in processing the results and flexibility for incorporating future changes, the sources were modeled with unit emission rates, resulting in predictions of normalized concentrations (also referred to as Chi/Q values).

The normalized concentrations, having dimensions of 1.0E-06 seconds/cubic meter (s/m^3), were produced by assigning each source a unit emission rate of 1.0 grams per second (g/s). The concentration at a receptor was calculated by multiplying the actual emission rate (referred to as the source term) by the appropriate Chi/Q value. For example, a source term expressed in units of g/s will produce a concentration given as micrograms per cubic meter ($\mu g/m^3$), and a source term expressed in units of curies per second (Ci/s) will produce a concentration given as $\mu Ci/m^3$.

The total concentration at any receptor consists of the sum of the concentrations contributed by each emitting source. Therefore, the total concentration at a receptor with *n* contributing sources is calculated as follows:

Where:

C_{total} = total concentration ($\mu g/m^3$ or $\mu Ci/m^3$)
$(Chi/Q)_n$ = predicted Chi/Q value (1.0E-06 s/m^3) for source *n*
T = source term (g/s or Ci/s) for source *n*

Separate Chi/Q plot files were generated for each of the 30 identified sources. To calculate the total concentration values these plot files have been entered into spreadsheets. These spreadsheets allow the input of source terms of interest for each pollutant and the calculation of total concentration values at each receptor location.

G.3.2.2 Averaging Time Conversions

Values for 3-, 8-, and 24-hour averages were obtained by multiplying the calculated 1-hour average concentration by the following conversion factor: 0.9 for 3-hour averages, 0.7 for 8-hour averages, and 0.4 for 24-hour averages (EPA 1992b).

G.4.0 MODEL RESULTS

The results of the modeling were compared with Washington State air quality standard or acceptable source impact levels. Washington State standards are listed in the Washington Administrative Code (WAC) and include:

- Acceptable Source Impact Levels for toxic air pollutants (WAC 173-460);
- Ambient Air Quality Standards for particulate matter (WAC 173-470);

- The Ambient Air Quality Standards for sulfur oxides (WAC 173-474);
- The Ambient Air Quality Standards for carbon monoxide ozone and nitrogen dioxide (WAC 173-474);
- The Ambient Air Quality Standards for radionuclides (WAC 173-480); and
- The Ambient Air Quality Standards for fluorides (WAC 173-481).

The results were also compared with national primary and secondary Ambient Air Quality Standards listed in 40 CFR Part 50. The Washington Ambient Air Quality Standards are equal to or are more stringent than the National Ambient Air Quality Standards, and thus compliance with the Washington Ambient Air Quality Standards implies compliance with the National Ambient Air Quality Standards.

Predicted maximum emissions for hazardous air pollutants and pollutants for which a Washington Acceptable Source Impact Level exists are provided along with the applicable level. Modeling results for chemical pollutants are given in Tables G.4.0.1 through G.4.0. 20 . Modeled impacts for key radionuclides during operations are plotted in Figures G.4.0.1 through G.4.0. 13 and presented for each alternative in Tables G.4.0. 21 through G.4.0. 32 . The modeling results show radionuclide emissions converted to doses and compares them to Washington Air Quality Standards for radiation doses contained in WAC 173-480 and Federal standards for radioactive emissions from DOE facilities (40 CFR 61, Subpart H). The Ambient Air Quality Standard (WAC 173-480) for the maximum accumulated dose equivalent at any offsite receptor from a commercial nuclear facility is 25 mrem/yr. As a Federal facility, the Hanford Site could be expected to comply with the EPA regulation (40 CFR 61), which limits the maximum predicted dose at the nearest residence to 10 mrem/yr dose equivalent. Uranium-235 (U-235) was not included in the impacts for radionuclides. Uranium trioxide was, however, analyzed as a hazardous air pollutant. This approach is consistent with the risk analysis for routine operations for each alternative, because the chemical toxicity of uranium is much greater than its radiological hazard. Additionally, emissions of U-235 were determined to have a very small contribution to overall risk.

The modeling results for all alternatives show no exceedances of Federal or State air quality standards for criteria pollutants, hazardous air pollutants, or radionuclides. Substantial impacts from all sources (those that exceed 10 percent of the applicable standard) are listed in the following text:

Particulates	The impacts, as a percentage of the Federal and State 24-hour standard, that would occur during the construction phases of the In Situ Vitrification alternative (64 percent of the standard) and the construction phases of the Ex Situ Extensive Separations, Ex Situ Intermediate Separations, and Ex Situ No Separations) alternatives (63 percent, 62 percent, and 57 percent, respectively). In addition, substantial impacts occur during the construction phases of the Ex Situ/In Situ Combination 1 and 2 alternatives (34 percent of the 24-hour State and Federal standards), the Phased Implementation Phase 1 alternative (58 percent of the State and Federal 24-hour standard), Phased Implementation Phase 2 (65 percent of the State and Federal 24-hour standard) and the Capsules Onsite Disposal alternative (12 percent of the State and Federal 24-hour standard).
Carbon Monoxide	The impacts, as a percentage of the Federal and State 8-hour standard, that would occur during the construction phases of the Ex Situ Extensive Separations, Ex Situ Intermediate Separations, and Ex Situ No Separations alternatives are 25 percent, 21 percent, and 17 percent, respectively.
Sulfur Oxides	The impacts, as a percentage of the State 1-hour standard, that would occur during the In Situ Vitrification alternative are 10 percent of the standard.
Radionuclides	The impacts, as a percentage of the State annual standard, that would occur during the In Situ Vitrification alternative are 75 percent of standard, with primary contributors being C-14 and iodine-129 (I-129). The impacts, as a percentage of the Federal annual standard, that would occur during the In Situ Vitrification alternative are 24 percent of standard, with primary contributors being C-14 and I-129.

G.5.0 ACCURACY AND UNCERTAINTY

Various assumptions and other factors can introduce uncertainty in air dispersion modeling studies. With regard to the modeling performed to analyze air impacts from the various alternatives, these uncertainties can be broadly separated into the following categories:

- Uncertainty inherent in the air dispersion models;
- Uncertainty in data used as model inputs; and
- Uncertainty in interpretation of model output.

These categories are discussed in more detail in the following text.

G.5.1 AIR DISPERSION MODELING

Air dispersion models are mathematical tools designed to estimate pollutant concentration and/or deposition at specific locations. These predictions are based on various input parameters and physical assumptions, such as the following:

- Pollutant release characteristics (emission rate, temperature, flow rate);
- Meteorological conditions (ambient temperature, mixing height, stability, wind speed and direction, atmospheric temperature and wind speed profile); and
- Pollutant transport behavior (dispersion, plume rise, interaction with terrain).

In an ideal case, the values entered into the model for these known parameters will closely duplicate the range of actual conditions that exist for a particular scenario. However, the stocastic nature of the atmosphere results in other unknown factors (e.g., wind perturbations) that influence the actual dispersion at a particular time or place. It has been estimated that even when the known conditions are exactly duplicated in the model, the unknown factors can contribute to variations in concentration as much as ±50 percent (EPA 1995).

Gaussian air dispersion models are accurate within a factor of two when properly executed with accurate data. In general, models are more reliable when estimating long-term average concentrations as opposed to short-term averages, and are reasonably reliable in estimating the magnitude of the highest concentration occurring, but are not capable of predicting the exact time or position of the occurrence. In other words, the highest concentration that can be expected in an area can be predicted with reasonable accuracy; the location and time that the maximum concentration will occur are less reliably predicted.

The air dispersion models used in this study are considered to be state-of the-art for regulatory modeling and are recommended by EPA for this type of analysis. To compensate for the uncertainties in model results, conservative input values were used that provide conservative (higher than might actually occur under average conditions) results.

G.5.2 MODEL INPUT DATA

Two types of input data are used for the air dispersion models: meteorological data and source data. Both types of input data are discussed in the following text.

G.5.2.1 Meteorological Data

Two types of meteorological data (i.e., long-term and short-term) were used in the dispersion modeling study. Long-term (i.e., annual) average concentrations were estimated using meteorological data collected at the Hanford Meteorological Station from 1989 to 1993. The assumption inherent in this choice is that this data represent future meteorological conditions. A 5-year record is generally accepted as an adequate sample set for modeling purposes. Although long-term climatic shifts may occur, many of the air pollutant emitting activities analyzed in this study are expected to occur within several decades of project initiation, which is a relatively short time frame on a climatic scale. Therefore, the use of this data is not expected to adversely affect the results.

Typically, short-term average (i.e., 1- 3- 8- and 24-hour) concentrations are predicted using hourly meteorological measurements from a station located at, or near, the site of interest. Because the data were not available for this study, a screening approach was taken, and a standard set of hourly meteorological conditions were incorporated in the modeling. These standard conditions are accepted by the EPA to encompass the range of atmospheric stabilities and wind speeds that could be expected to occur anywhere. Each combination of wind speed and atmospheric stability was assumed to occur in every possible wind direction. The predicted concentrations represent the highest value that could be reasonably expected to occur anywhere. This approach is conservative because the meteorological condition leading to the reported result may not occur at the site for all wind directions.

G.5.2.2 Source Data

Data describing the location, emission rate, and emission characteristics of the sources was input to the models. Information concerning pollutant emission rates was derived from data packages supplied by the Site Management and Operations contractor and analyzed by the Environmental Impact Statement contractor. In general, when emissions estimates were being developed, conservative values were used.

The location of the pollutant emitting sources is not known with complete certainty in all cases. Pollutant emitting activities associated with the existing tank farms will occur in the present locations. However, the exact location of future facilities is subject to some uncertainty. In general, the closer a source is to a receptor, the higher the predicted concentration at that receptor will be. As a consequence, if the eventual location of an emitting activity is closer to a plant boundary than depicted in the model, the impacts may be higher. Of course, if the activity is located farther from the boundary than depicted in the model, the impacts may be lower.

The temporal arrangement of the pollutant emitting activities affects the predicted concentrations as well. The predicted concentration at any receptor represents the contributions of each individual emitting source. To properly analyze a scenario, all the pollutant emitting activities that could occur at the same time must be considered. In general, most of the scenarios analyzed involved a period of facility construction followed by an operational period.

In some cases, the location of an emitting source is expected to move from place to place as the project progresses. An example of this would be emissions related to remedial activities at tank farm locations. In most cases, work would be occurring at one or two of the possible 17 locations at one time. Given these uncertainties, a conservative analysis was produced by assuming that activities that might or might not overlap in time would occur simultaneously. In addition, activities that would be expected to move from place to place were modeled as if occurring in the location producing the highest potential impact.

Sources were modeled as either point or area sources. Point sources are used to approximate pollutant releases from a stack or other fixed, functional opening or vent. The dispersion algorithms used for point sources modify the effective release height to take into account plume buoyancy (from a heated release) and momentum (from vertical release velocity). Typically, area sources are used to approximate pollutant releases that do not occur at a single well-defined point, but instead can be defined as occurring within a defined area. For instance, an area source could include many small fixed point sources that were too numerous to model individually, or could made up of several mobile sources that may move about within the fixed area. In this study, the construction activities were represented as area sources. The classification of the sources into these two categories involved some degree of uncertainty and some assumptions as well. The models use different algorithms to represent dispersion from point and area sources and the predicted concentration at a receptor could vary, depending on the algorithm chosen. In general, these effects are more noticeable at locations close to the source and tend to diminish as the distance between source and receptor increases.

G.5.3 INTERPRETATION OF MODEL OUTPUT

The short-term model was run using screening meteorology to produce maximum predicted 1-hour average concentrations. These 1-hour average values were converted to 3- ,8-, and 24-hour average concentrations, when appropriate, to compare to applicable standards. This was accomplished by applying conversion factors to the 1-hour average values. Consistent with modeling guidelines (EPA 1988), the factors of 0.9, 0.7, and 0.4 were applied to convert to 3-, 8-, and 24-hour averages, respectively. These factors involve an implied assumption regarding the persistence of the meteorological condition producing the highest 1-hour impact. In other words, conservative meteorological conditions that produced the highest 1-hour concentration can be expected to persist for most of a 3-

hour period and to a lesser degree over an 8- or 24-hour period. The modeling guidelines indicate a range of values for each conversion factor: the 3-hour conversion factor can range from 0.8 to 1.0, the 8-hour factor from 0.5 to 0.9, and the 24-hour factor from 0.2 to 0.6. Use of the midpoint values was considered appropriate for this study.

FIGURES:

TABLES:

Table G.4.0. 32 Radionuclide Modeling Results for the Phased Implementation Alternative Phase 2

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APPENDIX H

SOCIOECONOMIC IMPACT MODELING

ACRONYMS AND ABBREVIATIONS

D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
HLW	high-level waste
LAW	low-activity waste
M&M	monitoring and maintenance
MSA	Metropolitan Statistical Area
NEPA	National Environmental Policy Act
TAR	Tri-Cities Association of Realtors
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TWRS	Tank Waste Remediation System
WSDES	Washington State Department of Employment Security
WSDFM	Washington State Department of Financial Management
WSDR	Washington State Department of Revenue

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length		**Area**		**Volume**	
cm	centimeter	ac	acre	cm^3	cubic centimeter
ft	foot	ft^2	square foot	ft^3	cubic foot
in	inch	ha	hectare	gal	gallon
km	kilometer	km^2	square kilometer	L	liter
m	meter	mi^2	square mile	m^3	cubic meter
mi	mile			ppb	parts per billion
				ppm	parts per million
				yd^3	cubic yard
Mass		**Radioactivity**		**Electricity/Energy**	
g	gram	Ci	curie	A	ampere
kg	kilogram	MCi	megacurie (1.0E+06)	J	joule

lb	pound	mCi	millicurie (1.0E-03 Ci)	kV	kilovolt
mg	milligram	Ci	microcurie (1.0E-06 Ci)	kW	kilowatt
mt	metric ton	nCi	nanocurie (1.0E-09 Ci)	MeV	million electron volts
		pCi	picocurie (1.0E-12 Ci)	MW	megawatt
				V	volt
				W	watt

Temperature

C	degrees centigrade
F	degrees Fahrenheit

H.1.0 INTRODUCTION

This appendix

describes the socioeconomic impact modeling for the Tank Waste Remediation System (TWRS) Environmental

Impact Statement (EIS) alternatives. It describes the methodology and assumptions used in the modeling effort and provides additional

technical information about the analysis. This appendix discusses:

- # The development of the baseline

Hanford Site employment estimates used to assess the socioeconomic impacts of the EIS alternatives;

- # The econometric

forecasting model used to project economic variables; and

- **Details of the employment projections for the EIS alternatives.**

The appendix also includes tables showing socioeconomic impacts for each alternative during each year of the remediation

period, analyzed up to the year 2040.

The socioeconomic impact analysis addresses the Tri-Cities

Metropolitan Statistical Area (MSA), which encompasses all of Benton and Franklin counties. The analysis does not address

impacts on other areas of the region because there are too few Hanford Site employees in the surrounding counties for changes in

Hanford Site employment to cause substantial economic impacts there. Historically, only about 7 percent of the total Site work force has

lived outside Benton and Franklin counties (Cushing 1995). Most of these employees live in Yakima County, which has a total

nonfarm employment of over 65,000 (WSDES 1993b). With Hanford Site employees representing approximately 1

percent of total Yakima County nonfarm employment, the EIS alternatives would have too small an employment

impact to warrant detailed analysis. The analysis does not address potential economic impacts of accidents that potentially could

occur during implementation of the alternatives. Because there is a very low probability that an accident would have major

economic impact, this issue does not warrant detailed analysis. However, Appendix E does provide a discussion of potential impacts

associated with remediation accidents and mitigation measures that would be taken to address those impacts.

It was assumed that the schedule for implementing each alternative would meet the applicable Hanford Federal Facility Agreement

and Consent Order (Tri-Party Agreement) milestones (Ecology et al. 1994). There are uncertainties related to waste

characterization (Appendix A, Section A.3.0) and waste loading (Appendix B, Section B.3.10 and B.8.0) that could affect the

schedules for completing all of the ex situ alternatives. Under conservative case conditions, because of these

uncertainties completing the ex situ alternative could require from one to four years beyond the applicable Tri-Party Agreement

milestones for low-activity waste. However, there are factors that could compensate for these uncertainties and allow the Tri-Party Agreement

schedule to be maintained. For example, it may be possible to achieve a higher percentage of waste loading than projected under

the conservative case. Also, larger processing facilities could be constructed or construction schedules could be accelerated, both

of which could shorten alternatives' schedules for completion.

Section H.1.1 provides a

discussion of the assumptions, data, methodology, and uncertainties directly associated with the development of the baseline scenario

used to calculate and compare the impacts of the EIS alternatives. The major uncertainties are associated with the projection of

future levels of non-TWRS Hanford Site employment and future overall employment in the Tri-Cities MSA. In both cases,

substantial changes in future overall employment would change each alternative's impact on future Hanford Site

employment, Tri-Cities MSA nonfarm employment, population, taxable retail sales, and average home prices. In turn,

changes to the population projection would result in comparable changes to each alternative's impact on public

services and facilities such as schools, police, and fire (Volume One, Section 5.6). Also, changes to the projection of future Hanford

Site employment would result in changes to the analysis of transportation impacts (Volume One, Section 5.10). In each case,

however, the changes in future employment would impact all of the alternatives equally. Therefore, while the level of each impact would

change, the comparison of the relative impacts among the alternatives would not be affected.

In the time

between publication of the Draft EIS and preparation of the Final EIS, revisions have occurred in the schedules of a

number of EIS alternatives. In all cases except for Phase 2 of the Phased Implementation alternative, these schedule changes

would have a very small effect (less than 5 percent) on the level or timing of employment under the various alternatives. Because this is well

within the accuracy of the socioeconomic modeling, the modeling was not revised.

The Final EIS

includes a new alternative that was not analyzed in detail in the Draft EIS. This alternative, the Ex Situ/In Situ Combination 2

alternative, would have lower overall employment levels than the Ex Situ/In Situ Combination 1 alternative that was analyzed in detail in the Draft

EIS. However, the timing of the employment peaks under the Ex Situ/In Situ Contamination 2 alternative, as well as the duration of

its construction and operations phases, would be similar to the Ex Situ/In Situ Combination 1 alternative. Data are provided in

this appendix for peak and average employment levels for the Ex Situ/In Situ Combination 2 alternative. However, no socioeconomic

modeling has been performed because of its similarity to the Ex Situ/In Situ Combination 1 alternative.

H.1.1 DEVELOPMENT OF THE BASELINE ECONOMIC ESTIMATE

This section describes the assumptions, data, and methodology used to develop the baseline estimate of future economic activity in the Richland, Kennewick, and Pasco (also called the Tri-Cities) MSA. This estimate was used to analyze the socioeconomic impacts of the EIS alternatives.

The socioeconomic impact analysis compares the impacts of the EIS alternatives to an estimate of future economic conditions in the Tri-Cities area, based on Hanford Site employment in the absence of any

TWRS activities (except for a phased shutdown of routine tank farm operations). The scenario for future Hanford Site employment that provided the baseline for the impact analysis was calculated using the following method:

- **The latest available estimate of total Hanford Site employment was obtained from Hanford Site facility planning personnel (Daly 1995). This estimate assumed implementing the TWRS program as defined by the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1994).**

- **Labor requirements were estimated over time to implement the TWRS programs as defined in the Tri-Party Agreement, based on engineering data provided by the Hanford Site Management and Operations contractor (WHC 1995a). The engineering data were provided for total labor hours by phase of the activity. The EIS contractor then adjusted the labor hours to reflect the final alternatives selected for analysis in the EIS and to ensure consistency in the methodology used to develop labor estimates among the alternatives (Jacobs 1996). These data were then provided for**

inclusion as inputs into the socioeconomic modeling.

- # The labor requirements for the TWRS program were then subtracted from the overall estimate of Hanford Site employment to derive a calculational baseline for Hanford Site employment that excludes remediation of the tank waste.

This calculational baseline for Hanford Site employment (total employment without TWRS employment) then was used in an econometric forecasting model to analyze the socioeconomic impacts of

the various EIS alternatives. Figure H.1.1.1 shows both the estimate of total Site employment and the calculational baseline of total Site employment without TWRS employment. All figures and tables in this appendix are provided after page H-1 5 .

Assumptions incorporated into the impact analysis included the following:

- **The latest available estimated total Hanford Site employment (including potential TWRS activities as defined in the Tri-Party Agreement) was**

derived from data for selected years between 1994 and 2025. The intervening years were estimated using straight-line interpolation. For the years subsequent to 2025, a straight-line extrapolation was used, with 2040 as the end year.

- **The latest available estimated total Hanford Site employment incorporated planned restructuring of the Hanford Site labor force, including early retirements and reductions in force, as well as new hires expected in 1995 for the Hanford Site environmental restoration contractor, and for the U.S. Department of Energy (DOE),**

Richland Operations Office. Because plans for labor force restructuring and new hires are under constant review, these estimates are imprecise but are the best currently available.

- # The latest available total Hanford Site labor employment estimate includes other (non-TWRS) environmental cleanup and restoration activities, operations and maintenance, research and development (including the Environmental and Molecular Sciences Laboratory and the Laser Interferometer Gravitational Wave Observatory), and facilities management personnel required to

operate and maintain the Hanford Site.

- **The data on the proposed TWRS program, as defined in the Tri-Party Agreement, provided by the Hanford Site Management and Operations contractor and the TWRS EIS contractor were used in the following manner. Annual employment data were developed based on engineering projections that allocated estimated labor requirements over the different phases of the project. The annual labor requirements data were then interpolated (or assigned intermediate values) to provide**

quarterly data, as required by the regression model, to be used to estimate impacts. Because the total Hanford Site employment data were estimated using smoothed interpolations, the TWRS Tri-Party Agreement labor requirements estimates also were smoothed using a 30-quarter moving average before subtracting them from the total Hanford Site employment estimates to obtain the calculational baseline employment estimates. This smoothing was done to maintain consistency between the two data series. Without smoothing the data, the annual fluctuations in the TWRS

Tri-Party Agreement data would have been transferred to the calculational baseline estimate, creating a misleading result. However, the smoothed TWRS Tri-Party Agreement data were used only to estimate calculational baseline employment. The socioeconomic impact analysis of the EIS alternatives used unsmoothed data added to the calculational baseline. The calculational baseline estimate used to construct estimates of total Hanford Site employment for each of the proposed EIS alternatives is described in Section H.3.1.

- **Routine operations at the tank farms were included in the latest available total Hanford Site employment estimate and in the estimated labor requirements for the TWRS Tri-Party Agreement labor estimate. As envisioned in the Tri-Party Agreement, tank farm routine operations would be phased out over time as remediation occurs. Estimates for employment in routine operations (including phaseouts over time) were incorporated into the labor requirements for the other TWRS EIS alternatives as described in Section H.3.1. The inclusion of the routine operations labor estimate in**

the calculational baseline was factored into the labor estimates for each of the alternatives. Routine operations were estimated to require 1,016 full-time equivalent employees. In the calculational baseline, it was assumed that the routine operation activities would phaseout beginning in 2005, with an end to routine operations in 2029. For alternatives with routine operations extending at current levels beyond 2005, the labor required to maintain the 1,016 employment level was added to the alternative labor estimates. This was the case for the No Action, Long-Term Management, and In Situ Fill

and Cap alternatives. For other alternatives that ended routine operations prior to 2029, the appropriate level of employment was subtracted for the labor estimate. This was the case for the In Situ Vitrification, Ex Situ/In Situ Combination 1, Ex Situ/In Situ Contamination 2, and Phased Implementation alternatives.

The calculational baseline estimate of Hanford Site employment is used only to provide a basis for analyzing the impacts of the proposed EIS alternatives. These impacts are measured in terms of percentage

changes from the calculational baseline. Neither the calculational baseline nor the impact analysis itself is intended to be a precise forecast of future economic conditions in the Tri-Cities MSA. Any forecast that extends over 40 years can only project current trends and is subject to unpredictable changes in future economic conditions. The Tri-Cities is in the early stages of an economic transition as Site employment decreases. There are currently little definitive data to indicate how successful attempts to diversify the local economy will be in reducing dependence on the Hanford Site, the area's largest single

employer. Likewise, any estimates of future Hanford Site employment under any scenario must be considered as estimates rather than definitive data. The calculational baseline estimate, however, provides a consistent projection of one possible path for Hanford Site employment that can be used as the basis for analyzing and comparing the impacts of the EIS alternatives. Changes in future Hanford Site employment or future Tri-City MSA employment would affect the amount of population growth, taxable sales growth, housing price changes, and other socioeconomic factors analyzed in the

EIS. However, such future employment changes would affect all EIS alternatives equally and thus would not affect the comparison of the relative impacts of the alternatives.

H.2.0 ECONOMETRIC FORECASTING MODEL METHODOLOGY

Quantitative projections of the impacts of the TWRS EIS alternatives on nonfarm employment, population,

housing prices, and taxable retail trade were obtained by regression analysis, using Hanford Site employment as the

key independent variable. The regression analysis used data from historical experience to determine the statistical

relationship between Hanford Site employment and total Tri-Cities MSA nonfarm employment (1987 to 1993), and the

statistical relationship between nonfarm employment and taxable retail sales (1987 to 1993), population (1980 to 1993), and

housing market conditions (1980 to 1993). These statistical relationships provide information on the potential impacts

# of future changes in Hanford Site employment on retail sales, population, and housing market conditions.

Analyzing the impacts of the EIS alternatives required specific estimates of labor hours for implementing each alternative. In

each case, these labor hours were estimated based on cost and labor input data supplied by the Hanford Site Management and

Operations contractor (WHC 1995a, c, e, f, g, h, i, j, n) and by the TWRS EIS contractor (Jacobs 1996). The data first were

estimated as annual average full-time equivalent employees, then interpolated to obtain quarterly full-time

equivalent employees (at annual rates). The labor estimates for the EIS alternatives then were added to the calculational

baseline estimate of total Hanford Site employment to obtain total Hanford Site employment estimates under each alternative.

The estimates of total Hanford Site employment associated with the EIS alternatives then were used to estimate impacts on nonfarm

employment in the Tri-Cities MSA. Because Hanford Site activities do not impact farm employment, the analysis addresses nonfarm

employment only. Nonfarm employment then was used to estimate impacts on taxable retail sales and population.

Population was used to estimate impacts on housing prices.

The econometric model used to estimate impacts

accounts for the "multiplier effect" of Hanford Site jobs on the Tri-Cities economy. For each new job at the Hanford Site,

it was estimated that approximately 2.4 jobs would be created in the nonfarm employment sector. These jobs,

as well as the new Hanford Site jobs, then were used in estimating other impacts, including taxable retail sales, population, and housing

market conditions. This 2.4 multiplier is in reasonably close agreement with employment multipliers used in other recent

Hanford Site National Environmental Policy Act (NEPA) documents. For example, the Safe Interim Storage of

Hanford's Tank Waste Final EIS (DOE 1995i) used a 2.2 multiplier based on input/output analysis by the Pacific Northwest

National Laboratory. However, the model used for the TWRS is based on historical data for the Tri-Cities

through the end of 1993, whereas the Pacific Northwest National Laboratory multiplier was developed in the

late 1980's and is considered to be less representative of current economic conditions. These two models are the only known

comprehensive economic models that were developed by analyzing the local economy.

All equations are

linear and were estimated using ordinary least squares. The following sections of this appendix (H.2.1 through H.2.4) document

the regression equations used in the quantitative assessments.

H.2.1 EMPLOYMENT

The regression equation for total Tri-Cities MSA nonfarm employment uses quarterly data from the third quarter of 1987 to the fourth quarter of 1993 and has the following

explanatory variables:

X1 = Hanford Site employment (full-time equivalent employees);
X2 = Time trend;
X3 = First quarter dummy variable;
X4 = Lagged Hanford Site employment (one year or four quarters); and
Y1 = Nonfarm employment.

The time trend starts at one for the third quarter of 1987. Data on Hanford Site employment were obtained from the DOE Richland Operations Office. Data on Tri-Cities MSA employment were obtained from

the Washington State Department of Employment Security (WSDES 1993b). Table H.2.1.1 shows the data used to estimate the regression equation. The T-value for each estimated parameter (a measure of the statistical significance of the estimated parameter, where a T-value greater than two means that there is a high degree of confidence that the true value of the parameter is different than zero) is shown in parentheses. The adjusted R-squared value (a measure of the goodness-of-fit of the estimated equation) is shown immediately after the equation. An adjusted R-squared value of 1.0

indicates a perfect fit.

The estimated equation for employment is:

Y1 = 36998.466489 + 2.438843 X1 + 209.789246 X2 - 1500.74503 X3 - 0.822646 X4

(4.574603) (3.103108) (1.039399) (-4.539982) (-4.440990)

Adjusted R-squared: 0.986

Note:

. = Multiplied by

H.2.2 TAXABLE RETAIL SALES

The regression equation for taxable retail sales uses quarterly data from the third quarter of 1987 to the third quarter of 1993 (the latest data available). The equation has the following explanatory variables:

X5 = Time trend;
X6 = Quarterly nonfarm employment at annual rates;
X7 = First quarter dummy variable;
X8 = Fourth quarter dummy variable; and
Y2 = Taxable retail sales.

The data on taxable retail sales were obtained from the Washington State

Department of Revenue (WSDR 1993). Table H.2.2.1 shows the data used to estimate the regression equation.

The equation for taxable retail sales is:

Y2 = -68.899165 + 5.089547 X5 + 0.005126 X6 - 37.779538 X7 + 0.687021 X8

(-0.613913) (3.652568) (2.471805) (-4.976665) (0.108059)

Adjusted R-squared: 0.964

Note:

. = Multiplied by

H.2.3 POPULATION

The regression equation for population in the Tri-Cities MSA used annual data on population for 1980 to 1993. The explanatory variables are:

X14 = Time trend;
X15 = Annual average nonfarm employment, with a lag of 1 year; and
Y3 = Population.

The time trend starts at one for 1980, although 1980 is not used in the regression because lagged employment is used. The data on population comes from the 1980 and

1990 U.S. Census (DOC 1991) and the Washington State Department of Financial Management (WSDFM 1987-95) for years other than 1980 and 1990. Table H.2.3.1 shows the data used in the regression analysis.

The equation for population is:

Y3 = 58107.265102 + 358.944822 X14 + 1.465489 X15
(3.805755) (1.160945) (5.370630)
Adjusted R-squared: 0.764
Note:
. = Multiplied by

H.2.4 AVERAGE HOME

PRICES

The regression equation for the average home price in the Tri-Cities MSA used annual data for 1980 to 1993 (HBA 1994). The explanatory variables are:

X9 = Time trend;
X10 = Population; and
Y4 = Average home price.

Data on home prices were obtained from the Tri-Cities Association of Realtors (TAR 1995). Table H.2.4.1 shows the data used to estimate the equation.

The equation for the average home price is:

$$Y4 = -176.372436 + 0.508830\ X9 + 0.001653\ X10$$

(-7.901429) (1.755588) (10.435336)

Adjusted R-squared: 0.926

Note:

. = Multiplied by

H.3.0 TWRS EIS ALTERNATIVES IMPACT

PROJECTIONS

For each EIS alternative, the economic impact estimates were made using the following four

steps.

Estimates of total Hanford Site employment under the alternative were used to estimate

quarterly nonfarm employment. Estimated quarterly nonfarm employment was used to estimate

quarterly taxable retail sales. Quarterly sales were summed for each year to yield estimated annual taxable retail sales.

Quarterly sales estimates of nonfarm employment for each year were averaged to estimate the average annual

employment for that year. Average annual employment was lagged 1 year and then used to estimate population.

Annual population estimates were used to estimate average annual home prices.

H.3.1 HANFORD SITE EMPLOYMENT PROJECTIONS

This section provides detail on the development of the employment estimates for the EIS alternatives. For each alternative, the annual average employment was estimated for each phase of activity based on engineering data and cost estimates provided by the Hanford Site Management and Operations contractor (WHCa, c, e, f, g, h, i, j, n) and the TWRS EIS contractor (Jacobs 1996).

Employment for each phase of each EIS alternative was divided into three phases for purposes of this analysis. These phases are 1) construction of

facilities; 2) facilities operations; and 3) post remediation, including decontamination and decommissioning (D&D) of remediation facilities and monitoring and maintenance (M&M) activities as applicable. Activities for each phase then were divided into waste retrieval, waste transfer, and waste processing activities. For analytical purposes, the estimates of waste retrieval and processing activities were aggregated into the construction, operations, and post-remediation phases. Each alternative would also involve routine operations of the tank farms that, for all alternatives except No Action and

Long-Term Management, would be phased out over time as remediation occurs.

Once total annual average employment for each alternative was derived by combining the annual data for the various phases, the data were converted to quarterly employment by straight line interpolation. Interpolation was used to build ramp-up and ramp-down periods into the quarterly Hanford Site employment data, which more accurately reflect the process of increasing or decreasing staffing levels for large-scale projects. However, because of

the interpolations, annual average Hanford Site employment data as used in the forecasts and reported in Tables H.3.2.1 through H.3.2.3 will differ slightly from the annual employment data reported in Tables H.3.1.1 through H.3.1.10. Then, the quarterly data for the alternatives were added to the calculational baseline of quarterly average total Hanford Site employment. The resulting estimate of total Hanford Site employment under each alternative then was input to the forecasting model to produce the socioeconomic impact analysis for the Tri-Cities MSA.

No Action Alternative (Tank Waste)

The No Action alternative would have one phase: routine tank farm operations. Figure H.3.1.1 and Table H.3.1.1 show the number of potential full-time equivalent employees by phase under this alternative. The routine tank farm operations phase assumes that routine operations would be maintained at the TWRS program Tri-Party Agreement level through 2005. After 2005, the TWRS program Tri-Party Agreement would involve a steady phaseout of routine operations, while the No Action alternative would maintain routine

operations staffing at the 2005 level of just over 1,000 full-time equivalent employees. The difference between routine operations employment under the No Action alternative and under the TWRS program Tri-Party Agreement was used to calculate total employment for the No Action alternative. Use of the TWRS program Tri-Party Agreement routine operations estimates in the baseline estimate resulted in the need to add employment to the No Action alternative estimates from 2005 through 2029. The jobs were added to maintain employment levels at 1,016 for routine operations.

Long-Term Management Alternative

The Long-Term Management alternative would have two phases: 1) routine tank farm operations; and 2) tank replacement (which would include waste retrieval and transfer activities as well as new tank construction).

The routine operations phase of the Long-Term Management alternative is identical to the routine operations phase for the No Action alternative. The Long-Term Management alternative assumes that the double-shell waste tanks would be replaced every 50 years. The data in Table H.3.1.2 and Figure H.3.1.2 show one such replacement cycle in the 2030's. Future tank replacements would occur beyond the 2040 time frame for the analysis in this EIS.

In Situ Fill and Cap Alternative

This alternative would involve neither a waste retrieval and transfer or a D&D phase. The phases for the In Situ Fill and Cap alternative would include:

- Construction (install fill equipment);
- Fill and cap operations;

Post remediation - M&M and tank closure; and

- **Routine tank farms operations.**

Employment under this alternative would be low; a maximum change from the calculational baseline of less than 150 in the peak year, which is approximately 1 percent of the calculational baseline total Hanford Site employment. Figure H.3.1.3 and Table H.3.1.3 show the number of full-time equivalent employees by phase for the In Situ Fill and Cap alternative. Under this alternative, routine tank farm operations would differ greatly from the TWRS

program Tri-Party Agreement estimate. The In Situ Fill and Cap alternative would result in a faster completion of tank waste remediation, which would result in routine operations being phased out sooner. The calculation of Hanford Site employment under the In Situ Fill and Cap alternative includes the difference between routine tank farm operations under the TWRS program defined in the Tri-Party Agreement and routine operations under the In Situ Fill and Cap alternative. This difference would represent a reduction in Hanford Site employment, as compared to the

baseline. Because of this difference, the estimate of employment impacts presented in Figure H.3.1.3 and Table H.3.1.3 show a negative estimate of total employment under the alternative from 2023 through 2030. This comparison only represents a negative number of jobs compared to the baseline estimate.

In Situ Vitrification Alternative

The In Situ Vitrification alternative would not involve waste retrieval and transfer but would involve a relatively minor D&D phase. The operations phases for this alternative would

include:

- Vitrification facilities construction;
- Vitrification operations;
- Post-remediation activities - M&M, D&D, and tank closure; and
- Routine tank farm operations.

Figure H.3.1.4 and Table H.3.1.4 show the number of full-time equivalent employees by phase for the In Situ Vitrification alternative.

Ex Situ Intermediate Separations Alternative

The Ex Situ Intermediate Separation s alternative would involve the

following phases:

- **Waste retrieval and transfer - construction;**
- **Waste retrieval and transfer - operations;**
- **Waste retrieval and transfer - D&D;**
- **Waste processing - construction;**
- **Waste processing - operations;**
- **Post remediation - M&M, D&D, and tank closure; and**
- **Routine tank farm operations.**

Figure H.3.1.5 and Table H.3.1.5 show projected employment for each phase of the alternative. The routine operations phase is identical to the

routine operations estimate for the TWRS program as defined in the Tri-Party Agreement, and it is therefore currently built into the baseline projection as part of the current forecast of Hanford Site employment. Because of this, routine operations were not separately incorporated into the calculated Hanford Site employment for this alternative. Construction employment for both waste retrieval and transfer and for the vitrification facilities would peak in the year 2000 and decline sharply through 2010. Operations employment would begin in 1997, climb steadily from 2001 through

2003, level off for several years, and then climb sharply in 2009 when full-scale waste processing operations would begin. Operations employment would drop off sharply in 2019, at which point post-remediation activities would be conducted.

Ex Situ No Separations Alternative

This alternative's breakdown by phase is the same as for the Ex Situ Intermediate Separations alternative. Figure H.3.1.6 and Table H.3.1.6 show employment for the Ex Situ No Separations alternative by construction, operations, and post-

remediation phases. The data show a large spike in construction activity in the period 1997 to 2003. Not only would the level of employment for construction reach almost 4,500 jobs in 2000, but the period of construction activity would be very short, with construction jobs falling to 3,000 in 2001 and below 1,000 by 2003.

Ex Situ Extensive Separations Alternative

Employment would involve the same phases for this alternative as for the Ex Situ Intermediate Separations alternative. As shown in Figure

H.3.1.7 and Table H.3.1.7, employment under the alternative would result in two spikes in construction activity. Both spikes would occur during construction of the waste processing facilities. The boom-bust cycle reflected by the two spikes would result in substantial economic impacts because of the transient nature of crews working on large construction projects. The Tri-Cities MSA experienced similar conditions in the early 1980's with the Washington Public Supply System nuclear project (as noted in Section 4.6).

Ex Situ/In Situ Combination 1 Alternative

This alternative is a combination of the In Situ Fill and Cap alternative and the Ex Situ Extensive Separations alternative. The waste from approximately 70 tanks would be retrieved, transferred, and processed as described for the Ex Situ Intermediate Separations alternative, with the remaining tanks undergoing fill and cap construction and operations activities as described for the In Situ Fill and Cap alternative. The breakdown by phases for Ex Situ/In Situ Combination 1 alternative

would be as follows:

In Situ Fill and Cap Component

- Construction (install fill equipment)
- Waste retrieval and transfer - construction
- Post remediation M&M, D&D; and tank closure; and
- Waste retrieval and transfer - D&D
- Waste processing - operations
- Routine tank farm operations

Ex Situ Intermediate Separations Component

- Fill and cap operations
- Waste retrieval and transfer - operations
- Routine tank farm operations
- Waste processing - construction
- Post remediation M&M, D&D, and tank closure; and

Figure H.3.1.8 and Table H.3.1.8 show estimated employment under the Ex Situ/In Situ Combination 1 alternative by project phase. Construction activity, including both waste retrieval and transfer and waste processing facilities, would peak in 2000, and then begin a steady decrease through 2010. After several years of level employment, construction activity then would fall

steadily until it ends in 2018. Operations, including both transfer and retrieval and waste processing, would begin to increase in the late 1990's with a fairly level period between 2003 and 2009. This would be followed by a large increase to a peak level in 2010, when waste processing would reach its full operational status. After 2018, operations would decline sharply when the post-remediation activity (including tank closure and D&D of facilities) would occur. Except for minimal M&M activities, total Hanford Site employment for the Ex Situ/In Situ Combination 1 alternative and the calculational

baseline would converge by 2030.

Ex Situ/In Situ Combination 2 Alternative

This alternative is very similar to the Ex Situ/In Situ Combination 1 alternative except that wastes would be retrieved from 25 tanks rather than from approximately 70 tanks under the Ex Situ/In Situ Combination 1 alternative. The remainder of the 177 tanks would undergo fill and cap construction and operations activities as described for the Ex Situ/In Situ Combination 1 alternative. The primary difference

between the two Ex Situ/In Situ Combination alternatives is that the Ex Situ/In Situ Combination 2 alternative would involve scaled-down waste retrieval, waste transfer, and waste processing activities, which include pretreatment, LAW processing, high-level waste (HLW) processing, LAW vaults, and HLW temporary storage. This smaller scale of operations is because there would be fewer tanks from which the waste would be retrieved and a smaller volume of waste to be processed. The smaller scale of operations generally would result in lower levels of employment to implement the Ex

Situ/In Situ Combination 2 alternative than would be required for the Ex Situ/In Situ Combination 1 alternative, particularly during the operations phase. However, the timing of the employment peaks and the nature and duration of the various phases of activity would be similar between these two alternatives.

Peak construction phase employment under the Ex Situ/In Situ Combination 2 alternative would occur in the year 2001 at about 2,200 workers. Over the 14-year construction period, employment would average about 1,400 workers.

Over the 35-year operating period under this alternative, there would be a broad peak employment period from the year 2008 to 2019. During this peak period, employment would average approximately 750 workers. Over the entire 35-year operations period, employment would average about 430 workers.

As mentioned in Section H.1.0, no detailed year-by-year employment data were generated for the Ex Situ/In Situ Combination 2 alternative, nor was any socioeconomic modeling performed to assess its impacts. Thus, this appendix contains no detailed

data tables or graphics for this alternative, either describing employment under the alternative or evaluating its impacts on overall Tri-Cities nonfarm employment, population, taxable retail sales, or housing prices. The lower levels of employment under this alternative compared to the Ex Situ/In Situ Combination 1 alternative would result in smaller socioeconomic impacts on the Tri-Cities area.

Phased Implementation Alternative

The Phased Implementation alternative differs from the other

alternatives, and this difference is reflected in the economic impact analysis. Phased Implementation would involve a demonstration phase (Phase 1) and a full-scale treatment phase (Phase 2). The demonstration phase would involve two combined separations and LAW facilities and one separations and HLW vitrification facility. After completing the demonstration phase, the demonstration plants would be shut down and two LAW vitrification facilities and one HLW vitrification facility would be built, together with waste retrieval and transfer facilities. The full-scale facilities would operate

through 2025. The economic impact analysis is divided into two parts; Phase 1 covers the demonstration phase only, and the total alternative covers the entire Phased Implementation alternative.

Labor force requirements for the Phased Implementation alternative were based on the Ex Situ Intermediate Separations alternative, scaled for the reduced size of the facilities, and include construction, operation, and post-remediation labor force for the two plants. In addition, there was a further 15 percent reduction in labor force requirements based on an improved overall efficiency in operating personnel operations during the first phase.

Phase 1

Phase 1 of the Phased Implementation alternative would consist of construction, operations, and post remediation (including D&D).

Because this alternative would involve a reduced-scale demonstration and terminate in 201 2 after processing only a portion of the tank waste, routine operations are assumed to be the same as under the calculational

baseline and are not separately identified. Also, M&M activities are not included because of the limited duration of the alternative. A small number of workers would be involved in transferring waste from the tanks to the treatment facility and are included in the operations phase labor force projections. Figure H.3.1.9 and Table H.3.1.9 show the labor force projections for each element of the alternative. Since publication of the Draft EIS, changes in Phase 1 of this alternative resulted in estimated employment levels that are within 2 percent of the levels presented in the Draft EIS. Thus, socioeconomic

impacts for Phase 1 would be very similar to those presented in the Draft EIS.

Total Alternative

The total Phased Implementation alternative would consist of construction, operations, post remediation (including D&D and M&M), and routine operations.

Labor requirements for the total Phased Implementation alternative track the Phase 1 labor requirements through 2003. Construction of waste retrieval and transfer facilities for

Phase 2 would begin in 2004. Construction of the waste treatment facility would begin in 2005. Operation of the Phase 2 waste retrieval and treatment facilities would extend through 2025. D&D of the waste retrieval and transfer facilities would begin in 2015 and extend through 2027, while D&D of the waste treatment facilities would begin in 2022 and extend through 2030. Tank closure would begin in 2016 and conclude in 2039. Routine operations virtually would be the same as in the calculational baseline, except for some accelerated reduction in the labor force after 2020. Figure

H.3.1.10 and Table H.3.1.10 show the labor force projections for each phase.

Capsule Alternatives

The maximum number of employees that would be involved in implementing any of the capsule alternatives would be 47 employees in the peak year. This low level of employment will not have a measurable impact on current and future socioeconomic conditions. For this reason, the socioeconomic impacts of capsule alternatives were not modeled. However, where appropriate, data regarding employment under the alternatives are presented in Section 5.6.

H.3.2 DATA TABLES FOR IMPACTS OF TWRS EIS ALTERNATIVES

The annual impacts of the EIS alternatives are presented in the following data tables.

Data regarding Hanford Site employment are presented in Tables H.3.2.1, H.3.2.2, and H.3.2.3. Tri-Cities nonfarm employment data are presented in Tables H.3.2.4, H.3.2.5, and H.3.2.6. Data regarding Tri-Cities

population are presented in Tables H.3.2.7, H.3.2.8, and H.3.2.9. Tri-Cities taxable retail sales data are presented in Tables H.3.2.10, H.3.2.11, and H.3.2.12 and data regarding Tri-Cities housing prices are presented in Tables H.3.2.13, H.3.2.14, and H.3.2.15.

For all tables presented in this Appendix, routine operations are those in addition to routine operations labor requirements under the TWRS program Tri-Party Agreement estimate, which includes approximately 1,000 employees for routine operations through 2005 and

a phaseout of employment through 2029. The employment estimate assumes employment for routine operations would continue at 1995 levels through 2040. Negative numbers in Tables H.3.1.3 to H.3.1.10 and H.3.2.1 to H.3.2.15 result from the phaseout of routine operations on an earlier schedule than included in the TWRS program Tri-Party Agreement estimates.

FIGURES:

Employees (Change from Baseline Estimate) - Ex Situ Intermediate Separations Alternative, 1995 to 2040

Figure H.3.1.6 Full-Time Equivalent Employees (Change from Baseline Estimate) - Ex Situ No Separations Alternative, 1995 to 2040

Figure H.3.1.7 Full-Time Equivalent Employees (Change from Baseline Estimate) - Ex Situ Extensive Separations Alternative, 1995 to 2040

Figure H.3.1.8 Full-Time Equivalent Employees (Change from Baseline Estimate) - Ex Situ/In Situ

Combination 1 Alternative, 1995 to 2040

Figure H.3.1.9 Full-Time Equivalent Employees (Change from Baseline Estimate) - Phased Implementation Alternative (Phase 1), 1995 to 201 3

Figure H.3.1.10 Full-Time Equivalent Employees (Change from Baseline Estimate) - Phased Implementation (Total Alternative), 1995 to 2040

TABLES:

Table H.2.1.1 Regression Data for Nonfarm Employment in the Tri-Cities MSA

Employees by Phase (Change from Baseline Estimate) - Long-Term Management Alternative, 1995 to 2040

Table H.3.1.3 Full-Time Equivalent Employees by Phase (Change from Baseline Estimate) - In Situ Fill and Cap Alternative, 1995 to 2040 [1]

Table H.3.1.5 Full-Time Equivalent Employees by Phase (Change from Baseline Estimate) - Ex Situ Intermediate Separations Alternative, 1995 to 2040

Table H.3.1.6 Full-Time Equivalent

Employees by Phase (Change from Baseline Estimate) - Ex Situ No Separations Alternative, 1995 to 2040

Table H.3.1.7 Full-Time Equivalent Employees by Phase (Change from Baseline Estimate) - Ex Situ Extensive Separations Alternative, 1995 to 2040

Table H.3.1.8 Full-Time Equivalent Employees by Phase (Change from Baseline Estimate) - Ex Situ/In Situ Combination 1 Alternative, 1995 to 2040

Table H.3.1.9 Full-Time Equivalent Employees by Element (Change from

Baseline Estimate) - Phased Implementation Alternative (Phase 1), 1995 to 2014

Table H.3.1.10 Full-Time Equivalent Employees by Element (Change from Baseline Estimate) - Phased Implementation Alternative (Total Alternative), 1995 to 2040

Table H.3.2.1 Hanford Site Employment with the No Action, Long-Term Management, and In Situ Fill and Cap Alternatives (Change from Baseline Estimate), 1994 to 2040 (Full-Time Equivalent Employees)

Table H.3.2.2 Hanford Site Employment with the In Situ Vitrification, Ex Situ Intermediate Separations, and Ex Situ No Separations Alternatives (Change from Baseline Estimate), 1994 to 2040 (Full-Time Equivalent Employees)

Table H.3.2.3 Hanford Site Employment with the Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1 , and Phased Implementation Alternatives (Change from Baseline Estimate), 1994 to 2040 (Full-Time Equivalent Employees)

Table H.3.2.4 Tri-Cities MSA

Nonfarm Employment with the No Action, Long-Term Management, and In Situ Fill and Cap Alternatives (Change from Baseline Estimate), 1994 to 2040

Table H.3.2.5 Tri-Cities MSA Nonfarm Employment with the In Situ Vitrification, Ex Situ Intermediate Separations, and Ex Situ No Separations Alternatives (Change from Baseline Estimate), 1994 to 2040

Table H.3.2.6 Tri-Cities MSA Nonfarm Employment with the Ex Situ Extensive Separations, Ex Situ/In Situ Combination 1 , and Phased

Implementation Alternatives (Change from Baseline Estimate), 1994 to 2040

Table H.3.2.7 Tri-Cities MSA Population with the No Action, Long-Term Management, and In Situ Fill and Cap Alternatives (Change from Baseline Estimate), 1994 to 2040

Table H.3.2.8 Tri-Cities MSA Population with the In Situ Vitrification, Ex Situ Intermediate Separations, and Ex Situ No Separations Alternatives (Change from Baseline Estimate), 1994 to 2040

Table H.3.2.11 Tri-Cities MSA

Taxable Retail Sales with the In Situ Vitrification, Ex Situ Intermediate Separations, and Ex Situ No Separations Alternatives (Change from Baseline Estimate), 1994 to 2040 ($ Millions)

Table H.3.2.14 Tri-Cities MSA Home Prices with the In Situ Vitrification, Ex Situ Intermediate Separations, and Ex Situ No Separations Alternatives (Change from Baseline Estimate), 1994 to 2040 ($ Thousands)

Table H.3.2.15 Tri-Cities MSA Home Prices with the Ex Situ Extensive Separations, Ex Situ/In Situ

Combination 1 , and Phased Implementation Alternatives (Change from Baseline Estimate), 1994 to 2040 ($ Thousands)

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APPENDIX I

AFFECTED ENVIRONMENT

ACRONYMS AND ABBREVIATIONS

ADT	average daily traffic
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
CLUP	Comprehensive Land Use Plan
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
dBA	decibels on the A scale
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FEALE	Fitzner Eberhardt Arid Lands Ecology
HMS	Hanford Meteorological Station
HSDP	Hanford Site Development Plan
L_{eq}	Level equivalent sound
LOS	Level of Service
MMI	Modified Mercalli Intensities
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHA	National Emission Standards for Hazardous Air Pollutants
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NWR	National Wildlife Refuge
PCB	polychlorinated biphenhyl
PM-10	particulate matter nominally greater than 10µm
	ppm parts per million
PSD	prevention of significant deterioration
PUREX	Plutonium-Uranium Extraction
SCS	Soil Conservation Service
SST	single-shell tank
TRAC	Track Radioactive Component

TWRS	Tank Waste Remediation System
USFWS	U.S. Fish and Wildlife Service

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length

cm	centimeter
ft	foot
in	inch
km	kilometer
m	meter
mi	mile

Area

ac	acre
ft^2	square foot
ha	hectare
km^2	square kilometer
mi^2	square mile

Volume

cm^3	cubic centimeter
ft^3	cubic foot
gal	gallon
L	liter
m^3	cubic meter
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard

Mass

g	gram
kg	kilogram
lb	pound
mg	milligram
mt	metric ton

Radioactivity

Ci	curie
MCi	megacurie (1.0E+06 Ci)
mCi	millicurie (1.0E-03 Ci)
Ci	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

Electricity/Energy

A	ampere
J	joule
kV	kilovolt
kW	kilowatt
MeV	million electron volts
MW	megawatt
V	volt
W	watt

Temperature

C degrees centigrade

F degrees Fahrenheit

? ? ? ? ?

I.1.0 INTRODUCTION

This appendix describes the environmental setting for the proposed Tank Waste Remediation System (TWRS) activities at the Hanford Site. By describing the environmental conditions that could be potentially impacted by TWRS activities, this appendix provides the context and basis for analyzing the impacts of the Environmental Impact Statement (EIS) alternatives. Data to support comparisons between the potential impacts of the various EIS alternatives are also provided within this appendix. Existing conditions are discussed for all aspects of the environment (soil, groundwater, air, plant and animal species habitats, socioeconomic conditions, biological and ecological resources, cultural resources, land use, visual resources, noise, and transportation). Additional details on existing environmental conditions can be found in the Hanford Site National Environmental Policy Act (NEPA) Characterization Report (Cushing 1994 and 1995 , Neitzel 1996), the Hanford Environmental Report for Calendar Year s 1994 and 1995 (PNL 1995 and 1996), and in other references cited within the text. Information on the potential TWRS borrow sites was obtained largely from the Site Evaluation Report for Candidate Basalt Quarry Sites (Duranceau 1995).

The Hanford Site is in the semi-arid region of the Columbia Plateau in southeastern Washington State (Figure I.1.0.1). The Hanford Site occupies about 1,450 square kilometers (km^2) (560 square miles [mi^2]) of shrub and grasslands just north of Richland, Washington. The majority of this large land area, with restricted public access, provides a buffer to the smaller areas within the Hanford Site historically used for producing nuclear materials, waste storage, and waste disposal. About 6 percent of the land has been disturbed and is actively used. The Hanford Site extends approximately 77 kilometers (km) (48 miles [mi]) north to south and 61 km (38 mi) east to west.

The Columbia River flows through the northern part of the Hanford Site, turning south to form part of its eastern boundary. The Yakima River runs along part of the southern boundary and joins the Columbia River at the city of Richland. Adjoining lands to the west, north, and east are principally range and agricultural land. The cities of Richland, Kennewick, and Pasco (also known as the Tri-Cities) comprise the nearest population centers and are located southeast of the Site.

I.1.1 GEOLOGY AND SOIL

Geologic information on the Hanford Site (Figure I.1.1.1) has been collected in connection with a variety of Site activities. Reports by Delaney (Delaney et al. 1991), Reidel (Reidel et al. 1992), and Cushing (Cushing 1994), summarizing the information collected during many of these activities, are the primary basis for the following overview of the Hanford Site's subsurface environment.

The geology of the Hanford Site forms the framework for the Site's groundwater and surface water resources. Of particular relevance are 1) the topography, which impacts surface water flows and infiltration; 2) the vadose zone, because of potential impacts associated with releases during proposed TWRS activities; and 3) the saturated sediments beneath the vadose zone that form the unconfined aquifer, because of potential impacts from releases that pass through the vadose zone from proposed TWRS activities.

Figure I.1.0.1 Hanford Site and Vicinity

Figure I.1.1.1 Geographic Setting and General Structural Geology of the Pasco Basin and Hanford Site

The geology and water resources sections focus primarily on conditions in the 200 Areas, where the tank waste and strontium (Sr) and cesium (Cs) capsules are located and where virtually all TWRS facilities, except for three potential borrow sites, would be located under any of the EIS alternatives. The potential Pit 30 borrow site, a possible source of sand and gravel, is located between the 200 East and 200 West Areas. The geologic setting of the Pit 30 area is the same as is described for the 200 Areas. The potential McGee Ranch and Vernita Quarry borrow sites, possible sources of silt (McGee) and basalt (Vernita), are located approximately 6 km (4 mi) north and west of the 200 West Area.

Geologic conditions for the McGee Ranch and Vernita Quarry areas are briefly described in the following sections.

I.1.1.1 Topography and Geomorphology

The existing tank farms are on a broad flat area called the Central Plateau, which overlies an alluvial terrace (Figure I.1.1.1). The Central Plateau is in a portion of the Pasco Basin, a topographic, structural depression in the southwest corner of the Columbia Basin physiographic subprovince. This subprovince is characterized by generally low-relief hills with deeply incised river drainage. The Central Plateau's elevation is approximately 200 meters (m) (650 feet [ft]) to 230 m (750 ft) above sea level. The Plateau decreases in elevation to the north, northwest, and east toward the Columbia River. Plateau escarpments have elevation changes of 15 m (50 ft) to 30 m (100 ft). The proposed Vernita Quarry and McGee Ranch borrow sites are located to the west of the northern portions of the Central Plateau.

The Pasco Basin is an area of generally low relief ranging from 120 m (390 ft) above mean sea level at the Columbia River level, to 230 m (750 ft) above mean sea level in the vicinity of the TWRS sites in the 200 East Area. The Pasco Basin is bounded on the north by the Saddle Mountains; on the west by Umtanum Ridge, Yakima Ridge, and the Rattlesnake Hills; on the south by Rattlesnake Mountain and the Rattlesnake Hills; and on the east by the Palouse Slope (Figure I.1.1.1).

Surface topography at the Hanford Site is the result of the uplift of anticlinal ridges, Pleistocene cataclysmic flooding, Holocene eolian activity, and landslides (Delaney et al. 1991). Uplift of the ridges began in the Miocene Epoch, concurrent with the eruption of the flood basalts and continues to present. Cataclysmic flooding occurred when glacial ice dams in western Montana and northern Idaho were breached, allowing large volumes of water to spill across eastern and central Washington State. Much of the landscape in the path of the floodwater was stripped of sediments and basalt bedrock was scoured, forming scabland topography (elevated areas underlain by flat-lying basalt flows that generally exhibit deep, dry channels scoured into the surface). The last major flood occurred approximately 13,000 years ago during the late Pleistocene Epoch.

Braided flood channels with giant water current ripples, bergmounds (hummocky areas where grounded icebergs melted), and giant flood bars are among the landforms created by flooding that are apparent on the Hanford Site. Since the end of the Pleistocene Epoch, winds have reworked the flood sediments locally, depositing sand dunes in the lower elevations and loess (wind-blown silt) around the margins of the Pasco Basin. Sand dunes generally have been stabilized by anchoring vegetation, except in localized areas where they have been reactivated around disturbed vegetation and within the barchan dune complex in the west-central portion of the Site.

Observed landslide activity in the area is generally limited to the White Bluffs area east of the Hanford Site and the Rattlesnake Hills south of the Hanford Site. No landslide activity has been observed in the vicinity of the tank farms or the TWRS sites in the 200 East Area.

I.1.2 GEOLOGIC STRUCTURE

The Hanford Site lies in the Pasco Basin near the eastern limit of the Yakima Fold Belt. The Pasco Basin is a structural depression bounded by anticlinal ridges on the north, west, and south and a monocline on the east (Figure I.1.1.1). The Pasco Basin is divided by the Gable Mountain anticline in the Wahluke syncline to the north and the Cold Creek syncline to the south. Geologic materials that include basalts and sediments thicken into the Pasco Basin and generally reach maximum thickness in the Cold Creek syncline (Delaney et al.1991).

The 200 Areas are situated between the Gable Mountain anticline and the Cold Creek syncline (Figure I.1.1.1). The Gable Mountain anticline is of particular importance to groundwater flow in the unconfined aquifer. This anticline consists of a series of southeast to northwest trending folds (Trent 1992b). Portions of the Gable Mountain anticline have been uplifted high enough that basalt is above the current water table. These basalts have a low hydraulic conductivity and act as a barrier to horizontal groundwater flow in the unconfined aquifer.

The uppermost basalt underlying the 200 Areas is the Elephant Mountain Member of the Saddle Mountain Basalt Formation (Trent 1992a and b). Two adjacent boreholes north of the 200 East Area (6-53-55 and 6-55-55) encountered the Rattlesnake Ridge interbed of the Ellensburg Formation (Trent 1992b), but the Elephant Mountain Member basalt flow was absent. The absence of the Elephant Mountain Member basalt flow is referred to as a "window" (Trent 1992a and b) and is probably erosional, formed during the Pleistocene cataclysmic flooding. There is no evidence for other substantial erosion into the top of the Elephant Mountain Member and no indication of erosional windows through the basalt into the underlying Rattlesnake Ridge interbed in the 200 West Area (Trent 1992a).

I.1.3 STRATIGRAPHY AND LITHOLOGY

A generalized stratigraphic column illustrating the nomenclature for the formations that underlie the Hanford Site is provided in Figures I.1.3.1 and I.1.3.2.

I.1.3.1 Columbia River Basalt Group

The Columbia River Basalt Group, which is a sequence of basaltic rock found typically on the ocean floor, erupted as basalt flows between 6 and 17 million years ago. These flows cover an area of more than 163,000 km^2(63,000 mi^2) and have an estimated area of 174,000 km^2(40,800 mi^2). The thickness of basalt accumulations in the Pasco Basin is in excess of 3,000 m (10,000 ft) (Delaney et al. 1991). The Columbia River Basalt Group is divided into five formations (from oldest to youngest): Imnaha Basalt, Picture Gorge Basalt, Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Only the Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt are exposed on the Hanford Site. The Elephant Mountain member of the Saddle Mountains Basalt forms the uppermost basalt unit beneath most of the Hanford Site, except near the 300 Area where the Ice Harbor member is present, and north of the Central Plateau near Gable Gap where the Saddle Mountains Basalt has been eroded down to the Umatilla member.

Figure I.1.3.1 Generalized Stratigraphy of the Hanford Site

Figure I.1.3.2 Stratigraphic Column for the Hanford Site Showing Nomenclature From Previous Investigations by Various Authors

I.1.3.2 Ellensburg Formation

The Ellensburg Formation consists of a series of sedimentary units that are interbedded between many of the basalt flows of the Columbia River Basalt Group. The Ellensburg Formation generally displays volcanic characteristics produced by volcanic events in the Cascade Range, and silicic characteristics derived from erosion of the Rocky Mountains. At the Hanford Site, the Ellensburg Formation consists of a mix of sediments deposited by the ancestral Clearwater and Columbia Rivers (Delaney et al. 1991). The three uppermost units of the Ellensburg Formation at the Site are the Levey Interbed, confined to the vicinity of the 300 Area, and the Rattlesnake Ridge and Selah interbeds, found beneath most of the Hanford Site (Delaney et al. 1991).

I.1.3.3 Suprabasalt Sediments

The suprabasalt sediments are a sedimentary sequence overlying the basalts at the Site and include the Ringold and Hanford formations. These sediments are up to approximately 230 m (750 ft) thick in the west-central Cold Creek syncline and pinch-out against the Saddle Mountains, Gable Mountain and Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills anticlines. The suprabasalt sediments are dominated by laterally extensive deposits assigned to the late Miocene to Pliocene Ringold Formation and the Pleistocene Hanford formation. The informally defined Plio-Pleistocene unit, early Palouse soil, and pre-Missoula gravels separate the Ringold Formation and Hanford formation locally.

I.1.3.4 Ringold Formation

The Ringold Formation consists of semi-indurated clay, silt, pedogenically altered sediment, fine to coarse grained sand, and gravel. The Ringold Formation at the Site is up to 180 m (600 ft) thick in the deepest part of the Cold Creek syncline south of the 200 West Area, but is largely absent in the northern and northeastern parts of the 200 East Area and adjacent areas to the north (Delaney et al. 1991, Reidel et al. 1992, and Cushing 1994).

Five sediment facies (or differentiation) associations, defined on the basis of lithology, stratification, and pedogenic (formation and development of soil) alteration, are recognized in the Ringold Formation (Delaney et al. 1991). These sediment facies include:

- Fluvial (produced by action of a stream) gravel deposited in wide-shifting river channels;
- Fluvial sand deposited in shallow channels incised into a muddy floodplain,
- Overbank-paleosol deposits that record deposition on a floodplain;
- Lacustrine (in-lake) deposits that record deposition in a lake; and
- Alluvial fan deposits that record deposition of basaltic detritus around the periphery of the Pasco Basin.

The distribution of facies associations within the Ringold Formation forms the basis for stratigraphic subdivision of the formation (Lindsey 1991). The lower half of the Ringold Formation contains five separate stratigraphic intervals dominated by fluvial gravels. These gravels, designated Units A, B, C, D, and E, are separated by intervals containing deposits typical of the overbank-paleosol and lacustrine facies associations (Delaney et al. 1991). The lowermost of the fine-grained sequences overlying Unit A is designated the lower mud sequence. The uppermost gravel unit, Unit E, grades upward into interbedded fluvial sand and overbank deposits that are in turn overlain by lacustrine-dominated strata.

The lower mud sequence (Figure I.1.3.3) consists of overbank and lacustrine deposits. The lower mud sequence is hydrologically substantive in that it is a potential confining layer that may offer some hydraulic separation between the saturated Ringold Formation above and the underlying Unit A gravels. The lower mud sequence is generally absent in the northern part of the 200 East Area and at the main lobe of B Pond (Trent 1992b). In the 200 West Area, the lower mud sequence is generally present throughout, except in the northeast corner (Trent 1992a). In the 200 West Area, the thickness of the lower mud sequence ranges from over 30 m (100 ft) in the south-central portion of the area to nonexistent in the northeast corner.

I.1.3.5 Post-Ringold and Pre-Hanford Units

Thin, laterally discontinuous alluvial deposits separate the Ringold Formation from the Hanford formation in various parts of the Hanford Site. These deposits are referred to informally as the Plio-Pleistocene unit, pre-Missoula gravels, and early Palouse soil (Figure I.1.3.3). The Plio-Pleistocene unit unconformably overlies the Ringold Formation in the western Cold Creek syncline in the vicinity of the 200 West Area. Depending on location, two types of materials may be present within the Plio-Pleistocene unit: 1) interfingering carbonate-cemented silt, locally referred to as the "caliche layer" (Trent 1992a), sand and gravel, carbonate-poor silt, and sand; and/or 2) basaltic detritus consisting of weathered and unweathered basaltic gravels deposited as locally derived slope wash, colluvium, and sidestream alluvium.

Pre-Missoula gravels are composed of quartzose to gneissic pebble-to-cobble gravel with a sand matrix. These gravels are up to 25 m (82 ft) thick, contain less basalt than underlying Ringold gravels and overlying Hanford deposits, have a distinctive white or bleached color, and sharply truncate underlying strata. The early Palouse soil consists of up to 20 m (66 ft) of silt and fine-grained sand. Deposits composing the early Palouse soil are massive, brownish-yellow, and compact.

I.1.3.6 Hanford Formation

The Hanford formation consists of pebble-to-boulder gravel, fine- to coarse-grained sand, and silt. These deposits are divided into three facies; gravel-dominated, sand-dominated, and silt-dominated (Figure I.1.3.3). These facies are referred to as coarse-grained deposits, plane laminated sand facies, and rhythmite facies, respectively (Reidel et al. 1992). The rhythmites also are referred to as the Touchet Beds or slack water deposits. The Hanford formation is thickest in the vicinity of the Central Plateau where it is up to 65 m (210 ft) thick. The Hanford formation was deposited by cataclysmic flood waters that drained out of a glacial lake named Missoula. Hanford Site deposits are absent on ridges more than approximately 385 m (1,260 ft) above sea level, the highest level of cataclysmic flooding in the Pasco Basin (Reidel et al. 1992).

Figure I.1.3.3 General Stratigraphy of the Suprabasalt Sediments of the Hanford Site

The sand-dominated facies was deposited adjacent to the main flood channelways and is found most commonly in the central Cold Creek syncline in the central to southern parts of the Central Plateau and in the vicinity of the Washington Public Power Supply System facilities. The silt-dominated facies was deposited under slack water conditions in back-flooded areas and is found throughout the central, southern, and western Cold Creek syncline within and south of the Central Plateau.

I.1.3.7 Holocene Surficial Deposits

Holocene surficial deposits consist of silt, sand, and gravel that form a thin (less than 10 m [30 ft]) veneer across much of the Hanford Site. These sediments were deposited by a mix of eolian (wind) and alluvial processes.

I.1.4 MINERAL RESOURCES

The geology of the potential Vernita Quarry and McGee Ranch borrow sites contains successions of basalts flows and suprabasalt sediments similar to those found on the Central Plateau and the areas near these sites along the Columbia River. The Vernita Quarry site is located in the Umatilla flow of the Saddle Mountain basalt. The Umatilla Flow at this location is composed of a single collonade characterized by columns 0.9 to 1.2 m (3.0 to 4.0 ft) wide. A bench approximately 12 to 15 m (40 to 50 ft) thick exists at the current quarry site and extends eastward as part of a series of benches that correspond to erode basalt flows along the valley of the Columbia River. The Pomona flow overlies the Umatilla flow and crops out approximately 300 m (1,000 ft) east of the existing quarry. The Pomona flow locally comprises a single colonnade with columns generally less than 0.6 m (2.0 ft) wide (Duranceau 1995).

At the potential McGee Ranch borrow site, a geological evaluation revealed a layer of fine-grained sediments immediately below the surface that range in thickness from 0.5 m to 10.0 m

(1.5 ft to 33 ft). A layer of silty, sandy gravel was identified directly beneath the surficial layer of fine-grained sediments. Hanford formation sediments overlay the Plio-Pleistocene unit and range in thickness from 0.15 to 12 m (0.5 to 40 ft). The ground surface at McGee Ranch is covered with pebbles, some cobble gravels and occasional boulders (DOE 1994h).

Currently no mineral resources other than crushed rock, sand, and gravel are produced from the Pasco Basin. Deep, natural gas production from anticlines in the basalt has been tested by oil exploration companies without commercial success. There are no current indications of any commercial mineral resource potential at any of the TWRS sites.

I.1.5 GEOLOGIC HAZARDS

Geologic processes that alter topography are landslides, floods, and volcanic activity. Each of these processes are briefly discussed in the following text as they relate to proposed TWRS activities.

I.1.5.1 Landslides

Landslides in the Ringold Formation sediments are common in areas where these sediments have been oversteepened by erosion, such as the White Bluffs area along the Columbia River. The likelihood of such oversteepening in the TWRS site areas is extremely low because of flat topography, a deep water table, and the absence of any actively eroding streams.

I.1.5.2 Floods

The nearest potential flooding source to the TWRS sites is Cold Creek. Studies of the probable maximum flood show that its effect is limited to the southwestern corner of the 200 West Area only (Cushing 1994). Because of the distance from the river, the probable maximum flood on the Columbia River would not impact the 200 Areas or any of the potential borrow sites. Failure of the upstream dams, either because of natural causes or sabotage, would not likely impact the 200 Areas or the potential borrow sites (Cushing 1994).

I.1.5.3 Volcanic Activity

Two types of volcanic activity have impacted the Pasco Basin in the past: basaltic flood volcanism and cascade-style diacitic volcanism to the west. The basaltic volcanism has been latent for the past eight million years and appears unlikely to resume because of changes in the plate tectonic regime of the region. The only source of volcanic activity that could impact the TWRS sites would be volcanism in the Cascade Mountain Range, more than 100 km (60 mi) west of the Hanford Site. The eruption of Mount St. Helens in 1980 is an example of such a volcanic event. This eruption caused considerable ashfall at the Hanford Site.

I.1.6 SEISMICITY

Seismicity at the Hanford Site is dominated by the position of the Site within the back-arc terrain of the Cascadia Subduction Zone formed where the Juan de Fuca Plate slides underneath the North American Plate (DOE 1995i). The back arc terrain of Washington occurs east of the Cascade Mountains and is underlain primarily by Jurassic to early Miocene metamorphic and volcanic rocks, which represent the accreted terrains of past collisions and continental deposits eroded from them (Reidel et al. 1989). Overlying a portion of this terrain is the Columbia Basalt Plateau, a region of thick tholeiitic basalt lava flows. The Hanford Site and proposed TWRS project sites lie within a subprovince of this basalt province known as the Yakima Fold Belt (RHO 1979).

The Yakima Fold Belt is characterized by narrow, linear anticlinal ridges of basalt and broad synclinal basins with an east to east southeast orientation. The folds have wavelengths of between 5 and 32 km (3 and 20 mi), amplitudes of less than 1 km (0.6 mi), and are commonly steeper on the northern limb. The faults in the subprovince appear to be associated with the folding and are found on the flanks of the folds. The folds extend eastward up to 113 km (70 mi) from the Cascade Range Province and were growing during the eruption and emplacement of the basalt and probably continue to grow at the present time (DOE 1988). In general, the structures do not impact the sediments that overlie the basalt.

Sources of seismic activity (earthquakes) at the Hanford Site include shallow structures in the Yakima Fold Belt or Columbia River Basalts. The orientation of the structural fabric of the Yakima Fold Belt suggests an origin by north-south compressional forces that operated from the middle Miocene age to the present. Compression during the extrusion of the lavas resulted in the folds propagating upwards through succeeding flows, folding the latest flow, and faulting the underlying flows (Reidel et al. 1989). The Hooper and Convey Model (Reidel et al. 1989) suggests that the compressive stress is horizontal and transmits deformation in a brittle manner only in the Columbia River Basalt Group (WHC 1993). It is believed that the underlying pre-basalt rocks deform in a ductile fashion and thus do not generate seismic activity. One of the most active areas of shallow earthquake activity is along the Saddle Mountain anticline, north of the Hanford Site (RHO 1979). Seismic activity within deep basement structures does not adequately explain the pattern of seismicity recorded in the region. The most recent seismic hazard analysis of the Hanford Site assumes that seismic activity occurs more or less randomly in the crust (WHC 1993). The source of seismic activity in the region that could potentially impact the Hanford Site is the Cascadia Subduction Zone, which lies off the coast of the Pacific Northwest. Two separate sources of seismic activity exist within this zone: an intraplate source where seismic events occur within the subducted Juan de Fuca oceanic plate, and an interplate source where seismic events occur at the interface of the Juan de Fuca and the North American plates. Of the two, the interplate source has the highest probability of generating earthquakes of a magnitude capable of causing ground motion at the TWRS sites that could impact the proposed facilities (WHC 1993).

I.1.6.1 Earthquake History

The Hanford Site lies in an area of relatively low seismic activity (Figures I.1.6.1. and I.1.6.2). Between 1870 and 1980 only five earthquakes occurred in the Columbia Plateau region that had Modified Mercalli Intensities (MMI) of VI or greater. All these events occurred prior to 1937. The largest event was the July 16, 1936 Milton-Freewater, Oregon earthquake (MMI=VII; surface wave magnitude = 5.8) (DOE 1988). The location of this earthquake and its association with known geologic structures are uncertain (DOE 1988).

Other earthquakes with a Richter magnitude of 5.0 or larger have occurred near Lake Chelan, Washington to the northwest, along the boundary of the Columbia Plateau and the Cascade Mountain range, west and north of the Hanford Site, and east of the Hanford Site in Washington State and northern Idaho. In addition, earthquake swarms of small magnitudes occur on and around the Hanford Site. An earthquake swarm is a series of earthquakes closely related in terms of time and space.

Seismicity with the Columbia Plateau can be segregated into three depth zones: 0 to 4 km (0 to 2.5 mi); 4 to 8 km (2.5 to 5 mi); and deeper than 8 km (5 mi). Approximately 70 to 80 percent of the seismic activity occurs in the 0 to 4 km (0 to 2.5 mi) zone, and 90 percent of the activity occurs in the first two zones (0 to 8 km [0 to 5 mi]) (DOE 1988). Most of the earthquakes in the central Columbia plateau are north or northeast of the Columbia River. Most of the earthquakes in the shallowest zone occur as swarms, which are not associated with mapped faults.

Figure I.1.6.1 Historical Seismicity of the Columbia Plateau and Surrounding Areas

Figure I.1.6.2 Recent Seismicity of the Columbia Plateau and Surrounding Areas as Measured by Seismographs

I.1.6.2 Seismic Hazards

Three major structures of the Yakima Fold Belt are found within the Hanford Site: the Umtanum Ridge-Gable Mountain Structure, the Yakima Ridge Structure, and the Rattlesnake Hills Structure. Each is composed of an asymmetrical anticline over-steepened to the north and with associated faults along their flanks. Two types of faults associated with the folds have been identified. Thrust faults occur on the northern, over-steepened limbs of the folds. These folds are sympathetic to the folds with more or less the same strike as the fold axes. Cross faults with a north-northwest trend cut the linear folds into separate segments and show a right lateral strike-slip movement (Reidel et al. 1989). Existing known faults within the Hanford area include wrench (strike-slip) faults, as long as 3 km (2 mi) on Gable Mountain and the Rattlesnake-Wallula Alignment, which has been interpreted as a right-lateral strike-slip fault. The faults in Central Gable Mountain are considered capable faults by Nuclear Regulatory Commission (NRC) criteria in that they have slightly displaced the Hanford formation gravels, but their relatively short lengths give them low seismic potential. No seismicity associated with the Gable Mountain Fault has been observed. The Rattlesnake-Wallula Alignment is interpreted to be capable faults by the NRC (Supply System 1981).

Earthquake sources considered relevant for the purpose of seismic design of TWRS facilities are the Rattlesnake-Wallula Alignment, Gable Mountain, an earthquake anywhere in the tectonic province, and the swarm area. For the Rattlesnake-Wallula Alignment, which passes along the southwest boundary of the Hanford Site, a maximum Richter magnitude of 6.5 has been estimated. For Gable Mountain, an east-west structure that passes through the northern portion of the Hanford Site, a maximum Richter magnitude of 5.0 has been estimated. An earthquake for the tectonic province was developed from the Milton-Freewater earthquake of Richter magnitude 5.75. A Richter magnitude 4.0 event is considered a maximum swarm earthquake for analyzing TWRS alternatives, based on the maximum swarm earthquake in 1973 (Cushing 1994). The Hanford Site current design basis for new facilities is for facilities to withstand a 0.2 gravity earthquake (Richter Magnitude of approximately 6.4) with a recurrence frequency of 2.0E-04.

I.1.7 SOIL

The surface and near-surface soils in the 200 Areas are not generally well developed and consist of a number of soil types: Rupert sand, Burbank loamy sand, and Ephrata sandy loam. Hezel sand is also present on the western boundary of the 200 West Area. Rupert sand consists of coarse sand and is also known as Quincy sand. Rupert sand covers the majority of the 200 West Area and approximately one-half of the 200 East Area. Burbank sand is coarse-textured sand that covers approximately the northeastern one-third of the 200 West Area, a relatively small portion of the 200 East

Area, and the majority of the area between the 200 West and 200 East Areas, where the potential Pit 30 borrow site (sand and gravel source) is located. Ephrata soil is medium-textured soil and covers the northern portion of the 200 East Area. Hezel sand is similar to Rupert sand and covers a portion of the area on, and immediately west of, the boundary of the 200 West Area. The predominant soil types in the general vicinity of the potential Vernita Quarry and McGee Ranch borrow sites are the Rupert sand and Burbank loamy sand.

I.1.7.1 Soil Contamination

Soil monitoring is conducted to detect the potential migration and deposition of radionuclides because of resuspension from other radioactive contaminated areas (wind-blown or water-borne) and waste intrusion by animals (PNL 1993a). The following contaminants have been consistently detectable in soil on the Hanford Site: cobalt-60 (Co-60), Sr-90, Cs-137, plutonium-239 (Pu-239), Pu-240, and uranium (U). Soil concentrations for these radionuclides were higher near and within Hanford Site facilities compared to offsite concentrations. In general, radionuclide concentrations near waste disposal sites are higher than concentrations further away.

Radiological surveys are conducted on Site areas that are known or suspected to contain surface or subsurface contamination. Areas that exceed specified levels are posted as radiologically controlled areas. A total of over 2,500 hectares (ha) (6,200 acres [ac]) of surface area and 1,030 ha (2,530 ac) of subsurface area were posted at the end of 1994. Ninety percent of the posted surface contamination area and 81 percent of the posted subsurface contamination area are in and near the 200 Areas. The net change in Sitewide surface contaminated areas reduced 44 ha (110 ac) from 1994 to 1995, which includes surface contamination areas, which includes a reduction of 33 ha (82 ac) in the 200 Areas. There was a corresponding net increase in Sitewide posted subsurface contamination areas of 44 ha (110 ac) from 1994 to 1995 , which includes an increase of 33 ha (82 ac) in the 200 Areas (PNL 1995).

I.2.0 WATER RESOURCES

Baseline conditions for water resources and hydrology encompass surface water, vadose zone, and groundwater, each of which may be impacted by implementing proposed TWRS activities.

I.2.1 SURFACE HYDROLOGY, INCLUDING FLOODPLAINS

The following subsections describe surface water resources, including the occurrence and characteristics of surface water, floodplains, and runoff.

I.2.1.1 Occurrence and Characteristics of Surface Water

West Lake and two small spring-fed streams in the Fitzner Eberhardt Arid Lands Ecology (FEALE) Reserve are the only naturally occurring water bodies on the Hanford Site. West Lake is several hectares in size and is located approximately 8 km (5 mi) northeast of the 200 West Area and about 3 km (2 mi) north of the 200 East Area. It is situated in a topographically low-lying area and is sustained by groundwater inflow resulting from an intersection with the groundwater table. West Lake was considered to be an ephemeral lake before operations began at the Hanford Site, with water level fluctuations dependent on groundwater level fluctuations. However, because of recharge (primarily from B Ponds) that contains low-level waste processing and cooling water from B Plant, water levels in the lake have become more stable.

Rattlesnake Springs, located 10 km (6 mi) west of the 200 West Area, forms a small surface stream that flows for approximately 2.5 km (1.6 mi) before it disappears into the ground as a result of seepage and evapotranspiration. The stream's base flow is approximately 0.01 cubic meters per second (m^3/sec) (0.4 cubic feet per second [ft^3/sec]). Snively Springs is located to the west and at a higher elevation than Rattlesnake Springs. It flows to the west and off of the Hanford Site (Cushing 1994).

Two ephemeral creeks, Cold Creek and its tributary, Dry Creek, traverse the uplands of the Hanford Site south and southwest of the 200 Areas. These creeks drain southeasterly toward the horn of the Yakima River, located south of the Hanford Site. Surface runoff from the uplands in and west of the Site is minor. These ephemeral creeks are not sustained by groundwater baseflow during any part of the year because depth to groundwater is over 46 m (150 ft) near the intersection of these creeks. The Columbia River is 16 to 24 km (10 to 15 mi) downgradient from the nearest TWRS site toward the east and approximately 11 km (7 mi) toward the north. The river forms the eastern boundary of the Hanford Site and comprises the base-level and receiving water for groundwater and surface water in the region.

I.2.1.2 Floodplains and Runoff

There are no floodplains in the 200 Areas. The potential Vernita Quarry and McGee Ranch borrow sites are also not within areas of high flood risk. Although floods in Cold Creek and Dry Creek have occurred historically, there have not been any observed flood events or evidence of flooding in these creeks that has reached the 200 Areas before infiltrating into permeable sediments.

Natural runoff generated onsite or from offsite upgradient sources is not known to occur in the 200 Areas. Measurable runoff occurs during brief periods in two locations, Cold Creek Valley and Dry Creek Valley, which are west and southwest of the 200 West Area (Newcomb et al. 1972). This surface runoff either infiltrates into the valley floor or evaporates. During periods of unusually rapid snowmelt or heavy rainfall, surface runoff extends beyond Rattlesnake Springs in the upper part of Dry Creek. However, this runoff quickly infiltrates into the alluvial sediments of Cold Creek Valley. The total amount of annual recharge to the unconfined aquifer from these areas is estimated to be 555,000 square meters (m^2) (5,970,000 square feet [ft^2]). This generally occurs east of the Hanford Site (Newcomb et al. 1972).

I.2.2 GROUNDWATER

Groundwater conditions in the 200 Areas are described in the following subsections in terms of the general hydrogeologic setting, vadose zone characteristics, aquifer characteristics, and groundwater flow. Groundwater conditions in the areas of the potential Vernita Quarry and McGee Ranch borrow sites are similar to those of the 200 Areas, although limited specific information is available. Groundwater quality and supply are discussed in Section I.2.3.

I.2.2.1 Hydrogeologic Setting

A thick vadose zone (approximately 70 m [200 ft] to over 90 m [300 ft] thick) as well as both confined and unconfined aquifers are present beneath the 200 Areas (DOE 1993a and b). The vadose zone is over 90 m (300 ft) thick in the vicinity of the TWRS site in the 200 East Area (DOE 1993a). The unconfined aquifer has not formally been named. This aquifer consists variably of the Ringold Formation (where present) and the lower portion of the Hanford formation. The confined aquifers are found primarily within the Columbia River Basalts. The confined aquifers are not a major focus of this EIS because they are separated from the TWRS facilities by the vadose zone, unconfined aquifer (the focus of the groundwater modeling effort), and confining layer(s) and thus are not likely to be impacted. The conceptual hydrogeologic column for the Hanford Site is illustrated in Figure I.2.2.1. Figure I.2.2.2 is a generalized cross section through the 200 Areas showing the major geologic units and the relative position of the water table. The water table is generally at or near the interface between the Hanford and Ringold formations, as illustrated in both Figures I.2.2.1 and I.2.2.2.

The occurrence and flow of groundwater in the unconfined aquifer must be described on a conceptual basis due to the difficulty of direct measurement. Five important concepts that describe flow in this aquifer are listed below:

1. The numerous strata within the Ringold Formation, described in the previous section on stratigraphy, result in a much lower vertical hydraulic conductivity compared to the horizontal hydraulic conductivity. This results in a strong preference for groundwater to move horizontally.
2. Groundwater movement occurs mostly in the upper portion of the Ringold Formation. That is, most groundwater movement occurs in the sands and gravel that predominate in the upper portion of the Ringold Formation (Unit E Gravels).
3. The overbank deposits and the lower mud sequence near the base of the Ringold Formation act as confining layers, hydraulically separating the overlying unconfined aquifer from the confined aquifer.
4. Recharge to the unconfined aquifer is primarily from artificial sources (e.g., B Pond), groundwater inflow from the Dry Creek and Cold Creek synclines, and recharge from the Columbia River along the western reach of the horn of the Colombia River near N Reactor.
5. Discharge from the unconfined aquifer is primarily to the Columbia River from the top of the horn south of the Columbia River to the 300 Areas, and in the vicinity of the B and C Reactors. Groundwater discharge also occurs to West Lake.

Natural recharge to the unconfined aquifer on the Hanford Site is extremely low and occurs primarily in the upland areas west of the Hanford Site. Artificial recharge from retention ponds and trenches contribute approximately 10 times more recharge than natural recharge. Seasonal water table fluctuations are not large because of the low natural recharge.

I.2.2.2 Vadose Zone Characteristics

The vadose zone extends from the ground surface to the top of the saturated sediments of the unconfined aquifer. Vadose zone characteristics determine the rate, extent, and direction of liquid flow downward from the surface. This zone variably includes the Hanford formation and locally includes the Ringold Formation Unit E Gravel. In the 200 West Area, the vadose zone is approximately 72 m (240 ft) thick (DOE 1993b). In the 200 East Area, the vadose zone is over 90 m (300 ft) thick, based on the 1991 depth to water level of the unconfined aquifer (DOE 1993a).

Figure I.2.2.1 Conceptual Hydrologic Column for the Hanford Site

Figure I.2.2.2 Generalized Cross Section of the Hanford Site

The following sections describe vadose zone characteristics (infiltration, perched water, and soil moisture) and vadose zone contamination .

I.2.2.2.1 Infiltration

The thick vadose zone, combined with the general aridity of the climate in the area, result in natural infiltration ranging from near zero (below detection) to approximately 11 centimeters per year (cm/yr) (4.3 inches [in.]/yr) (Gee et al. 1992). Some episodic recharge of groundwater may occur following periods of high precipitation, especially if combined with topographic depressions, highly permeable surface deposits such as gravel, and where the land is denuded of vegetation. Also, present conditions (bare ground and coarse sand and gravel surfaces) within the tank farms are conducive to higher infiltration than would be expected on undisturbed ground within the 200 Areas. For such conditions, infiltration near the upper range of 10 cm/yr (4.0 in./yr) would not be unreasonable. However, there are relatively recent changes that occurred after 1940 and would not necessarily have altered the flow within the full thickness of the vadose zone.

The total natural recharge in the 200 West Area is estimated to be approximately 1.3E+8 liters per year (L/yr) (3.4E+07 gallons [gal]/yr)(DOE 1993b). This is based on an average recharge rate of 0.1 cm/yr (0.04 in./yr) through fine-textured soil with deep-rooted vegetation. This value is approximately 10 times lower than recharge volumes from artificial sources.

The current principal sources of artificial recharge in the 200 West Area are four cribs and one ditch associated with the U Plant area, located in the eastern portion of the 200 West Area (DOE 1993b). There are also four septic tanks and drain fields that actively discharge water to the soil. The combined volume discharge from these drain fields is estimated to be 12,000 L/day (3,200 gal/day). The total wastewater discharged from these facilities from 1944 to 1992, including the U Plant cribs and ditches, is estimated to have been 1.7E+11 L (4.4E+09 gal). T Plant and S Plant operations also resulted in large volumes of wastewater discharged to the soil. Liquid is no longer discharged to the soil column from U, T, or S Plants.

Natural recharge in the 200 East Area is estimated to be approximately 2E+7 L (5E+06 gal) (DOE 1993a). This is based on a similar average natural recharge rate through fine-textured soil with deep-rooted vegetation, as noted previously for the 200 West Area. Artificial recharge in the 200 East Area is associated with approximately 140 ponds, trenches, cribs, and drains that were used to dispose of approximately 1E+12 L (3E+11 gal) of wastewater. The wastewater, except for limited discharges to the B Pond, is not directly discharged to the ground. The wastewater is treated to meet the State groundwater standards and piped to a common discharge location in the 200 Areas for discharge to the soil column. The remaining discharges to the ground at B Pond will be rerouted to the common discharge location in 1997. Currently, there are 11 active waste management units and 20 active drain fields. These waste management units are associated with B Plant and the Plutonium-Uranium Extraction (PUREX) Plant and are located east and northeast of the TWRS site (DOE 1993a). The primary recipients of the wastewater from three waste management units were the ponds and trenches associated with B Plant and PUREX Plant; the 216-A-25 and B-3 Ponds received approximately 7.0E+11 L (2.1E+11 gal) . Liquid is no longer discharged to the soil column from B Plant or the PUREX Plant.

Wastewater, such as the condensate removed from tank waste by the 242-A Evaporator, which is located in the eastern portion of the 200 East Area, is transferred by pipeline to the Effluent Treatment Facility, also located in the 200 East Area. The treated effluent from the Effluent Treatment Facility is then transferred by pipeline and discharged to the ground at the State-approved land disposal site located north of the 200 West Area. The treated wastewater meets all State groundwater discharge requirements except for tritium. The water is disposed of at this location further to the west so that the tritium contamination will decay to below drinking water standards in the groundwater before it reaches the Columbia River.

I.2.2.2.2 Perched Water

Perched water may occur within the vadose zone in the 200 West Area upon the caliche layer, approximately 55 m (180 ft) beneath the ground surface (DOE 1993b). Measured hydraulic conductivities of this unit range from 0.0009 to 0.09 m/day (0.003 to 0.3 ft/day). Caliche layers have not been encountered in the 200 East Area, and perched groundwater is not as likely to occur except in localized areas (Hoffman et al. 1992). Perched water has been reported in the vicinity of B Pond within the lower part of the Hanford formation.

I.2.2.2.3 Soil Moisture

In areas where artificial recharge is occurring from ponds and trenches, soil is expected to be close to saturation and would not likely be capable of holding substantial amounts of additional liquid. In addition, groundwater mounds have developed beneath these recharge areas. Where there is no artificial recharge, soil in the 200 Areas has a large moisture-holding capacity (DOE 1992a). The potential effect of recharge from Site waste water disposal activities is discussed in Volume Five, Appendix K, Section K.4.1.

I.2.2.2.4 Vadose Zone Contamination

Contaminants in the vadose zone in the 200 Areas are believed to be associated primarily with waste disposal practices that use engineered structures such as cribs, drains, septic tanks and associated drain fields, and reverse wells (wells that do not penetrate to the groundwater); percolation from ponds, ditches, and trenches such as B Pond and U Pond; and unplanned releases such as leaks from single-shell tanks (SSTs). The vadose zone is expected to be impacted by these past (and in some cases ongoing) waste management practices in the area immediately beneath the discharging facility and in an undetermined adjacent area (due to spreading as liquid percolates downward). Emerging data regarding vadose zone contamination from past SST leaks are provided in Volume Four, Appendix F, and Volume Five, Appendix K. Most Hanford Site environmental investigations have focused on the potential impacts of contaminants to the groundwater, not the vadose zone. Vadose zone investigations have often relied on geophysical gamma logs that are semi-quantitative. The types of contaminants potentially present in the vadose zone near planned and unplanned release sites can be inferred by contaminants detected in the underlying groundwater, contaminants that are reported in waste disposal inventories, or from the Track Radioactive Component (TRAC) inventory system used for SSTs that may be leaking. Table I.2.2.1 lists these contaminants, which include both radioactive materials (transuranic isotopes, U, and fission products) and nonradioactive materials (metals, volatile organics, semivolatile organics, and inorganics).

1.2.2.3 Aquifer Characteristics

Groundwater of the unconfined aquifer is found throughout the Hanford Site in the suprabasalt sediments and locally includes the Rattlesnake Ridge Interbed in the area north of the 200 East area, where erosion has removed a portion of the basalt sequence (Trent 1992b). The relationship between the various stratigraphic units and the hydrogeologic units is shown in Figure I.2.2.1.

Table I.2.2.1 Isotopes, Metals, and Organic Chemicals of Potential Concern at the 200 Areas

I.2.2.3.1 200 West Area

In the 200 West Area, the water table begins approximately 70 m (230 ft) beneath the surface. The saturated section, considered to be the unconfined aquifer, is composed of Ringold Formation Units A, B, C, D, and E gravels and is approximately 110 m (350 ft) thick above the Elephant Mountain member of the basalt. Hydraulic conductivities measured in the 200 West Area in the Ringold Unit E aquifer range from approximately 0.02 to 60 m/day (0.06 to 200 ft/day). Hydraulic conductivities range from 0.5 to 1.2 m/day (1.6 to 4.0 ft/day) in the semiconfined to confined Ringold Unit A Gravels (DOE 1993b). A discontinuous layer of silt and sand cemented by calcium-carbonate (caliche Plio-Pleistocene Unit), with a thickness up to 9 m (30 ft), occurs locally nearly 55 m (180 ft) in depth in the 200 West Area. This unit is believed to be responsible for perched water conditions in the vicinity of the TWRS sites in the 200

West Area.

I.2.2.3.2 200 East Area

Depth to groundwater in the 200 East Area ranges from 97 m (320 ft) in the southeast to 3 6 m (120 ft) in the vicinity of the 216-B-3C Pond (B Pond mound) located approximately 5 km (3 mi) east of the TWRS sites (DOE 1993a). The unconfined aquifer occurs within the Hanford and Ringold Formations. Groundwater near the TWRS sites occurs under unconfined conditions within the Ringold formation, approximately 96 m (315 ft) deep. The saturated (groundwater) section is approximately 34 m (110 ft) thick. Erosional windows occur in the basalt several kilometers north of the 200 East Area that allow some interconnection between the regionally confined Rattlesnake Ridge Interbed of the Ellensburg Formation in the basalt and the unconfined aquifer of the Hanford and Ringold Formations. Hydraulic conductivities of the unconfined aquifer near the TWRS sites in the 200 East Area range from 150 to 300 m/day (500 to 1,000 ft/day) (DOE 1993a).

I.2.2.4 Groundwater Flow

This section describes the physical characteristics of groundwater flow in the 200 Areas.

I.2.2.4.1 200 West Area

Figure I.2.2.3 is a contour map that shows the groundwater elevations for the Hanford Site. Groundwater generally flows from west to east, with some localized exceptions. In the northwest corner of the 200 West Area, groundwater flow is to the north. Also, it appears that flow from the 200 West Area may bifurcate east of the Gable Butte subcrop, with a lesser flow component north toward the gap between Gable Butte and Gable Mountain and the remaining flow east toward the Columbia River (Kasza 1994).

These groundwater movement patterns are also indicated by the 1994 distribution of tritium and nitrate in the unconfined aquifer, as shown on Figures I.2.2.4 and I.2.2.5, respectively. A north or northwest groundwater flow direction may also be indicated by the nitrate distribution in the area north and west of the 200 West Area. Because of the contrast in hydraulic conductivity, most basalt subcrops and outcrops appear as impermeable compared to groundwater flow in the transmissive Hanford and Ringold Formations.

Figure I.2.2.3 Groundwater Elevation Map of the Hanford Site

Figure I.2.2.4 Distribution of Tritium in the Unconfined Aquifer, 1994

Figure I.2.2.5 Distribution of Nitrate in the Unconfined Aquifer, 1994

The tank farms in the 200 West Area are located above a groundwater mound caused by artificial recharge from the U Plant area, especially the 216-U-10 Pond. Groundwater elevations have declined greatly since the 216-U-10 Pond was decommissioned in the fall of 1984. Large declines in groundwater elevations have been recorded in seven wells in the U Plant area since 1984. Hydrographs of two wells (299-W19-1 and 299-W19-10) west of the tank farms indicate that groundwater elevations have declined approximately 5 m (15 ft) since the 216-U-10 Pond was decommissioned. The mound seems to have shifted slightly as it continues to dissipate beneath 216-U-10 Pond toward the northeast beneath the 216-U-14 Ditch and 216-Z-20 Crib (DOE 1993b).

I.2.2.4.2 200 East Area

Groundwater flow in much of the 200 East Area is characterized by relatively low hydraulic gradients, ranging from 0.01 to 0.02 m/day (0.3 to 0.6 ft/day) (Kasza 1994). As shown in Figure I.2.2.3, water table elevations in the uppermost aquifer generally decrease from the margins of the Yakima Ridge in the west to the Columbia River in the east. There is a strong relationship between the water table as shown in Figure I.2.2.3 and the distribution of tritium in the uppermost aquifer as shown in Figure I.2.2.4. Both figures indicate that groundwater flow in the vicinity of the TWRS sites in the 200 East Area is toward the southeast.

I-129 is an unretarded contaminant (i.e., it moves with groundwater at the average groundwater velocity), as are nitrate and tritium. The distribution of i-129 in the unconfined aquifer (Figure I.2.2.6) also shows a southeasterly groundwater flow direction. The i-129 plume is much smaller than the plumes associated with nitrate and tritium, probably because i-129 sources are not as ubiquitous in the unconfined aquifer.

The mound resulting from discharge from the 216-B-3 Pond is a notable perturbation to the easterly flow direction. B Pond is approximately 5 km (3 mi) east of the TWRS sites. Near the western portion of the mound, the groundwater gradient has been reversed in a west direction. The magnitude of this gradient direction reversal is currently diminishing as the mound decays. The groundwater gradient in the southeastern portion of the 200 East Area is expected to resume a more easterly trend as the decay continues (Kasza 1994).

I.2.2.4.3 Vertical Gradients

Vertical hydraulic gradients in the unconfined aquifer are estimated from water measurements in wells that are near to each other (sometimes referred to as well pairs) and have their sensing zones (screened intervals) completed at different elevations within the unconfined aquifer. In both the 200 East and 200 West Areas, downward hydraulic gradients have been observed (Trent 1992, and b). In general, these downward hydraulic gradients are associated with the moundings that have been created from infiltration of water discharged to the U Pond and B Pond. Away from these mounds, the vertical gradients are smaller. For instance, near the Grout Treatment Facility in the 200 East Area, which is located along the central portion of the eastern part of the 200 East Area, the vertical head differences between nearby well pairs are so slight that they are indistinguishable from measurement errors (Trent 1992b). For information on the impact of the mounds on future groundwater flow see Appendix F, Section F.2.4.1.2.

Figure I.2.2.6 Distribution of Iodine-129 in the Unconfined Aquifer, 1994

I.2.2.4.4 Aquifer Communication

Aquifer communication is a process in which groundwater from distinct hydrogeological systems intermingle and mix. Of importance to the EIS is the degree of aquifer communication that exists between the unconfined aquifer and the underlying confined aquifer (Rattlesnake Ridge aquifer [Trent 1992b]). Several methods have been used to estimate the degree of aquifer communication at the Hanford Site including: analysis of joint and fracture systems in the basalt and presence of erosional windows, hydraulic head comparisons between aquifers, analysis and comparison of contaminant concentrations in adjacent aquifers, stable isotope analysis, and analysis of contaminant concentrations in adjacent aquifers. Interconnection between the unconfined and lower confined aquifer is possible across the Central Plateau; however, except for the area near the erosional windows, which occur in the basalt several kilometers north of the 200 East Area and B Pond vicinity, there is no indication of aquifer interconnection. In the vicinity of B Pond, groundwater mounding from B Pond discharges has resulted in a downward hydraulic gradient. Several kilometers north of the 200 East Area there is an absence of confining layer(s) associated with an erosional window that has resulted in enhanced interconnection of the aquifers in this area.

I.2.3 WATER QUALITY AND SUPPLY

Water for the Hanford Site is supplied by the Columbia River via distribution systems located at the 100-B, 100-D, 200, and 300 Areas, and at the Washington Public Power Supply System reactor. Wells supply water to the 400 Area and facilities at several remote locations. The city of Richland supplies water to the 700, 1100, and 3000 Areas.

Richland, Pasco, and Kennewick draw water from the Columbia River and operate their own water supply and treatment systems. Richland derives approximately 67 percent of its water from the Columbia River, 15 to 20 percent from a well field in North Richland, and the remaining 13 to 18 percent from groundwater wells (Cushing 1995). Richlands total water use in 1994 was 2.6E+10 L (6.9E+09 gal).

Pasco also obtains its water from the Columbia River and in 1994 consumed an estimated 8.6E+9 L (2.3E+09 gal) of water (Cushing 1995). The city of Kennewick's water supply is derived from the Columbia River and two wells. The wells serve as the sole source of water between November and March. The total maximum water supply for

Kennewick is approximately 2.8E+10 L (7.3E+09 gal); the wells can supply approximately 62 percent of that total. Kennewick's total water use in 1994 was 1.5E+10 L (3.9E+09gal) (Cushing 1995).

I.2.3.1 Surface Water

Surface waters considered for this EIS are onsite ponds, riverbank springs and seeps at the Columbia River, and the waters of the Columbia River. Water quality in ephemeral creeks is not known to be impacted by Hanford Site activities.

I.2.3.1.1 Columbia River

River water samples are routinely collected at the sample locations shown on Figure I.2.3.1. Additionally, river water samples have been collected at cross sections established at the Vernita Bridge upstream of the Hanford Site, and at the Richland City Pumphouse, downstream of the Hanford Site.

Radionuclides consistently detected in Columbia River water levels in 1995 were tritium, Sr-90, I-129, U-234, U-238, Pu-239, and Pu-240 (PNL 1996). Strontium-90 and tritium may come from worldwide fallout, as well as from releases of Hanford Site effluent. Tritium and U also occur naturally in the environment. Radionuclide concentrations at Priest Rapids Dam (upstream of the Site) generally were lower than those at the Richland Pumphouse (downstream from the Site), and were similar to levels observed in recent years.

All radiological contaminant concentrations measured in 1995 were less than the U.S. Department of Energy (DOE) Derived Concentration Guides and Washington State surface water quality standards (PNL 1996). Washington State classifies the Hanford Reach of the Columbia River as a Class A (Excellent) area. Class A waters are to be suitable for essentially all uses (e.g., raw drinking water, recreation, and wildlife habitat). Both State and Federal drinking water standards apply to the Columbia River and currently are being met (Neitzel 1996).

I.2.3.1.2 Ponds

Three ponds on the Hanford Site are routinely sampled: West Lake (located north of the 200 East Area), B Pond (located east of the 200 East Area), and the Fast Flux Test Facility Pond (located southeast of the 200 Areas) (PNL 1993a). Sampling data indicated that the ponds are impacted by Hanford Site activities, although the ponds are not used for human consumption. With the exception of U-234 and U-235 in the October 1995 sample of West Lake, all radionuclide concentrations were less than the DOE Derived Concentration Guides (PNL 1996) . Average annual total beta concentrations exceeded the ambient surface water quality criteria in West Lake. The U.S. Environmental Protection Agency (EPA) proposed Hanford Site-specific drinking water standards for U also was exceeded in West Lake. All other radionuclide concentrations were less than the applicable surface water quality criteria (PNL 1996) . West Lake surface water quality reflects the quality of the groundwater that feeds the lake (PNL 1993a).

Riverbank Springs and Seeps

Riverbank spring discharges have been documented along the Hanford Reach of the Columbia River since before the startup of Hanford Site operations. They have been observed to be of relatively small volume and to occur intermittently (PNL 1993a). Several springs in the 100 Areas, as well as the Old Hanford Townsite Springs and the 300 Area Springs, are routinely sampled. Water flows from these springs are a mechanism by which groundwater contaminated by past Site activities enter the river. All radiological contaminants measured in 1995 were less than the applicable DOE Derived Concentration Guides. However, Sr-90 in the 100-H Area and tritium in the 100- B Area and along the Old Hanford Townsite exceeded Federal and Washington State drinking water standards (PNL 1996) . Total U exceeded the proposed EPA Hanford Site-specific drinking water standards (PNL 199 6). The 1995 nonradiological contaminant concentrations were below Washington State ambient surface water toxicity standards with the exception of copper and zinc in the 100-K Area spring. The chronic toxicity level of cadmium and the EPA standard for trichlorethylene also were exceeded in the 100-K Area Spring (PNL 1996).

Figure I.2.3.1 Water and Sediment Sampling Locations, 1992

I.2.3.2 Groundwater

I.2.3.2.1 Supply

Groundwater is not used in the 200 Areas except for emergency purposes. Three wells for emergency cooling water are located near B Plant in the 200 East Area. Water for drinking, most emergency uses, and facilities processes is obtained from the Columbia River. There are no water supply wells downgradient of the 200 Areas. Water supply wells on the Hanford Site are located at the Yakima Barricade, 6 km (4 mi) west of the 200 West Area; in the 400 Area, 16 km (10 mi) southeast of the 200 Areas; and at the Hanford Safety Patrol Training Academy, 25 km (16 mi) southeast of the 200 Areas.

I.2.3.2.2 Water Quality

Contamination by both radionuclide and nonradionuclide contaminants has been identified in the groundwater beneath the Hanford Site. Liquid effluents have been discharged to various ponds, cribs, and other Hanford Site waste management structures. Adsorption into soil particles, chemical precipitation, and ion exchange attenuate or delay the movement of some radionuclides and nonradionuclide contaminants in the effluent as they percolate downward through the vadose zone (PNL 1993a).

Constituents such as Sr-90, Cs-137, Pu-239, and Pu-240 are attenuated to varying degrees but eventually enter the groundwater. Compounds such as nitrate and radionuclides such as tritium, technetium-99 (Tc-99), and I-129 are not readily attenuated in the soil and reach the groundwater sooner than those that are. These ions then travel downgradient at the same rate as the natural groundwater (PNL 1993a). Figure I.2.2.4 shows the distribution of tritium in the unconfined groundwater. Two other major contaminant plumes include nitrates (Figure I.2.2.5) and I-129 (Figure I.2.2.6).

Groundwater beneath the 200 Areas and in plumes leading from the 200 Areas toward the Columbia River is contaminated with hazardous chemicals and radionuclides at levels that exceed Federal drinking water standards and State groundwater criteria. Hazardous chemical contaminants present at levels exceeding drinking water standards and State groundwater criteria include nitrates, cyanide, fluoride, chromium, chloroform, carbon tetrachloride, trichloroethylene, and techrachloroethylene. Radiological contaminants include I-129, tritium, Cs-137, Pu-239, Pu-240, and Sr-90. Generally, the groundwater contamination beneath the 200 Areas substantially exceeds drinking water standards and State groundwater criteria. For example, I-129 is present at levels that exceed standards by up to 20 times. While other groundwater plumes from the 200 Areas tend to have lower levels of contaminants than the I-129 levels, many contaminants still exceed drinking water standards and State groundwater criteria. Groundwater use is controlled at the Hanford Site to prevent use of contaminated groundwater.

I.2.3.2.3 200 East Area

Unconfined groundwater beneath the 200 East Area contains 13 different contaminants that have been mapped as plumes: arsenic, chromium, cyanide, nitrate, gross alpha, gross beta, tritium, Co-60, Sr-90, Tc-99, I-129, Cs-137, Pu-239, and Pu-240 (DOE 1993a).

I.2.3.2.4 200 West Area

Beneath the 200 West Area, 13 overlapping contaminant plumes are located within the unconfined gravels of Ringold Unit E: Tc-99, U, nitrate, carbon tetrachloride, chloroform, trichloroethylene, I-129, gross alpha, gross beta, tritium, arsenic, chromium, and fluoride (DOE 1993b). The tank farms are within the boundaries of most of these plumes. Plumes of Tc-99, U, I-129, gross alpha, and gross beta are associated with the U Plant area.

I.3.0 METEOROLOGY AND AIR QUALITY

The following subsections discuss Hanford Site climatology and air quality. The meteorological section summarizes measurements of wind, temperature and humidity, precipitation, fog and visibility, severe weather, and atmospheric dispersion. The air quality section includes information on air quality standards, emissions sources, and air quality monitoring.

I.3.1 METEOROLOGY

The Cascade Mountains greatly influence the climate of the Hanford Site by their rain shadow effect. This range also serves as a source of cold air drainage, which has a considerable effect on the wind regime over the Site.

Climatological data has been collected at Hanford Meteorological Monitoring Network sites. The Hanford Meteorological Station (HMS), located between the 200 East and 200 West Areas, is the most completely instrumented station. The HMS data are considered representative for assessing proposed TWRS activities. The following meteorological discussion is largely based on the Hanford Climatological Summaries (Stone et al. 1972), as well as information compiled by Cushing (Cushing 1994).

I.3.1.1 Wind

Figure I.3.1.1 shows winds measured at the Meteorological Monitoring Network sites. Prevailing winds at the HMS are from the west-northwest and northwest in all months of the year. Monthly average wind speeds are lowest during December, averaging 10 km/hr (6 mi/hr), and highest during June, averaging approximately 15 km/hr (9 mi/hr). The most prevalent wind speed class,

6 to 11 km/hr (4 to 7 mi/hr), occurs 36 percent of the time. Wind speeds are less than 21 km/hr (13 mi/hr) 84 percent of the time, and greater than 29 km/hr (18 mi/hr) less than 5 percent of the time. Peak gusts occur from the south-southwest, southwest, and west-southwest during all months.

Figure I.3.1.1 Hanford Meteorological Monitoring Network Wind Roses for the Period from 1982 through 1993

I.3.1.2 Temperature and Humidity

From 1961 through 1990, the average monthly temperatures varied from -1 centigrade (C) (30.3 Fahrenheit [F]) in January to 24.6 C (76.2 F) in July with a yearly average of 11.8 C (53.2 F). On the average, 51 days during the year (April through September) had maximum temperatures greater than or equal to 32 C (90 F), and 12 days (May through September) had a maximum temperature greater than or equal to 37.8 C (100 F). Also, an average of 25 days during the year (October through February) experienced maximum temperatures less than 0 C (32 F). An average of 106 days per year (October through April) experienced minimum temperatures less than 0 C (32 F). An average of 4 days per winter season (November through February) experienced daily minimum temperatures less than -18 C (0 F) but approximately half of all winters were free of such days. The record maximum and minimum temperatures recorded during the period 1945 to 1991 were 45 C (113 F) in 1961 and -45 C (-23 F) in 1950.

The annual average relative humidity, based on data from the years 1950 through 1993, was 54.5 percent. Relative humidity was highest during the winter months, averaging 80.2 percent in December, and lowest during the summer, averaging 33.3 percent in July.

I.3.1.3 Precipitation

The average annual precipitation measured at the HMS is 17 cm (6.6 in.). The bulk of the precipitation (54 percent) occurs during November through February. As the wettest month, December receives an average of 2.5 cm (1 in.) of precipitation while July averages 0.5 cm (0.2 in.) and is the driest month. On the average, only 1 day per year experiences precipitation greater than 1.3 cm (0.5 in.), and 68 days per year have precipitation greater than 0.02 cm (0.01 in.) per year. An average of 125 days per year receive a trace amount or more of precipitation. The monthly total time during which precipitation occurs ranges from 12.4 percent in December to 1.5 percent in July. Winter monthly average snowfall ranges from 0.8 cm (0.3 in.) in March to 13.5 cm (5.3 in.) in January. Yearly snowfall has ranged from 0.8 cm (0.3 in.) to 140 cm (56 in.). Annual average snowfall is 38 cm (15 in.).

I.3.1.4 Fog and Visibility

Although fog (visibility less than or equal to 10 km [6 mi]), has been recorded during every month of the year at the HMS, nearly 90 percent of the occurrences are during the late fall and winter months. The months of April through September account for only about 1 percent of the occurrences. On average, 46 days per year experience fog and 24 days per year experience dense fog (visibility less than or equal to 0.4 km [0.25 mi]).

Other phenomena restricting visibility to 10 km (6 mi) or less include dust, blowing dust, and smoke (typically from wildfires, orchard smudging, and agricultural field burning). An average of 5 days per year have dust or blowing dust and only about 2 days per year have reduced visibility resulting from smoke. On an annual basis, 3.8 percent of the hourly observations recorded for the years 1960 through 1980 indicate restricted visibility because of all phenomena.

I.3.1.5 Severe Weather

Severe high winds are associated with thunderstorms. On average the Hanford Site may experience 10 thunderstorms per year, most frequently (80 percent) occurring May through August. However, thunderstorms have been observed to occur in every month of the year. Estimates of the extreme wind velocities, based on peak gusts observed from 1945 through 1980, are shown in Table I.3.1.1 (Stone et al. 1983).

Tornadoes are smaller and less frequent in the northwest portion of the United States than elsewhere in the country. There were no reports of violent tornadoes for the region surrounding the Hanford Site. The HMS climatological summary (Stone et al. 1983) and the National Severe Storms Forecast Center database list 22 separate tornado occurrences within 160 km (100 mi) of the Hanford Site from 1916 through August 1982. Two additional tornadoes have been reported since August 1982. The probability of a tornado striking at the Hanford Site has been estimated to be approximately one in 10,000 (NRC 1977).

Table I.3.1.1 Estimates of Extreme Winds at the Hanford Site

I.3.1.6 Atmospheric Dispersion

Atmospheric dispersion is a function of wind speed, duration and direction of wind, atmospheric stability, and mixing depth. Dispersion conditions are generally good if winds are moderate to strong, the atmosphere is of neutral or unstable stratification, and there is a deep mixing layer. Good dispersion conditions associated with neutral and unstable stratification exist about 57 percent of the time during the summer at the Hanford Site. Less favorable dispersion conditions may occur when the wind speed is light and the mixing layer is shallow. These conditions are most common during the winter when moderately to extremely stable stratification exists about 66 percent of the time. Less favorable conditions also occur periodically for surface and low-level releases in all seasons from sunset to 1 hour after sunrise as a result of ground-based temperature inversions and shallow mixing layers. Mixing layer thicknesses have been estimated at the HMS using remote sensors. The variations in the mixing layer are summarized in Table I.3.1.2.

The Hanford Site may experience occasional extended periods of poor dispersion conditions associated with stagnant air in stationary high-pressure systems that occur primarily during the winter months.

Table I.3.1.2 Percent Frequency of Mixing-Layer Thickness by Season and Time of Day

The probability of an inversion period (e.g., poor dispersion conditions) extending more than 12 hours varies from a low of about 10 percent in May and June to a high of about 64 percent in September and October (Stone et al. 1972).

I.3.2 AIR QUALITY

Federal and State ambient air quality standards have been set for a limited number of pollutants. Monitoring is conducted to measure levels of selected pollutants that can then be compared to the standards.

I.3.2.1 Air Quality Standards

National Ambient Air Quality Standards (NAAQS) have been established by EPA, as mandated in the 1970 Clean Air Act. Ambient air is the portion of the atmosphere, external to buildings, that is accessible to the general public. The NAAQS define levels of air quality that, with an adequate margin of safety, are protective of public health (primary standards) and welfare (secondary standards). NAAQS exist for the following six criteria pollutants; sulfur oxides (measured as sulfur dioxide), nitrogen dioxide, carbon monoxide, particulate matter (PM-10, measured as particles less than 10 micrometers [µm] aerodynamic diameter), lead, and ozone. The standards specify the maximum pollutant concentrations and frequencies of occurrence that are allowed for various averaging periods ranging from 1 hour to 1 year depending on the pollutant.

Washington State has largely adopted the current NAAQS. However, Washington State has established more stringent standards for sulfur dioxide and ozone and maintains an air quality standard for total suspended particulates and gaseous fluorides. Table I.3.2.1 summarizes the NAAQS and supplemental Washington State standards.

The Hanford Site also evaluates concentrations of selected pollutants for which national and State ambient air quality standards do not exist. For toxic organic compounds (e.g., toluene, benzene), comparisons are made to the Occupational Safety and Health Administration's maximum allowable concentrations (29 Code of Federal Regulations [CFR] 1910). Concentrations of polychlorinated biphyenyls are compared against the National Institute of Occupational Safety and Health limit of 1,000 micrograms per m^3 ($\mu g/m^3$) as a 10-hour time-weighted average.

Table I.3.2.1 Federal and Washington State Ambient Air Quality Standards

I.3.2.2 Emission Sources

Sources of airborne emissions at the Hanford Site include combustion equipment (e.g., steam boilers, electric generation plants), coal handling operations, chemical separation processes, storage tanks, waste handling, and waste disposal. These activities result in routine emissions of air pollutants, including radionuclides.

The Clean Air Act amendments of 1990 established a new national permitting system for major sources of air pollution, and other categories of sources, such as facilities with equipment subject to a National Emission Standard for Hazardous Air Pollutants (NESHAP). The Hanford Site is classified as a major source for one or more criteria pollutants, as well as for hazardous air pollutants. The Hanford Site is currently subject to the radionuclide NESHAP of 10 millirems (10 mrem) per year. DOE has applied for a Sitewide Air Operating Permit for the Hanford Site, which will cover all substantial emission sources for which the Site is considered a major source.

For areas in attainment of the NAAQS, the EPA has established the Prevention of Significant Deterioration (PSD) program to protect existing ambient air quality while at the same time allowing a margin for future growth. Under the PSD program, new stationary sources of air pollution may only impact air quality by set increments and they must install best available control technology emission controls. The Hanford Site obtained a PSD permit in 1980 requiring specific limits for oxides of nitrogen emitted from the PUREX Plant.

I.3.2.3 Air Quality Monitoring

Air quality data have been collected at onsite and offsite locations. The following discussion concentrates on recent monitoring activities conducted largely for the purpose of assessing air quality impacts from the Hanford Site. The information was taken from the Hanford Site Environmental Report (PNL 1995 and 1996) and from the Site NEPA Characterization Report (Cushing 1995 and Neitzel 1996).

I.3.2.3.1 Onsite Monitoring

Onsite air quality monitoring was conducted during 1990 for nitrogen oxides at three locations. The monitoring was discontinued after 1990 because the primary source ceased operation. The highest annual average concentration was less than 0.006 parts per million (ppm), well below the applicable Federal and Washington State annual ambient standard of 0.05 ppm.

Based on a review of chemicals of concern for surveillance at PCBs, the Site, three types of semi-volatile organic compounds were identified for monitoring: polycyclic aromatic hydrocarbons, and a phthalate ester plasticizer. Organochlorine pesticides also were analyzed. Four polycyclic aromatic hydrocarbons, 19 polychlorinated biphenyl congeners, and 16 organochlorine pesticides were found above detection limits. The measured concentrations of pesticides were orders of magnitude below the occupational maximum allowable concentration values. No phthalate esters were found above detection limits (PNL 1996).

Nine of a total 17 PCB samples collected during 1993 were below the detection limit of 29 µg/m^3. Eight PCB samples were above the detection limit, with values ranging from 0.25 to 3.9 µg/m^3, all well below the National Institute of Occupational Safety and Health occupational limit of 1,000 µg/m^3. Fourteen volatile organic compound samples were obtained in 1993. All samples analyzed for benzene, alkylbenzenes, halogenated alkanes, and alkenes were within allowable limits. Volatile organic compound data from 1994 were within a similar range of values and also were within allowable limits.

I.3.2.3.2 Offsite Monitoring

The only offsite monitoring in the vicinity of the Site in 1993 was conducted by Washington State Department of Ecology. PM-10 was monitored at Columbia Center in Kennewick. The State's 24-hour PM-10 standard was exceeded twice in 1993. The maximum reading was 1,166 µ/m^3, with the suspected cause being windblown dust. There was no exceedance of the annual primary standard of 50 µg/m^3(Cushing 1995).

Particulate concentrations can reach relatively high levels in eastern Washington State because of exceptional natural events (i.e., dust storms, volcanic eruptions, and large brush fires) that occur in the region. State ambient air quality standards have not distinguished rural fugitive dust from exceptional natural events when estimating the maximum background concentrations of particulates in the area east of the Cascade Mountain crest. No decision has been made to designate Benton County a nonattainment area pending studies to determine the source of high local PM-10 concentrations. It is suspected that the high readings are due to natural conditions (e.g., dust storms, brush fires) rather than man-made pollution.

I.3.2.3.3 Radiological Monitoring

Data were collected in 1995 through a system of 47 radiological monitoring stations located onsite, at the Site perimeter, in nearby communities (e.g., Richland, Kennewick, and Pasco), and in distant communities (Sunnyside and Yakima). Cesium-137, Pu-239, Pu-240, Sr-90, and U were consistently detected in air samples collected in the 200 Areas. Concentrations of these radionuclides were higher than concentrations measured offsite and were in the same range as measured in recent years . The levels measured at both onsite and offsite locations were much lower than the applicable standards (PNL 1996) .

I.4.0 BIOLOGICAL AND ECOLOGICAL RESOURCES

This section describes the ecological resources potentially impacted by the proposed action and alternatives. A brief description of the regional environment is followed by a discussion of the ecological resources of the Central Plateau and nearby areas, which are the location of all facilities under all alternatives addressed in this EIS. The material presented is based largely on reports by Cushing (Cushing 1994 and 1995), which summarize many other site studies, on the 1994 biological survey of the TWRS site in the 200 East Area (PNL 1994e), and on the Site Evaluation Report for Candidate Basalt Quarry Sites (Duranceau 1995).

The Hanford Site and adjacent region have been characterized as shrub-steppe (Daubenmire 1970). Shrub-steppe vegetation zones are dominated by a shrub overstory with an understory of grasses. The Hanford Site has not been farmed or grazed by livestock for more than 50 years, allowing it to serve as a refuge for a variety of plant and animal species (Gray-Rickard 1989). Approximately 665 km^2 (257 mi^2) of undeveloped land within the Hanford Site have been designated as ecological study areas or refuges. Washington State considers shrub-steppe a priority habitat because of its importance to wildlife species of concern. The National Biological Service has identified native shrub and grassland steppe in Washington State and Oregon as an endangered ecosystem.

I.4.1 BIODIVERSITY

Biodiversity has been defined as the diversity of ecosystems, species, and genes, and the variety and variability of life (CEQ 1993). Major components of biodiversity are plant and animal species, microorganisms, ecosystems, and ecological processes, and the interrelationships between and among these components. Biodiversity also is a qualitative measure of the richness and abundance of ecosystems and species in a given area (NPS 1994). Biodiversity also provides a moderating effect on wide fluctuations in environmental conditions.

Two major factors that contribute to biodiversity on the Hanford Site are 1) the Site is one of the largest relatively undisturbed tracts of native shrub-steppe left in Washington State; and 2) the Hanford Reach is the last free-flowing nontidal stretch of the Columbia River in the United States (Sackschewsky et al. 1992 and Cushing 1994). Other factors include topographic features such as Rattlesnake Mountain, Gable Butte, and Gable Mountain, a variety of soil textures ranging from sand to silty and sandy loam, and the lack of human use and development over much of the Hanford Site. Specialized terrestrial habitats contributing to the biodiversity of the Hanford Site include areas of shrub-steppe, basalt outcrops, scarps (cliffs), scree slopes (accumulations of material at the base of a hole or cliff), and sand dunes. Aquatic components of biodiversity are mainly associated with the Columbia River and include aquatic habitat, wetland and riparian areas, and riverain habitat along the Hanford Reach shoreline and islands in the Columbia River.

The biological diversity of the Hanford Site has been emphasized by the recent discovery of 21 new species (two plant and 19 insects) in a study by the Nature Conservancy of Washington (Nature Conservancy 1996) . These species may be dependent on the shrub-steppe environment and destruction, fragmentation, or other disturbance of this habitat could lead to the loss of these and other as yet unidentified species. None of these newly recorded species were found in potential TWRS areas (Brandt 1996).

Ecologically important plant and animal species on the Hanford Site include species of concern (Section I.4.6); commercial and recreational wildlife species such as salmon and steelhead, mule deer, and upland game birds; and plant species used as a source of food, medicine, fiber, and dye in the traditional lifestyles of Native People of the Columbia Basin (Section I.4.7) (Sackschewsky et al. 1992).

As stated previously, the Hanford Site has not been farmed or grazed for over 50 years and thus has served as a refuge for various plant and animal species. However, the invasion and spread of nonnative plant species into previously disturbed areas, such as abandoned farmland, represent a potential threat to biodiversity by displacing native species, simplifying plant communities, and fragmenting habitat. Introduced plant species account for approximately 21 percent of the vascular plants found on the Hanford Site and include species such as cheatgrass, Russian-thistle, and most of the tree species found onsite (Sackschewsky et al. 1992). Most of the Site's disturbed areas include abandoned farmland and areas burned by wildfire. These areas are dominated by pure stands of cheatgrass where the native shrub component has been modified severely or replaced altogether (Cushing 1994).

I.4.2 VEGETATION

The Hanford Site is a relatively undisturbed area of shrub-steppe, which is considered priority habitat by Washington State (WSDW 1993). Also, the National Biological Service has listed native shrub and grassland steppe in Washington and Oregon as an endangered ecosystem. Historically, the predominant plant in the area was big sagebrush (*Artemisia tridentata*) with an understory of perennial bunch grasses such as Sandbergs bluegrass (*Poa sandbergii*) and bluebunch wheatgrass (*Agropyron spicatum*). Following human settlement in the early 1800's, grazing and agriculture disrupted the native vegetation and opened the way for invader species such as tumbleweed or Russian-thistle (*Salosa kali*) and cheatgrass (*Bromus tectorum*). Establishing the Hanford Site as a nuclear facility in 1943 created a protected area of mostly undeveloped land with scattered, small industrial complexes. Consequently, the Hanford Site is one of a small number of remaining shrub-steppe tracts in Washington State that is relatively undisturbed.

The Central Plateau and the nearby areas of the potential McGee Ranch and Vernita Quarry borrow sites have been identified as predominantly shrub-steppe (Cushing 1994 and Duranceau 1995). This designation includes communities dominated by big sagebrush and bitterbrush (*Purshia tridentata*) with an understory of cheatgrass or Sandbergs bluegrass (Figure I.4.2.1). Over 100 plant species occur on the Central Plateau and vicinity. Common plant species include big sagebrush, rabbitbrush (*Chrysothamnus nauseous*), cheatgrass, and Sandbergs bluegrass(Table I.4.2.1). Much of the 200 Areas (e.g., the tank farms, the sites of several large processing facilities), have been disturbed by human activities. In these disturbed areas, introduced species, such as Russian-thistle and cheatgrass are common (Cushing 1994).

The TWRS sites in the 200 East Area and the immediate surrounding area are approximately 40 percent big sagebrush and rabbitbrush. Another 20 percent is dominated by Russian-thistle, with the remainder disturbed vegetation or bare gravel (PNL 1994e). The proposed Phased Implementation alternative site in the easternmost portion of the 200 East Area is comprised of approximately 65 percent shrub-steppe, with the remaining area disturbed by the construction in the 1980's of the unused Grout Treatment Facility (ASI 1995).

Figure I.4.2.1 TWRS Areas Vegetation Types (Simplified)

Table I.4.2.1 Common Vascular Plants Found on the Hanford Site

Other vegetation in the 200 Areas includes wetland species associated with man-made ditches and ponds and introduced perennial grass planted to revegetate disturbed areas. Wetland species such as cattail, reeds, and various trees, such as willow, cottonwood, and Russian-olive, are established around some of these ponds (Cushing 1992). However, several of the ponds have been decommissioned, which eliminated the supply of industrial water feeding the ponds. Without the water supply, the artificial wetland habitat was eliminated. None of the wetlands or ponds are near the TWRS sites.

Introduced perennial grass, such as Siberian-wheatgrass (*Agropyron sibericum*), has been used extensively in the 200 Areas to revegetate and stabilize waste burial grounds against wind and water erosion. Siberian-wheatgrass has proven to be drought tolerant and better adapted to sandy soil than other species used in the 200 Area's revegetation (Stegen 1993).

At the potential Vernita Quarry borrow site, the areas at the top of the basalt cliffs have very low shrub densities, primarily big sagebrush and rigid sagebrush. Grasses such as bluebunch wheatgrass and Sandbergs bluegrass are common. Areas between and below the basalt cliffs have shrub coverage of 30 to 40 percent, primarily big sagebrush with some spiny hopsage and prickly phlox (Duranceau 1995).

The potential McGee Ranch borrow site contains a wide variety of shrubs and flowering plants. Large portions of the site are covered with a dense stand of big sagebrush and spiny hopsage. This area has a Sandbergs bluegrass understory with very little cheatgrass or other alien weed species (Duranceau 1995). Approximately 25 percent of the site is abandoned farmland and is dominated by cheatgrass and Russian-thistle. The McGee Ranch area also is an important vegetation and wildlife corridor linking the Hanford Site and the Yakima Training Center, which are two largest shrub-steppe areas remaining in Washington State (Fitzner 1992). In 1996, the Washington State Department of Fish and Wildlife asked DOE to preserve the McGee Ranch area as a wildlife corridor (Baker 1996).

The Nature Conservancy of Washington recently discovered a new species of buckwheat in the Umtanum Ridge area, which is in the same general area of the Hanford Site as McGee Ranch and Vernita Quarry (Nature Conservancy 199 6).

I.4.3 WILDLIFE

Approximately 290 species of terrestrial vertebrates have been observed at the Hanford Site, including 41 species of mammals, 238 species of birds, three species of amphibians, and nine species of reptiles (Weiss-Mitchell 1992). Major terrestrial habitat types occurring on the Site include basalt outcrops, scarps and screes, riparian and riverain areas, shrub-steppe, sand dunes and blowouts, and abandoned fields (Downs et al. 1993).

I.4.3.1 Mammals

Common large mammal species include the mule deer and Rocky Mountain elk; predators such as coyotes, bobcats, and badger; and a variety of small mammals (Table I.4.3.1). Elk were not present when the Hanford Site was established in 1943 and did not appear onsite until 1972. The elk occur primarily on the FEALE Reserve, although they also may be found elsewhere on the Site, such as on the islands and along the Columbia River (PNL 1993a). Mule deer may occur almost anywhere on the Hanford Site, although concentrations are highest along the Columbia River between the Hanford townsite and the B Reactor area (Rickard et al. 1989). White-tailed deer are occasionally sighted along the Columbia River and at the Yakima River Delta near Richland (Fitzner-Gray 1991). Six species of bats also occur on the Hanford Site, primarily as fall or winter migrants, with some using abandoned buildings as roosting sites (Cushing 1992).

I.4.3.2 Birds

Bird species on the Site include a variety of raptors, songbirds, and species associated with riparian, riverain, and upland habitats. Approximately 240 species of birds, including migrants and accidental species, have been observed at the Hanford Site (Landeen et al. 1992). Of these, 36 are common species (Table I.4.3.2) and 40 occur as accidental species (Cushing 1994).

Common raptors that may occur onsite year-round are the northern harrier, red-tailed hawk, golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), American kestrel (*Falcosparverius*), barn owl (*Tyle albu*), great horned owl (*Bubo virginianus*), and long-eared owl (*Anio olus*) (Fitzner-Gray 1991). Raptors use a variety of habitats for nesting and foraging at the Hanford Site. Nest habitat include outcrops and cliffs, trees, marsh lands and fields, and utility towers. Depending on raptor size and species, prey may include small mammals, birds, reptiles such as snakes, and insects.

A variety of passerine (songbird) species is known to occur in the shrub-steppe vegetation type on the Hanford Site. These include the western meadowlark (*Sturnella neglecta)*, grasshopper sparrow (*Ammodramus savannarum*), horned lark (*Eremophila alpestris)*, and sage thrasher (*Oreoscoptes montanus*) (Downs et al. 1993). The western meadowlark and horned lark are the most abundant shrub-steppe passerine bird species that breed on the Hanford Site (Rickard-Poole 1989). The western meadowlark and horned lark nest on the ground in the open, while shrub-steppe species like the sage sparrow, sage thrasher, and loggerhead shrike require sagebrush or bitterbrush for nesting habitat.

Table I.4.3.1 List of Mammals Occurring on the Hanford Site

Table I.4.3.2 Common Birds Occurring on the Hanford Site

Common upland game bird species include the chukar partridge (*Alectoris chukar*), california quail (*Callipepla californicus*), and chinese ring-necked pheasant (*Phasianus colchicus*). Sage grouse (*Centrocercus urophasianus*) and gray partridge (*Perdix perdix*) are less common and rarely seen. Although once more common, sage grouse are now essentially absent from the Site, displaced after a major wildfire in 1984 (Brandt 1995). None of the upland birds are native to the area except the sage grouse.

I.4.3.3 Reptiles and Amphibians

Nine species of reptiles and three species of amphibians occur on the Hanford Site (Table I.4.3.3) (Fitzner-Gray 1991). The most abundant reptile is the side-blotched lizard (*Uta stansburiana*) (Cushing 1992). The short-horned lizard (*Phrynosoma douglassii*) and northern sagebrush lizard (*Sceloporous graciosus*) are also common in mature sagebrush habitats with sandy soil. Common snakes include the gopher snake (*Pituophis melanoleucus*), yellow-bellied racer (*Coluber constrictor*), and pacific rattlesnake (*Crotalus viridis*). Less common are striped whipsnakes (*Masticophis taeniatus*) and desert night snakes (*Hyspiglena torquata*). Amphibians on the Hanford Site are associated with riparian habitats located along permanent water bodies or the Columbia River (Fitzner-Gray 1991). Included are the Great Basin spadefoot (*Spea intermontana*), Woodhouses toad (*Bufo woodhouseii*), and the Pacific tree frog (*Hyla regilla*).

Table I.4.3.3 Amphibians and Reptiles Occurring on the Hanford Site

I.4.3.4 Insects

The Nature Conservancy of Washington, in an ongoing multi-year inventory project, has identified approximately 1,2 00 species of insects on the Hanford Site. This includes the discovery of six new species of bees , six new species of flies, five new species of leafhopper and planthopper insects , one new species of wasp and one new species of beetle (Nature Conservancy 199 6). None of the new species were found in potential TWRS areas. However, The Nature Conservancy project focused on the FEALE Reserve, the North Slope, and along the Columbia River rather than in areas of the Site where TWRS activities may occur under the various EIS alternatives.

Table I.4.3.4 lists the relative abundance (percentage) of insect taxa collected from three shrub species on the Site. Grasshoppers and darkling beetles represent some of the more conspicuous insect groups. The populations of both of these species of insects are subject to seasonal changes and weather variations (Rogers-Rickard 1977). Fifty percent of the known insect species are of the order Coleoptera (beetles) (ERDA 1975). Many of the insect species are important in the food web of birds and mammals found onsite. Species like the darkling beetle play an important role in the decomposition process by feeding on decaying plant material, animal excrement, fungi, and live plant tissue (Weiss-Mitchell 1992).

Table I.4.3.4 Relative Abundance of Insect Taxa Collected from Sagebrush, Rabbitbrush, and Hopsage

I.4.4 AQUATIC ECOLOGY

Aquatic habitats on the Hanford Site are primarily associated with the Columbia River, two small spring-fed streams on the FEALE Reserve, and artificial ponds and ditches occurring in or near the 200 Areas. Past studies (Cushing-Watson 1974, Emery-McShane 1978, and Cushing 1994) describe the ecology of some of these ponds. The Columbia River supports a large and diverse community of plankton, benthic invertebrates, fish, and other communities. The springs are also diverse and productive (e.g., dense watercress blooms and fairly high aquatic insect populations). The artificial ponds and ditches, many of which are now abandoned and dried out, often provide lush riparian habitat and support populations of migratory and breeding birds, particularly waterfowl. No extensive discussions are provided of Site aquatic habitats because none of them are in close proximity to any TWRS sites.

I.4.5 SENSITIVE HABITATS

Sensitive habitats on the Hanford Site include wetlands and riparian habitats. Wetlands include those transitional lands occurring between terrestrial and aquatic ecosystems where the water table is usually close to the surface or where shallow water covers the surface (Cowardin et al. 1979). The primary wetlands found on the Site occur along the Hanford Reach of the Columbia River and include the riparian habitats located along the river shoreline. Other wetland habitats found on the Hanford Site are associated with man-made ponds and ditches. These include B Pond and its associated ditches located near the 200 East Area. The B Pond Complex was constructed in 1945 to receive cooling water from facilities in that area. Wetland plants occurring along the shoreline of B Pond include herbaceous and woody species such as showy milkweed (*Asclepias speciosa*), western goldenrod (*Solidago occidentalis*), three square bulrush (*Scirpus americanus*), horsetail (*Equisetum*sp.), rush (*Juncus* sp.), common cattail (*Typha latifolia*), mulberry (*Morus alba*), silver poplar (*Populus alba*), black cottonwood (*Populus trichocarpa*), and willow (*Salix* sp.) (Sackschewsky et al. 1992). Wildlife species observed at B Pond include a variety of mammals and waterfowl species (Meinhardt-Frostenson 1979).

I.4.6 SPECIES OF CONCERN

Species of concern on the Hanford Site include Federally-listed threatened and endangered species, Federal candidate species, Washington State threatened or endangered species, State candidate species, State monitor species, State sensitive plant species, and species of ethnobiological concern to Native Americans.

Species of concern occurring on the Hanford Site are listed in Tables I.4.6.1 and I.4.6.2, along with definitions of each category. No Federally-listed threatened or endangered plant or animal species occur in the 200 Areas, at the potential Pit 30 borrow site located between the 200 East and 200 West Areas, or at the potential Vernita Quarry and McGee Ranch borrow sites. (Sackschewsky et al. 1992). Pipers daisy (*Erigeron piperianus*), a State sensitive species, has been found at B Pond near the 200 East Area and at Pit 30. The crouching milkvetch, stalked-pool milkvetch, and scilla onion, all State Class 3 monitor species, are also found in the 200 East Area.

Wildlife species of concern observed or considered likely to be found on or near the Central Plateau include the sage sparrow (*Amphispiza belli*), loggerhead shrike (*Lanius Ludovicianus*), and Swainsons hawk (*Buteo swainsoni*). The loggerhead shrike and sage sparrow commonly nest in undisturbed shrub-steppe habitat. The sage sparrow is one of the most common nesting birds on the Hanford Site (Downs et al. 1993). Other bird species of concern that may be found include the burrowing owl, ferruginous hawk, Swainsons hawk, golden eagle, sage thrasher, and prairie falcon (Cushing 1994).

Nonavian wildlife species of concern using the Central Plateau and vicinity include the striped whipsnake (*Mastocophis taeniatus*), which is a State candidate species; the desert night snake (*Hypsiglena torquata*), which is a State monitor species; the northern sagebrush lizard, a Federal Category 2 candidate species, and the pygmy rabbit, a Federal Category 2 candidate and State threatened species (Rogers-Rickard 1977).

Table I.4.6.1 Plant Species of Concern on the Hanford Site

Table I.4.6.2 Wildlife Species of Concern on the Hanford Site

To understand the role of the Central Plateau in terms of ethnobiology, the role of the natural environment in a culture, it is necessary to briefly describe the subsistence life-style of the Native Americans that have long resided in the general area (Hunn 1990). The Native American people that resided along the reach of the Columbia River flowing through what is now the Hanford Site followed a seasonal, migratory life-style, as did the majority of Native American people along the Columbia River. They concentrated on salmon fishing at Priest Rapids in the summer and early fall (June through October) when weather and water conditions combined with salmon migration provided a productive fishery. In the spring, they moved towards the areas now known as Moses Lake and Ephrata to gather roots, at one time a substantial component of their diet. In the late fall, the Native Americans moved to the surrounding mountains to gather berries and hunt. In the winter they returned to lower, warmer, elevations along the river where they over-wintered in semi-permanent long-houses. Although Native Americans followed a well-defined pattern of movement throughout the year, they fished for other species when salmon were not present, hunted whenever the opportunity was available, and gathered available, edible food plants.

Affected Tribes have indicated that big game including elk and antelope were abundant on the Columbia Plateau (CTUIR 1996). Other researchers have indicated that the Columbia Plateau historically did not support large populations of big game and that it is more likely that big game hunting was associated with fall berry-gathering expeditions to areas where larger animals were more abundant (Devoto 1953 and Irving 1976) . Smaller mammals such as the yellow-bellied marmot, Beldings ground squirrel, Townsends ground squirrel, jackrabbits, and cottontails probably made up a large portion of the diet of Columbia Basin Native Americans. This has been substantiated by archeological finds along the Columbia River (Aikens 1993).

Bird species were an additional source of food for Native Americans (CTUIR 1996) . Historically, the Hanford Reach of the Columbia River has been an important waterfowl wintering and breeding area. Waterfowl were netted or shot. Egg collecting probably contributed to the Native Americans diet. Birds and bird parts were used for medicinal purposes or as a part of religious practices. Bird parts were also used as decorations and to fletch arrows. Waterfowl and sage grouse probably made up the bulk of birds used for food (Hunn 1990).

Fish have been and remain an important part of the diet of the Native Americans residing along the Columbia River. Salmon played an important role in their diet, but suckers and other bottom fish are thought to have contributed as much to the diet as did salmon (Hunn 1990 and Aikens 1993).

For the Native Americans that live along the Columbia River, salmon and other fish continue to be an important part of their diet.

Plants have been and remain important to Native Americans along the Hanford Reach. Plants or plant parts provide food, medicine, cordage, building materials, and materials of religious significance. Several dozen plant species at the Hanford Site are considered to have uses in traditional Native American cultures and lifestyles. A number of these plants species were identified in 1994 biological surveys of the TWRS sites in the 200 East Area (Fortner 1994).

I.5.0 CULTURAL RESOURCES

The Hanford Site is abundant in cultural sites, including such items as archaeological sites, districts, and objects; standing historical structures, locations of important historic events; and places, objects, and living or nonliving sites that are important to the practice and continuity of traditional cultures. In most cases, cultural sites are finite, unique, fragile, and nonrenewable (PNL 1989).

Archaeological sites are considered to be substantial if they are eligible for inclusion in the National Register of Historic Places (NRHP). Properties are deemed to be eligible for the NRHP if they are important in American history, architecture, archaeology, engineering, or culture.

Three categories of cultural sites are commonly delineated: prehistoric resources, historic era sites, and ethnographic or traditional cultural sites. Prehistoric sites date from before the time of written records. In the interior Pacific Northwest, prehistory refers to the period of time predating Euro-American contact with the Native American cultures and societies of the region. Historic resources are defined as those sites or properties that were occupied or used after written records became available. Structures must usually be at least 50 years old to be deemed historic. However, those items and structures that were built in support of the Manhattan Project during World War II, as well as those that are representations of the Hanford Site's defense mission during the Cold War must also be considered for historic significance (Harvey 1994). Ethnographic sites (traditional cultural sites with historic or socio-religious affiliations) are locations that are important to the heritage of contemporary communities.

The Hanford Site contains a rich diversity of known cultural sites in all three categories. The Site contains seven NRHP Districts as well as 964 sites and isolated finds representative of prehistoric, historic, and modern eras (Neitzel 1996). The overall condition (i.e., integrity) and thus potential significance of Hanford Site cultural sites is high because the area has had limited public access for over 50 years. This restricted access has saved most archaeological sites from looting and other adverse impacts. Another contributing factor to the importance of the Site's cultural sites is that similar areas along the Columbia River have been inundated by hydroelectric development. The Hanford Site has not experienced this type of development nor the resultant depletion of cultural sites, because the reach of the Columbia River adjacent to the Hanford Site has not been dammed.

The Hanford Site is of particular importance to Native Americans. The Hanford Site is part of the original homeland of a number of Tribal Nations. Although no specific religious sites have been identified at the TWRS sites, Gable Mountain is a traditional cultural property located approximately 3 km (2 mi) north of the 200 Areas that would potentially experience impacts from implementation of TWRS alternatives. Further, it is the view of the affected Tribes that all natural resources, including the Sites groundwater and the Columbia River, are also cultural resources to indigenous people (CTUIR 1996).

Archaeological sites or artifacts in the 200 Areas are scarce. A review of existing data for the TWRS sites in the 200 East Area indicates that 28 cultural resource surveys have been previously conducted (ASI 1994). These surveys included 18 block-tract surveys, 7 linear surveys, and 3 historic well surveys. In all, these surveys covered approximately 1,350 ha (3,400 ac). The number of archaeological sites or artifacts recorded as the result of these surveys is limited. Findings recorded in the areas surrounding and including the TWRS sites in the 200 East Area consist of individual isolated artifacts and four archaeological sites. Cultural resource surveys of the TWRS sites and vicinity conducted in 1994 confirmed the overall scarcity of archeological sites and artifacts in the 200 East Area. These surveys indicate no archeological resources in the 200 East Area that are likely to meet the eligibility criteria for inclusion in the NRHP (PNL 1994a, b, c).

The portion of the 200 East Area where TWRS facilities are proposed includes potentially historic buildings and structures associated with the Hanford Site's defense mission. Some of these may meet NRHP eligibility criteria although they have not yet been evaluated for their historical significance. Evaluations of the buildings and structures in the 200 Areas are expected to be completed by the end of 1996 (Cushing 1995). TWRS implementation is not expected to impact these structures.

The 200 West Area has not been as completely surveyed as the 200 East Area. However, a 1988 project by the Hanford Cultural Resources Laboratory surveyed 50 percent of the undisturbed, previously unsurveyed land in the 200 West Area. This survey recorded a small number of isolated historical and prehistoric artifacts, and one extensive cultural feature that has historical significance, the White Bluffs Road (Chatters-Cadoret 1990). None of these sites or artifacts are near TWRS sites, except the White Bluffs Road.

I.5.1 PREHISTORIC RESOURCES

Current cultural resources survey data for the potential TWRS sites in the 200 East Area indicates an overall low probability for prehistoric materials in these locations. Much of the land surface in the 200 East Area has been extensively disturbed by construction and other development activity.

A previous archaeological survey of all the undeveloped portions of the 200 East Area had indicated no findings of archaeological sites or known areas of Native American interest (Chatters-Cadoret 1990). The 1994 cultural resources surveys of the TWRS site and surrounding areas found only individual isolated artifacts and sites (lithics and historic trashcan scatters) (PNL 1994a, b, c). Surveys of the proposed Phased Implementation alternative site in the easternmost portion of the 200 East Area have identified no archaeological sites or artifacts (Cadoret 1995).

As stated previously, a 50 percent survey of all undeveloped and unsurveyed portions of the 200 West Area recorded no prehistoric sites and one prehistoric artifact (Chatters-Cadoret 1990).

Cultural resources surveys of the potential Vernita Quarry borrow site recorded several prehistoric isolates and prehistoric sites. A number of prehistoric isolates and prehistoric sites were also recorded at the potential McGee Ranch borrow site. No prehistoric materials have been recorded at the potential Pit 30 borrow site. The Vernita Quarry and McGee Ranch sites are considered likely to contain more prehistoric materials (Duranceau 1995). Based on the scarcity of prehistoric resources in and around the 200 Areas, there is little likelihood of finding prehistoric resources at Pit 30.

I.5.2 HISTORICAL RESOURCES

The first Euro-Americans to enter this region were Lewis and Clark, who traveled along the Columbia and Snake rivers during their exploration of the Louisiana Territory from 1803 to 1806. Lewis and Clark were followed by fur trappers who also traversed the area on their way to more productive lands up and down the river and across the Columbia Basin. It was not until the 1860's that merchants set up stores, a freight depot, and the White Bluffs Ferry on the Hanford Reach. Chinese miners began to work the gravel bars for gold. Cattle ranches opened in the 1880's and farmers soon followed. Several small, thriving towns including Hanford, White Bluffs, and Ringold, grew up along the riverbanks in the early 20th century. Other ferries were established at Wahluke and Richmond. The towns, settlements, and nearly all other structures were razed after the U.S. Government acquired the land for the Hanford Site in the early 1940's (PNL 1989 and Cushing 1994).

The historic White Bluffs Road extends northeast-southwest across the northwest corner of the 200 West Area. It was an important transportation route during the mining, cattle ranching, and settlement eras of the 19th century, before Washington became a state. In the early 20th century, the road apparently was the primary northeast-southwest route across what is now the Hanford Site. The route was also used in prehistoric and historic times by Native Americans as a trail that connected Rattlesnake Springs with a Columbia River crossing at White Bluffs (Chatters-Cadoret 1990).

The White Bluffs Road has been nominated for the NRHP, although the segment in the 200 West Area is not considered to be a critical element in its historic value (Cushing 1994). The nomination to the NRHP is still pending. A 100-m (330-ft) easement has been created on either side of the road to protect it from uncontrolled disturbance (Cushing 1994). The CTUIR have indicated that the White Bluffs Road is an important cultural site to Native Americans. The road has been fragmented by recent activities associated with the Hanford Site (CTUIR 1996).

Historic materials from Euro-American settlement activities of the 19th and early 20th centuries have been found at both the potential Vernita Quarry and McGee Ranch borrow sites (Duranceau 1995). The McGee Ranch area has been deemed eligible for nomination to the NRHP as the McGee Ranch and Cold Creek District, in large part because of its historic sites (Cadoret 1995). No historic materials have been recorded at the potential Pit 30 borrow site.

Additional historic materials are likely to exist at both McGee Ranch and Vernita Quarry (Duranceau 1995). There is a low likelihood of important historic sites at Pit 30, although one homestead era structure is located in the area (Cadoret 1995).

Of a more recent historical nature (World War II and the Cold War period) are the nuclear reactors and associated materials processing facilities that now dominate the Hanford Site. The construction of three reactor facilities (100-B, 100-D, and 100-F) began in March 1943 as part of the Manhattan Project. In late 1944, the first reactor (100-B) became operational. Plutonium production began in early 1945 and continued into the post-war period. Plutonium for the world's first nuclear explosion test at the Trinity Site in New Mexico and for the bomb that destroyed Nagasaki was produced at the 100-B Reactor (PNL 1989 and Cushing 1994).

Additional reactors and processing facilities were constructed after World War II during the Cold War. All the reactor buildings constructed during these periods still stand, although many of the ancillary support structures have been removed. Because of its significance in contributing to international and national historical events, the 100-B Reactor has been listed individually on the NRHP and is a National Mechanical Engineering Monument ; approximately 110 other buildings have been evaluated for National Register eligibility. Other Manhattan Project facilities have yet to be evaluated. Until a full evaluation addressing each individual structure is conducted, no statement can be made about NRHP eligibility status. As mentioned in Section I.5.0, evaluation of the historic value of structure and buildings in the 200 Areas is scheduled for completion in 2000 (DOE 1996e) . The Washington State Historic Preservation Officer and DOE have determined that the Hanford Site is a Manhattan Project/Cold War era historical district (Neitzel 1996). The waste storage tanks in the 200 Areas may be considered historically substantial, and documentation of the history and use of examples of the various kinds of tanks (e.g., SSTs, DSTs) will be required (DOE 1996e).

The Advisory Council on Historic Preservation recognizes the need to balance the historic preservation of facilities with operational or health and safety issues. The DOE Richland Operations Office , the Advisory Council on Historic Preservation, and the Washington State Historic Preservation Office have signed a Programmatic Agreement that addresses cultural resources management of the built environment at the Hanford Site (DOE 1996e).

I.5.3 NATIVE AMERICAN RESOURCES

The Hanford Site is situated on lands ceded to the U.S. Government by the Confederated Tribes and Bands of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation. The Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation occupy reservations within 130 km (80 mi) of the Hanford Site. Until 1942, the Wanapum People resided on land that is now part of the Hanford Site. In 1942, the Wanapum People agreed to move from their residence near White Bluffs to the Priest Rapids Area. The Nez Perce Tribe also has retained rights to the Columbia River under a treaty with the U.S. Government.

The Hanford Site has been occupied by humans since the end of the last glacial period. Over 10,000 years of continuous prehistoric human activity in this largely desert environment is reflected by the extensive archaeological deposits along the river shores. Inland areas with water resources point to evidence of concentrated human activity. Recent surveys also indicate the extensive, although dispersed, use of arid lowlands for hunting. Graves are common in various settings and spirit quest monuments are still to be found on high, rocky summits of the mountains and buttes (Cushing 1994).

As mentioned previously, recent biological and cultural resource surveys of the TWRS sites and nearby areas in the 200 East Area found plant species that are of ethnobotanical significance to Native Americans (e.g., plants used for food or medicinal purposes).

Native Americans have retained traditional secular and religious ties to the Hanford Site. Certain landmarks such as Rattlesnake Mountain, Gable Mountain, Gable Butte, and various sites along the Columbia River are sacred to tribes. Native American people also consider numerous burial sites to be sacred (PNL 1989 and Cushing 1994). No specific sacred sites are known at any of the TWRS sites. However, affected Tribes indicate that other culturally important sites are found within areas that may be impacted by TWRS alternatives (i.e., downgradient in the groundwater, the Columbia River, and areas downwind of possible air releases) (CTUIR 1996).

I.6.0 SOCIOECONOMICS

The socioeconomic analysis focuses on Benton and Franklin counties in Washington State. These counties make up the Richland-Kennewick-Pasco Metropolitan Statistical Area (MSA), also known as the Tri-Cities MSA. Other jurisdictions in Benton County include Benton City, Prosser, and West Richland. Connell is the largest city in Franklin County after Pasco. A number of neighboring counties: Yakima, Walla Walla, Adams, and Grant counties in Washington; and Umatilla and Morrow counties in Oregon are impacted by activities at the Hanford Site. However, because nearly 90 percent of Hanford Site employees live in Benton and Franklin counties, the Site's impacts on these other counties are very small (Serot 1995). Thus, no discussion of baseline conditions in the neighboring counties is provided.

In accordance with Federal environmental justice policy, a discussion is provided in Sections I.6.1.4 and I.6.1.5 concerning the distribution and size of minority and Native American and low-income populations within an 80-km (50-mi) radius of the Hanford Site (Executive Order [EO] 12898). This discussion provides the basis for the required identification of potential disproportionate and adverse environmental impacts of EIS alternatives on minority and Native American populations and low-income populations. The 80-km (50-mi) radius includes counties not otherwise covered in this socioeconomic section because overall Site socioeconomic impacts on these counties are very small. However, this section does identify the minority and Native American population and employment within the Hanford Site's primary zone of socioeconomic influence, the Tri-Cities MSA (Benton and Franklin counties).

Before World War II, the economy in the Tri-Cities MSA was based primarily on agriculture. Since World War II, the Hanford Site has been the largest factor in the local economy. Plutonium production and processing was the primary mission of the Site until 1988 when the Site's mission became waste management and environmental restoration. Basic and applied research became an important secondary mission continuing to present.

Changes in the Hanford Site's mission and the cancellation of a Washington Public Power Supply System project at Hanford in the early 1980's (after only one of three planned nuclear power plants was completed) have had a large impact on the economy of the Tri-Cities MSA, creating boom-bust cycles that have had ramifications for employment, population, housing, and infrastructure. Table I.6.0.1 details Hanford Site employment, Washington Public Power Supply System employment, and total nonfarm employment for the Tri-Cities MSA, together with population in the MSA for 1980 to 1994. The Tri-Cities is currently in the early stages of an economic transition as employment at the Hanford Site declines from its recent peak levels.

I.6.1 DEMOGRAPHICS

This section examines population characteristics in the Tri-Cities MSA and the effects of the Hanford Site on the demographics of the area.

I.6.1.1 Population Trends

Population tended to follow changes in nonfarm employment in the Tri-Cities area during the 1980's and early 1990's (Table I.6.0.1). Between 1981 and 1984, nonfarm employment fell by approximately 11,000 jobs, while population fell by about 6,000. Employment began to increase after 1984 but population continued to fall, hitting a low of 138,300 in 1989. Employment increased until 1987 and then fell in 1988 after the decision to close the last plutonium production reactor (N Reactor). Between 1988 and 1989, however, employment in the Tri-Cities jumped by almost 2,000 (despite a continued decline in Hanford Site employment). When employment began to increase again at the Hanford Site in 1990, population increased by almost 12,000, effectively returning to the 1981 level.

The population trends reflected actual employment in the Tri-Cities MSA and expectations of employment. Once the economy began to grow in the late 1980's, people moved into the area, some because they had jobs but many others because they were searching for work. The population of the Tri-Cities area continued to grow as the Site and total nonfarm employment increased through 1994. Data for 1995 showed total Tri-Cities population continuing to grow, while Hanford Site employment declined and total area nonfarm employment remained virtually unchanged from 1994 (Table I.6.0.1) (Neitzel 1996).

Table I.6.0.1 Population and Employment in the Richland-Kennewick-Pasco MSA, 1980 to 1994

I.6.1.2 Population by Race and Minority Status

Table I.6.1.1 details the 1990 population for Benton and Franklin counties and for comparison provides Washington State population by race and minority status. The data show that minorities are a smaller percentage of Benton County population than in Franklin County or Washington State. The largest minority group in the Tri-Cities MSA is the Hispanic origin group, which makes up 30.2 percent of the population of Franklin County and 7.7 percent of Benton County. African Americans make up 1 percent of population in Benton County and 3.5 percent of Franklin County's population.

The American Indian, Eskimo, and Aleut category (Native Americans) accounts for less than 1 percent of the population in each county.

I.6.1.3 Urban, Rural, and Farm Populations

Benton County has a higher percentage of its population classified as urban (87.2 percent) than Washington State (76.4 percent) as a whole, while Franklin County has a lower percentage of urban residence (72.7 percent) than Washington State. At the same time, Benton County's farm population is more than twice as large as a percentage of total population than for Washington State as a whole (12.6 percent to 5.5 percent). Franklin County's farm population is almost five times as large on a percentage basis (24.9 percent) as Washington State's farm population. Franklin County's nonfarm rural population makes up 30 percent of the county's total population, which is virtually the same as the State's (29.3 percent), while more than twice the percentage in Benton County (13.0 percent). These data suggest the relative importance of farming in Franklin County and to a lesser extent in Benton County, compared to Washington State as a whole.

Table I.6.1.1 Population by Race and Minority Status, 1990

I.6.1.4 Minority and Native American Populations

This section and the following section on low-income populations (I.6.1.5) provide data on the distribution of minority, Native American, and low-income populations within an 80 km (50 mi) radius of the Hanford Site, in accordance with the Federal environmental justice policy (EO 12898).

The data provided are based on the following definitions:

- Minority and Native American population: Individuals identified in U.S. Bureau of the Census data for 1990 as Negro, Black or African American, Hispanic, Asian, and Pacific Islander, Native American, Eskimo, Aleut, and other non-White persons (DOC 1991). The minority population consists of the number of individuals residing in the 80-km (50-mi) radius of the Hanford Site who are members of a minority group.
- Low-Income population: Individuals identified in the U.S. Bureau of the Census data for 1990 as having incomes at or below 100 percent of the poverty level (DOC 1991). The low-income population consist of the number of individuals residing in the 80-km (50-mi) radius of the Hanford Site who have incomes below the poverty level.
- Minority and CTUIR, Yakama Indian Nation, and Nez Perce Tribes and low-income communities: For the purposes of this EIS, minority and Native American and low-income populations were analyzed at the census tract level. All tracts within a 80-km (50-mi) radius of the Hanford Site were included in the analysis. Tracts with a substantial minority or low income population were identified as a community for purposes of

environmental justice analysis. The 80-km (50-mi) area of interest was selected based on guidance from DOE regarding the analysis of environmental justice in NEPA documents and is the same area used for the analysis of environmental and human health impacts in other sections of the EIS.

The first step in identifying minority and Native American and low-income communities was to identify the total population of each group within the 80-km (50-mi) radius area of interest. Native American populations of primary concern include members of the three affected Tribes: the Yakama Indian Nation, the CTUIR, and the Nez Perce Tribe. The second step was to identify the combination of census tracts for each type of community that had a total minority and Native American or low-income population that would total one-half of the total population for the entire area of interest.

For minority populations, census tracts with populations that when combined, totaled one-half of the minority and Native American population for the area of interest, had an average percentage of minority and Native American individuals of 33 percent of the tract's total population. These census tracts were then considered minority and CTUIR, Yakama Indian Nation, and Nez Perce Tribes for the purpose of environmental justice analysis in the EIS (Figure I.6.1.1). For low-income populations, census tracts with populations that when combined totaled one-half of the low-income population for the area of interest had an average percentage of low-income individuals of 22 percent of the census tract's total population. These census tracts were then considered low-income communities for the purpose of the environment justice analysis in the EIS (Figure I.6.1.2).

The 80-km (50-mi) radius surrounding the Hanford Site's Central Plateau had a total minority and Native American population of 86,415 individuals as of the 1990 Census (Table I.6.1.2). The area's minority and Native American population of 19.3 percent greatly exceeds the Washington State average of 13.1 percent. The Hanford Site region's principal minority groups consist of Hispanics. In 1990, Hispanics comprised approximately 14.3 percent (64,300 individuals) of the area's population. The Hispanic population is relatively dispersed throughout the area, although Adams, Franklin, and Yakima counties in Washington State have relatively higher populations of Hispanic residents than do the other counties in the region. The Native American population of the surrounding area was approximately 2.4 percent (10,800 individuals). The Native American population is disproportionately located on the Yakama Indian Reservation in south-central Washington, with smaller concentrations in Benton and Grant counties in Washington. African American (5,200 or 1.2 percent) and Asian (6,100 or 1.4 percent) populations in 1990 within the surrounding area were very small and located predominantly in Yakima, Benton, and Franklin counties in Washington State.

As of the 1990 census, 17 of the 97 census tracts that are contained completely or partially within the 80-km (50-mi) radius of the Hanford Site had minority or Native American populations that exceeded 33 percent of their total tract populations (Table I.6.1.3).

Figure I.6.1.1 Census Tracts Within an 80-km (50-mi) Radius of the Hanford Site with Minority Populations Greater than 33 Percent of the Tract Population

Figure I.6.1.2 Census Tracts Within an 80-km (50-mi) Radius of the Hanford Site with Low-Income Populations Greater than 22 Percent of the Tract Population

Table I.6.1.2 Minority Populations Within an 80-km (50-mi) Radius of the Hanford Site by County (1990 Census)

These 17 census tracts contained less than one in five of the area's total residents, yet approximately 52 percent of the region's total minority or Native American population reside in these tracts. Moreover, in 1990 these 17 census tracts were home to over 6 in 10 of the area's Native American residents and at least 57 percent of the region's Hispanic population. Only 4 of the 10 counties in the area (Yakima, Franklin, Grant, and Adams) have census tracts with high levels of minority or Native American residents compared to the region as a whole. In 1990, Yakima County had 10 of the 17 tracts with a 33 percent or greater minority or Native American population. The highest percentage population of minority or Native American residents was found in census tract 0025, located in Yakima County (71.4 percent).

Geographically, the tracts with disproportionately high minority populations or Native American are located northeast of the Hanford Site in Adams and Grant counties, southeast of the Site in Franklin County, southwest and west of the

Site along the Yakima River Valley in Yakima County, and on the Yakama Indian Reservation (Figure I.6.1.1). Of the remaining census tracts, 49 tracts had 1990 minority and Native American populations of less than 10 percent, 23 tracts had minority or Native American populations under 20 percent, and 9 tracts had minority and Native American populations of between 21 and 33 percent.

Table I.6.1.3 Census Tracts Within an 80-km (50-mi) Radius of the Hanford Site With Minority Populations Greater Than 33 Percent of the Tract Population

Five census tracts (Table I.6.1.4), all located within the Yakama Indian Reservation in Yakima County, Washington have large Native American populations. In 1990, the population of these tracts contained nearly 57 percent of the 80-km (50-mi) radius area's Native American population. As of 1990, these tracts were the only census tracts in the area where the Native American population exceeded 8 percent of the tract population.

Census data are an imprecise tool for determining the exact representation of the Hispanic population. Individuals of Hispanic origin derive from diverse cultures and ethnicities. Racial identification is complicated by the lack of a Hispanic category. Hence, Hispanics select from among the available choices of White, African American, American Indian, or Other. Many select Other, although up to 4 in 10 select a different designation, with the bulk selecting White. For the purposes of this report, the census data for the Other category is used to provide an indication of those census tracts that are disproportionately populated by residents of Hispanic origin. Although the Other category does tend to under report the Hispanic population, it provides a tool of sufficient accuracy to approximate Hispanic population concentrations.

Table I.6.1.4 Census Tracts Within an 80-km (50-mi) Radius of the Hanford with Native American Populations Greater Than 500 Individuals (1990 Census)

All of the 17 census tracts with a minority and Native American population greater than 33 percent had substantial numbers of individuals listed in the Other category (Table I.6.1.5.). In all but three of the tracts, the Other category alone accounted for more than 33 percent of the population of the census tracts. Two of these three tracts are located on the Yakama Indian Reservation and have substantial Native American populations. The third tract is located in Franklin County.

I.6.1.5 Low-Income Populations

Figure I.6.1.2 shows the census tracts within an 80-km (50-mi) radius of the Hanford Site with low-income populations greater than 22 percent of the tract population. The 80-km (50-mi) radius surrounding the Hanford Site had a total low-income population in 1990 of 77,700 (Table I.6.1.6).

The area's low-income population of 17.3 percent greatly exceeded the Washington State average of 10.9 percent. In counties examined within Washington, only Walla Walla, Kittitas, and Benton counties had low-income populations below or slightly above the State-wide average.

All of the remaining counties had low-income populations exceeding the 17.3 percent region average. Franklin County, Washington had a low-income population more than double the State-wide average.

Table I.6.1.5 Census Tracts Within an 80-km (50-mi) Radius of the Hanford With Substantial Other Populations Within a Tract With Greater Than 33 Percent Minority and Native American Population (1990 Census)

In all, 25 of the 97 census tracts that are contained all or in part within the 80-km (50-mi) radius of the Hanford Site had low-income populations in 1990 greater than 22 percent of their total populations (Table I.6.1.7). These 25 census tracts contained less than 3 in 10 of the area's total residents (27.9 percent), yet, more than half of the region's total low-income population lived in these tracts (50.8 percent). All but 4 of the counties, Walla Walla, Kittitas, and Klickitat in Washington, and Morrow County, Oregon, had at least 1 census tract containing at least 22 percent of the low-income population. Adams and Benton Counties in Washington, and Umatilla County, Oregon, had 2 or fewer census tracts with low-income populations greater than 22 percent.

Table I.6.1.6 Low-Income Population Within an 80-km (50-mi) Radius of the Hanford Site by County (1990 Census)

Yakima County had 4 of the 5 tracts with 22 percent or greater low-income population in 1990. The highest percentage population of low-income residents was found in census tract 0001, located in Yakima County (45.4 percent). The 25 tracts had a total average low-income population of more than 31.5 percent. Geographically, the tracts with large, low-income populations (22 percent or greater) are located north and northeast of the Hanford Site in Grant County, southeast of the Site in Franklin County, and southwest and west of the Site along the Yakima River Valley and on the Yakama Indian Reservation in Yakima County (Figure I.6.1.2).

Of the remaining census tracts, 30 tracts had 1990 low-income populations that are less than the Washington State average (10.9 percent), 27 tracts had low-income populations between 11 percent and the average low-income population level of 17.3 percent of the 80-km (50-mi) area, and 15 tracts had low-income populations between 17.3 and 22 percent. Fourteen of the 30 census tracts with low-income populations under the Washington State average are located in Benton County (12 tracts) or in the two Franklin County tracts located closest to Hanford Site transportation access.

I.6.1.6 Household Income

The largest fraction of Franklin County households is in the $15,000 to $24,999 income range (Table I.6.1.8). Benton County has its highest concentration of households in the $35,000 to $49,999 range, as does Washington State as a whole. Benton County incomes are slightly skewed to the higher household income ranges as compared to incomes in Washington State as a whole, while Franklin County incomes are skewed to the lower income ranges. Median household income in Benton County was $41,800 in 1993 , while per capita income was $21,030 . Median household income in Franklin County was $30,525 in 1993 , while per capita income was $17,230 . In 1993 , Washington State median household income was $37,316 , while per capita income was $21,770 .

Table I.6.1.7 Census Tracts Within an 80-km (50-mi) Radius of the Hanford Site With Low-Income Populations Greater Than 22 Percent of the Population (1990 Census)

Table I.6.1.8 Household Income, 1990

Data on persons and families below the poverty level show that for most categories Benton County has the same or slightly higher poverty rates as Washington State (11.1 percent compared to 10.9 percent). In contrast, Franklin County's 23 percent poverty rate is substantially higher than the poverty rates for Washington State and Benton County (Table I.6.1.9). The data on income reflect overall the greater urbanization of Benton County and the effects of the Hanford Site as a large source of specialized technical and professional employment in Benton County.

Table I.6.1.9 Persons and Families Below Poverty Level, 1990

I.6.1.7 Educational Attainment

Benton County residents have approximately the same level of education as residents State-wide while Franklin County residents tend to have a lower level of educational attainment (Table I.6.1.10).

I.6.2 PUBLIC FACILITIES AND SERVICES

The following sections describe public facilities and service systems in the Tri-Cities that potentially could be impacted by implementation of the EIS alternatives. Discussions are provided for public safety, hospitals, electricity and natural gas, sewer, and solid waste. Water supply systems are discussed in Section I.2.3.

I.6.2.1 Public Safety

Public safety services, including police and fire, are provided by a number of jurisdictions in the region. Police protection is provided by the county sheriff departments of Benton and Franklin counties, local municipal police departments (Pasco, Richland, Kennewick, and West Richland), and the Washington State Patrol Division in Kennewick. In terms of total staffing, the local municipal police departments (179 commissioned officers and 76 reserve officers) are considerably larger than the two county sheriff departments, which had 62 commissioned officers and 45 reserve officers in 1995 (Neitzel 1996).

Fire protection in the Tri-Cities area is provided by fire departments in the cities of Kennewick, Pasco, and Richland, a volunteer fire department in West Richland, and three rural fire departments in Benton County.

Table I.6.1.10 Educational Attainment, 1990

Public safety services are also provided at the Hanford Site. In the past the Hanford Patrol has provided security and law enforcement services for the Site. Currently, the Benton County Sheriffs Department is providing law enforcement support. The Sheriffs Department maintains an office in the 300 Area. The Hanford Fire Department has approximately 155 firefighters who are trained to dispose of hazardous waste and fight chemical fires. The Hanford Fire Department has fire stations in the 100, 200, 300, 400, and 1100 Areas of the Hanford Site.

I.6.2.2 Hospitals

There are three large hospitals and four small emergency centers in the Tri-Cities area. Kadlec Medical Center in Richland has 133 beds, approximately 6,000 annual admissions, and operates at 50 percent capacity. Kennewick General Hospital has 70 beds, 4,800 annual admissions, and operates at approximately 44 percent capacity. Our Lady of Lourdes Hospital in Pasco had over 4,400 admissions in 1994 (Neitzel 1996) .

The Hanford Environmental Health Foundation primarily provides risk-management services for the Site; they also provide health screening for workers and respond to emergencies at the Site. The Hanford Environmental Health Foundation currently operates five onsite health service centers including facilities in the 100, 200 East, 200 West, and 300 Areas.

I.6.2.3 Schools

Educational services at the primary and secondary level are provided by four school districts. Kennewick is the largest district, serving approximately 13,000 students in 1994, with nearly 8,700 students in the Richland district, 7,800 students in the Pasco district, and 1,500 students in the Kiona-Benton district (Cushing 1995).

School enrollment has increased over the last few years, with all four school districts operating at or near their capacity during the 1994 school year (Cushing 1995). Despite declining Hanford Site employment, school enrollment in the 1995 school year increased by the following approximate amounts: Richland 0.9 percent; Pasco 1.1 percent; Kennewick 2.6 percent; and Kiona-Benton 5.1 percent (Brown 1995, Foley 1995, Haun 1995, Marsh 1995, Meilour 1995, O'Neil 1995). Portable classrooms are used in the Richland (20 portables) and Pasco (60 portables) school districts. In 1995, the Richland, Kennewick, and Kiona-Benton districts were operating at capacity, while the Pasco district was at capacity for the primary grades but had room for more students at the secondary level (Neitzel 1996).

Post-secondary education in the area is provided by the Columbia Basin Community College and the Tri-Cities branch campus of Washington State University. The fall 1995 enrollments for these schools were approximately 6,700 and 1,200 , respectively (Neitzel 1996) .

I.6.2.4 Electricity and Natural Gas

Electricity in the Tri-Cities is provided by the Benton County Public Utility District, Benton Rural Electrical

Association, Franklin County Utility District, and the City of Richland Energy Services Department. The Bonneville Power Administration, a Federal power marketing agency, supplies all the power that these utilities provide in the local area.

Electrical power for the Hanford Site is purchased wholesale from the Bonneville Power Administration. The Hanford Site electrical distribution system is used to distribute power to the majority of the Site. The city of Richland distributes power to the 700, 1100, and 3000 Areas. This is approximately 2 percent of the total Hanford Site usage. Energy requirements for the Hanford Site exceeded 550 megawatts (MW) during fiscal year 1988 (Cushing 1994). The Site's electrical requirement in 1993 was substantially lower at approximately 57 MW (Cushing 1994).

Natural gas, provided by the Cascade Natural Gas Corporation, serves a small portion of the regions residents. In December 1993, Cascade Natural Gas Corporation had approximately 5,800 residential customers (Cushing 1994).

Hydroelectric, coal, nuclear power, oil, and natural gas fuel the Pacific Northwest's electrical generation system. Hydroelectricity is the primary power source in the region, accounting for approximately 74 percent of the regions installed generating capacity of 40,270 MW, and supplying approximately 56 percent of the electricity used by the region. Coal provides 16 percent of the region's electrical generating capacity (Cushing 1994). The one operating commercial nuclear power plant in the Pacific Northwest (located on the Hanford Site) provides approximately 6 percent of the regions generating capacity.

Throughout the 1980's, the Pacific Northwest had more electric power than it required. However, this surplus has been exhausted and the regional system generates only enough power to meet regional electrical needs. It is estimated that the Pacific Northwest will need an additional 2,000 MW over 1991 consumption by the turn of the century (Neitzel 1996).

I.6.2.5 Sewer

Sanitary waste in the 200 Areas is currently disposed of through septic tanks and drain fields. There are concerns about the ability of the current system to handle projected sanitary waste disposal needs resulting from new facilities, increased personnel, and changing environmental regulations. The planned construction of a central collection and treatment facility in the 200 Areas was canceled due to funding constraints. Future upgrades to 200 Areas septic systems may be needed to meet capacity and regulatory requirements (Harvey 1995).

The major incorporated areas of Benton and Franklin counties are served by municipal wastewater treatment systems and the unincorporated areas are served by onsite septic systems. The city of Richland's wastewater treatment system is designed to treat a total capacity of 1.1E+08 L (30E+07 gal/day). The Richland system processed an average of 7.6 E+07 L/day (2.0E+07 gal/day) in 1994 (Nietzel 1996). The wastewater treatment system for the city of Kennewick is also operating well below capacity. The Kennewick system has a treatment capacity of 8.3E+07 L/day (2.2E+07 gal/day) . In 1994 the Kennewick system processed an average of 3.8 E+07 L/day (1.0E+07 gal/day). The Pasco wastewater treatment system has the capacity to treat 9.5E+07 L/day (2.5E+07 gal/day) , and currently processes an average of 2. 9 E+07 L/day (7.8E+06 gal/day) (Neitzel 1996).

I.6.2.6 Solid Waste

The existing Hanford Site nonradioactive solid waste landfill is expected to reach its capacity in 1996. In October 1995 it was announced that DOE and the city of Richland reached an agreement to send the Site's nonregulated and nonradioactive solid waste to the Richland Sanitary Landfill (DOE 1995k).

The city-operated Richland Sanitary Landfill serves Benton County. The landfill, which receives about 200 tons of solid waste per day, has a current life expectancy of 50 years (Penour 1994). This could be extended to approximately 100 years with design modifications.

The city of Kennewick has a contract with Waste Management of Kennewick for solid waste disposal. Waste Management disposes of the solid waste at the Columbia Ridge Landfill in Arlington, Oregon, a facility with a life expectancy of approximately 50 years (Denley 1994).

The cities of Pasco and West Richland have contracts with Basin Disposal, Inc. for solid waste disposal. Basin Disposal, Inc. disposes of the solid waste at the Roosevelt Regional Landfill in Roosevelt, Washington, a facility with a life expectancy of approximately 40 years (Thiele 1995).

I.6.3 ECONOMY

The Hanford Site is the largest employer in the Tri-Cities area. This is a key factor in the local economy. In 1995 , total nonfarm employment in the area averaged about 72,200 . During the same period, Hanford Site employment was about 15,800 or nearly 22 percent of total nonfarm employment. In addition, other workers who are not included in the data as Hanford Site employees provide goods and services to the Hanford Site or its contractors. Agriculture, food processing, retail trade, and other industries provide substantial economic diversity to the Tri-Cities MSA.

Farm employment averaged about 3,500 jobs in Franklin County in 1992 and 4,200 jobs in Benton County. However, Franklin County farm employment ranged from a high of about 9,000 in June 1992 to a low of 1,100 in January. The range in Benton County was 10,700 in June to 1,900 in December. This range reflects the seasonal nature of farm labor. In addition, many farm workers are migratory workers who come to the area during harvest seasons then move on to other regions. Also, year-to-year changes in farm employment are subject to random variations in weather and agricultural market conditions. Changes in Hanford Site employment do not impact the area's farm employment, and for this reason the following discussion focuses on nonfarm employment only.

I.6.3.1 Industries and Employment

Besides DOE and the Hanford Site contractors, major employers in the Tri-Cities MSA include Siemens Nuclear Power Corporation, Sandvik Special Metals, Burlington Northern Railroad, and the Washington Public Power Supply System. Two other major employers, Iowa Beef Processors and Boise-Cascade, have facilities in Walla Walla County adjacent to Franklin County with many of their employees living and shopping in the Tri-Cities (Cushing 1994).

Table I.6.3.1 shows average annual employment by sector in 1993 and 1995 . Total nonfarm employment was approximately 72,200 in 1995, compared to 72,300 in 1994. The largest sector is services, which includes business services, research services (including most Hanford Site employees), and other services. Other Hanford Site employees are classified in the construction, health services, and business services sectors.

After services, the next largest sector is wholesale and retail trade. The Tri-Cities MSA is the main retailing sector for southeastern Washington State and northeastern Oregon. A number of national retail chains have opened outlets in the MSA in the last few years. Columbia Center in Kennewick is the primary regional shopping mall (Serot 1993).

Government is the third largest sector, including Federal, State, and local governments and public schools. Construction has been a key sector in the past few years because of new housing construction, commercial construction, and construction at the Hanford Site. Food processing is the largest manufacturing industry, followed by chemicals. The services sector in Benton County, which includes most Hanford Site and Hanford-related employment, dominates the economy in the Tri-Cities MSA. The services sector in Benton County accounted for $769 million in wages, or about 43 percent of wages paid in the two counties (Table I.6.3.2). State-wide, services accounted for only 21 percent of wages paid. The average wage in the services sector in Benton County was more than $34,000, compared to $17,000 in Franklin County and $23,000 statewide. The higher wage in the services sector in Benton County reflects the specialized technical and professional work force at the Hanford Site.

Table I.6.3.1 Average Annual Employment by Sector Tri-Cities Area, 1993 and 1995

Average wages were higher in Benton County than in Franklin County except in the wholesale and retail trade sector. In that sector, Franklin County has more wholesale trade, which typically pays higher wages than retail trade. Also, agriculture is a larger share of Franklin County's economy than Benton County's, although Benton County had a somewhat higher level of wages paid.

I.6.3.2 Labor Force

Data on occupations for 1990 show that the Benton County labor force is concentrated in the managerial and professional and the technical, sales, and administrative occupations, each of which accounts for about 30 percent of the work force (Table I.6.3.3). Franklin County has much lower percentages in these categories. Technical occupations and farming, forestry, and fishing (agricultural) occupations each accounts for about 21 percent of the Franklin County labor force. Franklin County also has a higher percentage of workers in the operators, fabricators, and laborers occupational category (17.3 percent) than Benton County (12.0 percent).

Table I.6.3.2 Average Wage by Industry in Benton and Franklin Counties and Washington State, 1992

Table I.6.3.3 Civilian Labor Force by Occupation Group, Sex, Race, and Hispanic Origin, 1990

Hispanics account for 6.9 percent of the Benton County labor force and 46.3 percent of the workers in the agricultural occupational category (Table I.6.3.3). In Franklin County, Hispanics are 28.3 percent of the labor force and 63.2 percent of the workers in the agricultural occupations. At the same time, Hispanics in Franklin County account for over 37 percent of the operators category and almost 28 percent of the precision production, craft, and repair occupations. In Benton County, Hispanics represent about 6 percent of the production occupations and 12 percent of the operators occupations. Among other non-Hispanic minority groups, the agriculture occupations have the smallest representation.

African Americans, who make up 0.9 percent of the labor force in Benton County, account for 1.4 percent of the managerial occupations, while in Franklin County African Americans account for 2.1 percent of the labor force and 2 percent of the managerial occupations. In Benton County, Native Americans account for a larger percentage of the production and operators than their percentage of the total labor force. In Franklin County, Native Americans account for a larger percentage of the managerial and production occupations than of the total labor force.

Asians and Pacific Islanders account for 2 percent of the labor force in Benton County and 2.7 percent of the managerial occupations. The same group accounts for 2 percent of the labor force in Franklin County but only 1.2 percent of the managerial occupations. Service occupations show the highest rate of Asian and Pacific Islander representation in both counties. Women account for 40.4 percent of the labor force in Benton County and 42.7 percent in Franklin county. Women account for 51.5 percent of the managerial and professional occupations in Benton County and 39.4 percent in Franklin County. In the other occupational categories the representation of women is similar or virtually the same in the two counties.

In terms of the Hanford Site (Table I.6.3.4), the Hanford Site's maintenance and operators contractor's work force is approximately 29 percent female, 4 percent Hispanic, 3 percent African American, 2 percent Asian, and 1 percent Native American (Pitcher 1994).

Table I.6.3.4 Hanford Site Management and Operations contractor Workforce Representation by Gender and Ethnic Group, 1994

I.6.3.3 Tax Base

Local government revenues in Benton and Franklin counties come primarily from property taxes and the local share of sales taxes. Other revenues come from fees, fines, forfeitures, and transfers from the State or the Federal government. In 1993, assessed property values were about $3.8 billion in Benton County and $1.3 billion in Franklin County. These assessed values were $500 million more than 1992 assessments in Benton County (15 percent increase) and $86 million more in Franklin County (7 percent increase). These increases reflect both new residential and commercial construction and increasing property values caused by the increased demand for residential and commercial property (Serot 1993).

In 1992, the last year for which complete data are available, taxable retail sales were $1,054 million for Benton County and $400 million for Franklin County. This represents a 14 percent increase for Benton County from 1991 levels and a 16 percent increase for Franklin County. Between 1988 and 1992, combined taxable retail sales for the two counties increased from $992 million to $1,481 million (WSDR 1987-1995). This represents almost a 50 percent increase or about 10.5 percent per year. The increase in taxable retail sales shows the effects of rising employment (leading to more consumer spending), population growth, and a general increase in economic activity (Serot 1993).

I.6.3.4 Housing

The growth in employment and population in the Tri-Cities MSA in the late 1980's and early 1990's created a tight housing market. Between 1988 and 1993, the average price of a single-family home increased from approximately $59,000 to $107,000. This increase occurred despite record levels of housing construction. Housing starts increased from 42 in 1988 to 1,200 in 1993 (Table I.6.3.5). However, recent declines in Hanford Site employment, as well as continued construction, resulted in a softening of the housing market and a decline in housing prices and housing starts in 1995 (TAR 1980-1995). The average home sale price in August 1995 was approximately $101,000, down from $126,000 in August 1994. However, most of the drop in home prices occurred in the upper prices ranges, with sales remaining strong in the $70,000 to $120,000 range. In September 1995, the Tri-City Association of Realtors described the local housing market as healthy (Schafer 1995).

Housing prices and housing starts in the Tri-Cities MSA have responded to changes in economic conditions during the past 15 years. Home prices declined after the termination of the Washington Public Power Supply System construction project in 1982 and then again after the shut-down of the Hanford Site's last production reactor in 1987. However, the Hanford Site cleanup and environmental restoration mission and increasing staffing levels, as well as growth in other sectors of the economy caused housing prices to increase dramatically. Until recently, despite new construction and new residences, first-time home buyers faced both rising prices and the lack of available housing, especially at the lower end of the price spectrum.

Table I.6.3.5 Tri-Cities MSA Home Prices and Housing Starts, 1980 to 1993

The housing problem was compounded by very low vacancy rates and increasing rents in rental housing. A December 1993 survey of apartment complexes in Richland, Kennewick, Pasco, and West Richland showed vacancy rates between 1.0 and 2.3 percent. Overall Tri-Cities housing occupancy rates (both single-family and multiple-unit housing) were approximately 95 percent in 1994 and 1995 (Cushing 1995 and Neitzel 1996).

I.7.0 LAND USE

While the focus in the following land-use section is on the 200 Areas, a brief summary is provided on land uses for the remainder of the Hanford Site as well as surrounding offsite land-use patterns. Also addressed are the future planning efforts of other Federal and State agencies, Tribes, and local governments. Prime and unique farmlands and recreational opportunities also are identified.

I.7.1 PRIME AND UNIQUE FARMLAND

The Farmland Protection Policy Act requires Federal agencies to consider prime or unique farmlands when planning major projects and programs on Federal lands. Federal agencies are required to use prime and unique farmland criteria developed by the U.S. Department of Agriculture's Soil Conservation Service (SCS). Under Farmland Protection Policy Act, the SCS is authorized to maintain an inventory of prime and unique farmlands in the United States to identify the location and extent of rural lands important in the production of food, fiber, forage, and oilseed crops (7 CFR Part 657). The SCS has determined that because of low annual precipitation in southeast Washington State, none of the soil occurring on the Hanford Site would meet prime and unique farmland criteria unless irrigated (Brincken 1994). The specific location of potential irrigable prime or unique farmlands at the Hanford Site has not been determined by the SCS because of the absence of detailed slope information.

I.7.2 EXISTING LAND-USE TYPES AND LAND-USE PLANS

This section discusses 1) existing Site land uses and associated issues based on the Hanford Site Development Plan (HSDP); 2) the Comprehensive Land Use Plan (CLUP) for the Site that was prepared by DOE and released for public comment in August 1996 (DOE 1996c) , and other relevant land-use plans by Federal, State, and local agencies and Tribal Nations; and 3) recreational uses.

I.7.2.1 Hanford Site Development Plan

The HSDP provides an overview of land use, infrastructure, and facility requirements to support DOE at the Hanford Site (DOE 1993e). Although the HSDP is not a formal land use plan, it is the most current available planning document until the Site's CLUP is finalized . DOE has invited Trib al Nations , county and city governments, and other stakeholders to participate in the planning process. A draft of the CLUP was release d for public comment in August 1996. Because the CLUP is not yet final , the following discussion focuses on the HSDP.

The HSDP has a Master Plan section that outlines the future land and the infrastructure needed by Hanford Site missions. The primary objective of the Master Plan has been to develop and maintain the Hanford Site infrastructure to meet ongoing and future program requirements (DOE 1993e). A goal of the HSDP has been to maximize the amount of land available for other beneficial uses, including protecting cultural and biological resources.

The HSDP provides for a compatible land-use transition from offsite agricultural uses in Adams, Grant, Franklin, and Benton counties to passive uses onsite in the FEALE Reserve and the proposed National Wildlife Refuge north of and along the Columbia River. The areas of the Hanford Site nearest to the river are proposed to remain undeveloped, providing an additional buffer area between sensitive natural areas and more intensely developed areas such as the Central Plateau. The HSDP accommodates future intensive uses, such as industrial development and research in the southeast area of the Hanford Site near the urban development of Richland. These more intensive uses are adequately separated from less intensive agricultural uses in Franklin County by the Columbia River. The future land uses are designed to facilitate cleanup, maintain a stable employment and economic foundation, provide energy research and development, continue waste management and disposal activities, and provide environmental protection.

Figure I.7.2.1 identifies the existing land uses on the Hanford Site. The Hanford Site has seven major land-use types:

- Reactor Operations, which involves the development and irradiation of nuclear fuels, fuel fabrication, fuel storage, and reactor plant operations (all operations except storage are currently inactive);
- Waste Operations, which include the treatment, storage, and disposal of radioactive and nonradioactive waste, including waste treatment facility operations, active and inactive tank farms, burial grounds, vaults, and cribs;
- Operations Support, which involves services provided specifically for operations that are primarily industrial;
- Administrative Support, which provides administrative services for overall Hanford Site activities;
- Research and Development and Engineering Development, which includes basic and applied research conducted to advance fundamental scientific knowledge related to Hanford Site activities as well as other major national needs;
- Sensitive Areas, which include environmentally (ecological) or culturally (historical, archaeological, and religious) important areas; and
- Undeveloped Areas, which include areas that have not been developed or have been restored to an undeveloped state. The undeveloped areas also contain sensitive biological and cultural resources.

Figure I.7.2.1 Existing Land-Use Map

Sensitive Areas are the largest portion of the existing land use on the Hanford Site. These include the FEALE Reserve, an area that occupies the entire southwest portion of the Hanford Site. Also included are all the Hanford Site lands north of the Columbia River, lands along the river, Gable Butte, Gable Mountain, and an area along the eastern boundary of the Hanford Site south of the river. The area north of the river, the North Slope, is administered by two separate agencies. The U.S. Fish and Wildlife Service (USFWS) administers the area in Grant County west of the northern point of the Hanford Reach known as the Saddle Mountain National Wildlife Refuge. The Washington State Department of Fish and Wildlife Services administers the area in Grant, Adams, and Franklin counties to the north and east of the Hanford Reach, which is known as the Wahluke Wildlife Recreation Area. These areas are undeveloped, natural wildlife areas.

The FEALE Reserve and the North Slope are being considered by DOE for release. The release of the FEALE Reserve could involve land exchange agreements between DOE and the Bureau of Land Management (BLM). The Yakama Indian Nation also has proposed that they take ownership of the Reserve, as has Benton County. Current considerations for the North Slope involve the proposed National Park Service designation of the area as a National Wildlife Refuge (NWR) to be administered by the USFWS. Benton, Franklin, and Grant county commissioners oppose the proposed designation of the North Slope (Campbell 1995). No final resolution of either of these issues has occurred .

The HSDP contains a Future Land Use Map that presents DOE's 1993 vision of future Site land-use needs (Figure I.7.2.2). The Future Land Use Map was intended for annual updates to reflect mission changes, regulatory decision documents, NEPA documents such as the Hanford Remedial Action EIS and the TWRS EIS, and other appropriate sources (DOE 1993e). However, the Site CLUP, was release d in draft form in August 1996 with final decisions expected in early 1997, will provide an official DOE vision of future Site land uses (DOE 1996c) .

Figure I.7.2.2 Future Land-Use Map

As previously mentioned, a goal of the HSDP has been to maximize the amount of land available for other beneficial uses. Future land-use designations were also based on existing and potential Hanford Site missions and assumptions, and the recommendations of the Hanford Future Site Uses Working Group (HFSUWG 1992). The Reactor Operations, Sensitive Areas, and Administrative Support areas remain unchanged from the existing land-use plan (Figure I.7.2.2).

The Hanford Site consists of 1,450 km^2 (560 mi^2) or 145,000 ha (358,000 ac) of land. Of the total Hanford Site area, the Central Plateau, which has been identified for waste management operations, constitutes 117 km^2 (45 mi^2) or 11,700 ha (29,000 ac) of land. This represents approximately 8 percent of the total Hanford Site area. The Central Plateau would consist of 1) a buffer zone of 49 km^2 (19 mi^2) or 4,900 ha (12,000 ac); and 2) a waste management area of 26 km^2(10 mi^2) or 2,600 ha (6,400 ac). The buffer zone would separate the waste management activities from other areas of the Hanford Site. The 200 Areas would be contained entirely within the waste management area. The

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200 Areas consists of 26 km (10 mi) or 2,600 ha (6,400 ac) of land. This represents approximately 22 percent of the total Central Plateau waste management area and 2 percent of the total Hanford Site.

The Waste Operations area is primarily limited to the 200 Areas. Virtually all proposed TWRS activities except two potential borrow sites would occur in or between the 200 Areas. The 200 Areas have been used to process irradiated nuclear fuel and store the resulting waste. Existing facilities in this area include the PUREX Plant, the Plutonium Finishing Plant, the U Plant, the tank farms, the Central Waste Complex, and the Waste Sampling and Characterization Facility. The PUREX, Plutonium Finishing Plant, and U Plants are being deactivated (DOE 1993e). The 200 Areas are also used for Research and Development and Engineering Development; they also contain meteorological towers.

The future locations of the Waste Operations area remain the same although the overall Waste Operation area has been expanded. This expansion reflects land dedicated to a potential cleanup scenario where Sitewide waste is collected and placed in a central location dedicated to exclusive use as a waste disposal area. This includes relocating waste sites, contaminants, and associated structures such as the 100 Area facilities.

According to the HSDP, the future Operations Support areas will remain unchanged except for closing and reclaiming the borrow pit in the western portion of the Hanford Site. The Research and Development and Engineering Development area has increased substantially to include the majority of the southeastern portion of the Hanford Site. The Undeveloped Areas, which include areas of sensitive ecological and cultural resources, have been reduced in size to reflect the future release and reuse of portions of the Site. DOE is working with a variety of governmental and nongovernmental organizations to ensure protection, preservation, and proper management of Hanford Site ecological and cultural resources.

The National Park Service released a Final EIS in June 1994 that recommended designating the Hanford Reach portion of the Columbia River as a Recreational River under the Wild and Scenic Rivers Act and also proposed designating the North Slope, an upland area north and east of the river, a National Wildlife Refuge (NPS 1994). This proposal would transfer management of the river and a 0.40 km (0.25 mi) strip of land along both shores of the river to the USFWS along with approximately 41,300 ha (102,000 ac) of adjacent lands. Development restrictions are included for protecting cultural resources, threatened and endangered species, water quality, unique scenic geologic features, and Native American access and use. The Secretary of the U.S. Department of Interior has issued a Record of Decision indicating a preference for this proposal. This recommendation has been sent to Congress with the final EIS for consideration (NPS 1994).

Benton, Franklin, and Grant count y commissioners oppose the proposed U.S. Department of Interior recommendation and have offered an alternative approach that would leave the Reach under local government control (Stang 1996b). Various local groups (e.g., the Lower Columbia Basin Audubon Society) and many area residents support the Wild and Scenic Rivers designation. No final decisions have been made.

BLM owned many scattered tracts of land on the Hanford Site prior to transferring those lands to the Atomic Energy Commission for national security reasons in 1943. BLM currently does not own any lands on the Site's Central Plateau. However, BLM owns land that includes the potential Vernita Quarry borrow site.

I.7.2.2 Washington State

Washington State has several land interests onsite. The Washington State Department of Fish and Wildlife currently administers the area of the Hanford Site north and east of the Hanford Reach known as the Wahluke State Wildlife Recreation Area. This area is considered sensitive ecological upland habitat and is part of the Wahluke Slope. Washington State also leases a square parcel in the south-central portion of the Hanford Site between State Route 240 and the Route 2/Route 4 junction. This property is located within the undeveloped area of the Hanford Site.

I.7.2.3 Tribal Nations

The Hanford Site is located on land ceded from the Confederated Tribes and Bands of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation (the Umatilla, Cayuse, and Walla Walla Tribes), based on treaties signed in 1855 (DOE 1992b). The Nez Perce Tribe has treaty rights on the Columbia River under a separate treaty.

I.7.2.4 Local Governments

The Hanford Site is located within portions of Benton, Franklin, Grant, and Adams counties. Other surrounding local jurisdictions include the cities of Richland, West Richland, Pasco, and Kennewick.

Because many of the local jurisdictions existing comprehensive plans are incomplete or outdated, they have been updated recently or are in the process of being updated as mandated by the 1990 Washington State Growth Management Act. Because of its limited recent growth, Adams County is not updating its plan.

The majority of the Hanford Site is located within Benton County and comprises up to 25 percent of the county land. The cities of Richland, West Richland, Kennewick, Prosser, and Benton City are located in Benton County. The unincorporated areas of the county adjacent to the Hanford Site currently have generalized land-use designations for rangeland and undeveloped and dry agriculture. Rangeland activities consist largely of cattle grazing. Undeveloped or vacant land is primarily open space. Dry agriculture, the largest single land use in the county, consists almost exclusively of dryland wheat and summer fallow (BCBCC 1985).

Benton County officials are concerned with the remediation and potential reuse of the Hanford Site because most of the land-use effects resulting from reuse would occur within Benton County. Benton County is in the process of updating its comprehensive plan. The county plan update will include a separate Hanford Comprehensive Plan that will be consistent with the overall county plan (Walker 1995). The County Planning Department has defined three categories of land use for the Site: 1) critical areas (e.g., wetlands, areas prone to landslides, fish and wildlife areas); 2) areas where development could occur only if damaged habitat was replaced or restored; and 3) areas where development could occur with minimal restrictions. Of the potential TWRS areas, the potential Vernita Quarry borrow site is within a defined critical area, and the potential McGee Ranch borrow site is within the land use category that would require replacement or restoration of affected land. The Washington State Department of Fish and Wildlife asked Benton County to designate the McGee Ranch as a critical area (preservation area) (McConnaughey 1996a). All other potential TWRS sites are within areas where only minimal development restrictions would be imposed (Fyall 1996).

Benton Countys proposed Hanford Comprehensive Plan is in the process of review and public hearings before the County Planning Commission and then before the county commissioners. The Hanford Comprehensive Plan is expected to be formally adopted by the end of 1996 (Fyall 1996).

Franklin County is located east of the Hanford Site and includes the city of Pasco. The unincorporated area of the county adjacent to the Hanford Site is rural and sparsely developed (Franklin County 1982). The land-use designation surrounding the Hanford Site, as with most of the county, is agricultural. Franklin County adopted an updated comprehensive plan in April 1995. The updated plan does not directly impact any land uses at the Hanford Site (German 1995).

Grant County is located north of the Hanford Reach and includes the Area of the Hanford Site north of the river. The land uses adjacent to the Hanford Site are designated as agricultural (Grant County 1994). This use type is restricted to crop agriculture, agricultural related industries, livestock, and public utility functions (Grant County 1988). Grant County is in the process of updating its comprehensive plan with an expected completion date in 1998 . However, no changes in the county plan would impact areas of the Hanford Site south and west of the Columbia River, which include all potential TWRS areas, because those areas are not within Grant County (Lambro 1996).

Adams County is located northeast of the Hanford Site although a small portion of the Site is located within Adams County. The land use adjacent to the Hanford Site within Adams County is designated as agricultural (Caputo 1994). These lands are either being used for rangeland or are lying fallow.

The city of Richland is located immediately adjacent to the Hanford Site. Richland is currently in the process of annexing the Site's 1100 Area (Milspa 1995). The existing land uses within Richland near the Hanford Site include industrial, agricultural, and public lands. The planned land use designation within the Richland area adjacent to the Site is identified as industrial (City of Richland 1988). Industrial use is compatible with the adjacent Site use. The city develop ed a set of alternatives for its updated comprehensive plan ; these alternatives were released for public review in March 1996 . The comprehensive plan itself is scheduled for adoption in early 1997 (Milspa 199 6). With respect to the Hanford Site, the Richland plan focuses only on the southern portions of the Site, which are within the city's 20-year growth boundaries. The various alternatives being considered for the updated plan would be expected to call for maintaining and expanding industrial and research and development activities in the areas of the city adjacent to the site (Milspa 1996).

West Richland is located to the south of the Hanford Site and is one of the closest developing residential communities. The West Richland land use near the Hanford Site is designated low-density residential (West Richland 1994). This use is consistent with the nearby existing uses (FEALE Reserve and Undeveloped Area) at the Hanford Site. The West Richland Comprehensive Plan update was released in June 1996 and is expected to be adopted in September 1996 . There is little in the update that would impact Hanford Site land-use issues (Corcoran 199 6).

Pasco is located southeast of the Hanford Site and includes the Tri-Cities Airport, which is the area's primary airport. Pasco has been planning major commercial, industrial, office, and residential improvements along the Interstate 182 corridor to attract future Hanford Site-related and other businesses (McDonald 1994). Pasco adopted its updated comprehensive plan in August 1995. However, very little in the update is related to Hanford Site land-use issues (McDonald 1995).

Kennewick is located south of the Hanford Site and is separated from the Site by the Yakima River and the city of Richland. Like Pasco, Kennewick has been planning additional industrial and office areas to attract new businesses. Kennewick adopted its updated comprehensive plan in April 1995. Very little in the updated plan is related to Hanford Site land uses (White 1995).

Another local agency that could be impacted by remediation and reuse of the Hanford Site is the Port of Mattawa. The Port of Mattawa is located in Grant County, northwest of the Hanford Site. The Port of Mattawa is a local government agency obligated to enhance the economic development within District No. 3 of Grant County (Connelly 1994). The Port of Mattawa supports the Wahluke 2000 Plan, which proposes, with U.S. Bureau of Reclamation assistance, to expand irrigated farming acreage and increase recreation uses while protecting wildlife habitat (Wahluke 1994). The Wahluke 2000 Plan represents a different approach than the one outlined by the Park Service (in the Hanford Reach EIS), which has proposed a Recreational River status under the Wild and Scenic Rivers Act for the Hanford Reach of the Columbia River.

I.7.2.5 Natural Resources Trustees Council

The Hanford Site Natural Resources Trustees Council is composed of representatives from the States of Washington and Oregon, Federal agencies (DOE and Interior), and three affected Tribal Nations (Yakama Indian Nation, CTUIR, and Nez Perce Tribe). The primary purpose of the Council is to facilitate the coordination and cooperation of the trustees in their efforts to restore and minimize impacts to natural resources injured as a result of or during cleanup of releases associated with DOEs activities at the Hanford Site. The Councils primary role with respect to the TWRS project will be to consult with DOE during development of the Mitigation Action Plan for impacts identified in the TWRS EIS.

I.7.3 RECREATIONAL RESOURCES AND THE NATIONAL ENVIRONMENTAL RESEARCH PARK

For the purposes of wildlife management and outdoor recreation, some portions of the Hanford Site are administered by agencies other than DOE. The entire Hanford Site was designated by DOE as a National Environmental Research Park in 1976 (NPS 1994). National Environmental Research Parks are aimed at original research into the ecology and natural sciences of an area. Nearly one-half of the Site is designated for use as wildlife management (Figure I.7.3.1).

These wildlife management areas buffer developed areas of the Site. They are the FEALE Reserve, Saddle Mountain NWR, Wahluke Wildlife Recreation Area, Rattlesnake Slope Wildlife Area, and McNary NWR. Ecological data have been collected on these sites for more than 40 years.

I.7.3.1 Fitzner Eberhardt Arid Lands Ecology Reserve

The FEALE Reserve is located in the southwest corner of the Hanford Site. Currently, all research activities on the FEALE Reserve are funded by DOE. Consisting of 310 km^2 (120 mi^2) including Rattlesnake Mountain, the FEALE Reserve is managed for DOE by the Pacific Northwest National Laboratory.

BLM is also involved in the FEALE Reserve. In July 1993, BLM proposed exchanging sections of the Hanford Site with DOE for the FEALE Reserve. BLM propose d to continue management of the FEALE Reserve for its wildlife benefits and to designate it a National Conservation Area. The Yakama Indian Nation also proposed assuming control of the Reserve, with an emphasis on wildlife management, as well as use for Native American cultural purposes. In addition, Benton County has proposed taking over the FEALE Reserve (Stang 1996a).

In July 1996, DOE notified the Yakama Indian Nation, other Federal agencies, and Benton County of its decision to keep control of the Reserve (O'Leary 1996). The Reserve will continue to function as a buffer zone for ongoing waste management in the 200 Areas. DOE also announced its intention to negotiate an agreement with the U.S. Fish and Wildlife Service to manage the Reserve while protecting the ecologically sensitive area and allowing greater public access (Stang 1996c).

Figure I.7.3.1 Recreation and Wildlife Areas and the Hanford Reach

I.7.3.2 McNary National Wildlife Refuge

The McNary NWR, located near the confluence of the Columbia and Snake Rivers, includes three divisions: Burbank Slough, Strawberry Island, and Hanford Islands (Figure I.7.3.1). Only the Hanford Islands Division is within the boundaries of the Hanford Site. The Hanford Islands Division contains six islands in the Columbia River and is located upstream from the city of Richland.

The Hanford Islands extend a distance of 14.5 river km (9 river mi) and contain 140 ha (350 ac). The islands are closed to the public during waterfowl nesting season to protect breeding waterfowl, particularly aleutain canada geese, a Federal and State endangered species.

The McNary NWR was established in 1955 by a cooperative agreement with the U.S. Army Corp of Engineers, which transferred administrative control of nearly 1,200 ha (3,000 ac) of land to the USFWS. Additional acquisitions have enlarged the refuge to the present area of 1,300 ha (3,300 ac). Recreation activities include fishing, picnicking, swimming, and water skiing.

I.7.3.3 Saddle Mountain National Wildlife Refuge

The USFWS manages Saddle Mountain NWR, located on the Hanford Site north and west of the Columbia River (Figure I.7.3.1). Currently, the area is closed to all public use and is dedicated to wildlife management. The USFWS monitors the area for waterfowl populations, kestrel nesting activity, and raptor activity.

The Saddle Mountain NWR was established in 1971 by DOE through a joint agreement with the USFWS. The NWR is located north of the Columbia River from the center of the Hanford Reach to the western boundary of the Hanford Site. The area is currently controlled by DOE but will be transferred to the USFWS upon cleanup of its contaminated sites.

I.7.3.4 Wahluke Wildlife Recreation Area

The Washington State Department of Fish and Wildlife manages the Wahluke Wildlife Recreation Area, located on the Hanford Site north and east of the Columbia River (Figure I.7.2.1). The Wahluke Wildlife Recreation Area is open for public recreation. More than 41,000 people used the area and nearby facilities between July 1988 and July 1989, the most recent year for which statistics are available. More than half of this use took place at the Vernita boat launch, an unimproved launch area immediately upstream of the Vernita Bridge. The Washington State Department of Fish and Wildlife leases approximately 34 ha (85 ac) of Wahluke Wildlife Recreation Area to various private operations for agricultural sharecropping.

I.7.3.5 The Hanford Reach (Proposed Wild and Scenic River Designation)

As the last free-flowing segment of the Columbia River, the Hanford Reach has been proposed for Wild and Scenic River status. The Hanford Reach extends from river mile 396 downstream to river mile 345 and includes those portions of the Columbia River within the boundaries of the Hanford Site. The Hanford Reach boundaries include a 0.4-km (0.25-mi) strip of land on each side of the river, the Saddle Mountain NWR, and the Wahluke Wildlife Recreation Area (Figure I.7.3.1). Designation as a Recreational River (the least restrictive designation under the Wild and Scenic Rivers Act) would provide permanent protection for salmon and cultural resources, enhance wildlife habitats and populations, and improve access and natural resource interpretation for visitors. The USFWS would be designated as the administrating agency. All lands within the proposed boundary would be transferred to USFWS (NPS 1994).

Benton, Franklin, and Grant count y commissioners oppose designating the Hanford Reach as a Wild and Scenic River and have offered an alternative proposal that would provide for local government rather than federal control of the Reach (Stang 1996a). Other local residents support the Federal Wild and Scenic River designation. No final decisions have yet been made.

1.7.3.5.1 Recreational Use

The Hanford Reach and adjacent wildlife refuge and recreation areas provide a variety of recreational activities year-round for local residents and visitors. The most popular activities are sport fishing, boating, and waterfowl hunting, which are considered substantial in terms of impact on the local economy. Other popular activities include waterskiing, upland hunting, and nature observation. The heaviest use period occurs during September and October, coincident with runs of fall chinook salmon. Hunting occurs in areas downstream of the Hanford Townsite from mid-October until late January each year. Nature observation is most popular during autumn and winter months when the greatest number and diversity of migratory and wintering waterfowl species are present.

Because of restricted use of the Hanford Site and Saddle Mountain NWR lands, virtually all land-based recreation occurs on the Wahluke Wildlife Recreation Area. Water-based recreation is supplemented with boating that originates from areas downstream of the Hanford Site. However, the distance from Richland boat launches to key fishing and sightseeing locations suggests that boating accounts for less than 20 percent of water-based use within the Hanford Reach. Total current recreational use of the Hanford Reach comprises approximately 10,000 land-based visits by hunters, trappers, and nonconsumptive users and approximately 40,000 visits by water-based users (predominantly anglers) per year (NPS 1994).

I.7.3.5.2 Sport Fishing

The Hanford Reach is enjoyed by sport fisherman throughout the Pacific Northwest. Steelhead, sturgeon, and smallmouth bass are the primary sport fish. Of these species, the fall chinook salmon and steelhead are regionally important recreational resources, and the Hanford Reach is one of the leading sport salmon fishing areas along the Columbia River.

I.7.3.5.3 Waterfowl Hunting

Waterfowl hunting is the primary hunting activity in the Hanford Reach. The abundance of waterfowl and availability of favorable hunting conditions make the Hanford Reach a regionally important resource.

I.7.3.5.4 Boating

Although much of the boating along the Hanford Reach is related to fishing or waterfowl hunting, scenery, wildlife, and opportunities for solitude make the area increasingly attractive for recreational boaters. An analysis of flat-water boating rivers throughout Washington State, conducted as part of the Pacific Northwest River Study, identified the Hanford Reach as a regionally important boating resource (NPS 1994).

I.7.3.5.5 Nature Observation

The Hanford Reach and surrounding lands provide some of the best opportunities for viewing wildlife in eastern Washington State. Bald eagles, loons, pelicans, terns, gulls, great blue herons, mule and white-tailed deer, coyotes, and beavers are some of the larger species that may be observed. Bird-watching opportunities are optimal during winter months when the Hanford Reach is visited by many species of wintering birds and migratory waterfowl (NPS 1994).

I.7.3.5.6 Swimming

Swimming occurs locally from approximately Memorial Day to Labor Day. Visitors either swim from boats or from the shoreline. There are, however, no developed beaches or designated public swimming areas within the boundaries of the Hanford Site.

I.7.3.5.7 Waterskiing

Waterskiing typically occurs south of the Hanford Site in the vicinity of the city of Richland from mid-May to mid-September. Occasionally, water-skiers travel into the Hanford Reach north of Wooded Island in the vicinity of the Hanford Dunes.

I.7.3.5.8 Other Activities

A relatively small number of people pursue recreational activities within or adjacent to the Hanford Reach. Some activities such as off-road vehicle use, collecting artifacts, and camping are illegal and can be detrimental to the landscape and resources. Off-road vehicle use in the vicinity of White Bluffs has caused considerable damage in some areas and collecting artifacts is an ongoing problem throughout the Site. Camping is permitted at the Ringold boat launch, but occurs illegally at times along other parts of the Hanford Reach shoreline and on some of the islands. The sand dunes are sometimes used by shoreline swimmers, although this is a no-access area (NPS 1994).

I.7.3.6 Rattlesnake Slope Wildlife Refuge

The Rattlesnake Slope Wildlife Refuge is located adjoining the FEALE Reserve's southern boundary. The Refuge, which is managed by Washington State, is outside the boundary of the Hanford Site.

I.8.0 VISUAL RESOURCES

Visual resources reflect the importance of a landscape for its natural or man-made aesthetic qualities and for its sensitivity to change. Landscape character and potential viewing areas are primary factors to be considered in describing the Hanford Site's visual resource values.

I.8.1 LANDSCAPE CHARACTER

The landscape setting within the Hanford Site region is characterized by broad basins and plateaus interspersed with ridges, providing wide, open vistas throughout much of the area. Only about 6 percent of the Site has been disturbed. The remainder of the Site is undeveloped, including natural areas and abandoned agricultural lands that remain undisturbed because of restricted public access.

The major landscape feature of the Hanford Site is the Columbia River, which flows through the northern part of the Hanford Site and turns south, forming the eastern Hanford Site boundary. North of the Columbia River, the Saddle Mountains border the Hanford Site. The Yakima River is located along a small portion of the southern boundary and joins the Columbia River in the city of Richland on the southeastern border of the Hanford Site. Yakima Ridge and Umtanum Ridge form the western boundary of the Hanford Site. Two small east-west ridges, Gable Butte and Gable Mountain, rise above the Central Plateau of the Hanford Site. Adjoining lands to the north, east, and west are principally used for range and agriculture.

The primary focus of the proposed TWRS activities under all EIS alternatives would be in the interior of the Site on the large, flat, open, and semi-arid Central Plateau. Two potential borrow sites, Vernita Quarry and McGee Ranch, are located northwest of the Central Plateau. A third potential borrow site, Pit 30, is located on the Central Plateau between the 200 East and 200 West Areas. The dominant visual features of the Central Plateau vicinity include Gable Butte and Gable Mountain to the north, Rattlesnake Mountain to the south, and Umtanum Ridge to the west.

I.8.2 POTENTIAL VIEWING AREAS

For purposes of study and mapping, viewing areas are generally divided into four distance zones; the foreground, within 0.8 km (0.5 m); the middleground, from 0.8 km to 8 km (0.5 to 5 mi) ; the background, from greater than 8 to 24 km (5 to 15 mi) ; and seldom seen areas that are either beyond 24 km (15 mi) or are unseen because of topography (Figure I.8.2.1).

Hanford Site facilities can be seen from elevated locations such as Gable Mountain, Gable Butte, and Rattlesnake Mountain, which are used by Native Americans for religious purposes, and from offsite locations including State Routes 240 and 24 and the Columbia River. Because of terrain features, distances involved, the size of the Hanford Site, and the size of the individual facilities, not all facilities are visible from the highways or the Columbia River.

Facilities in the 200 East Area are in the interior of the site and cannot be seen from the Columbia River or State Route 24. Large facilities in the 200 East Area may be visible from State Route 240 only as distant background more then 8 km (5 mi) away. Facilities in the 200 West Area can be seen by travelers on an approximately 11 km (7 mi) segment of State Route 240 south of the Yakima Barricade. For these viewers the facilities are in the visual middleground (0.8 to 8 km [0.5 to 5 mi] away). Facilities in the 200 West Area cannot be seen from the Columbia River. Facilities throughout the 200 Areas are visible from elevated locations such as Gable Mountain, Gable Butte, and Rattlesnake Mountain.

Figure I.8.2.1 Viewing Areas of 200 East and 200 West Areas

The potential Vernita Quarry borrow site is situated on a basalt outcrop immediately adjacent to State Route 24. The basalt resource is exposed in basalt cliffs adjacent to the highway and past quarry operations are highly visible. Quarry activities at the site would be visible from the Vernita Bridge, the Hanford Reach, and the Wahluke Slope north of the Columbia River. The quarry would also be readily observed from State Route 24 leading south from the Vernita Bridge. The potential McGee Ranch borrow site would be located west and north of State Route 24 in slightly rolling terrain. The borrow site would be readily visible from State Route 24 south and east of the borrow site. The potential Pit 30 borrow site is located between the 200 East and 200 West Areas and is only visible offsite from elevated locations.

I.9.0 NOISE

Noise as defined by Washington State constitutes the intensity, duration, and character of sounds from any and all sources (WAC 173-60). Sound is produced when a noise source induces vibrations into the surrounding air causing fluctuations in atmospheric pressure. Decibels (dB) are units of sound pressure used to measure changes in atmospheric pressure caused by the vibrations. Primary factors that influence the measurement of noise in ambient air are frequency and duration. The normal human auditory system cannot clearly discern sounds below 100 Hz (hertz or Hz is a measure of frequency or pitch) or substantially above 10,000 Hz. Sound occurring outside this range is not generally perceived as noise. Researchers have developed an A-weighted noise scale (dBA) to describe sounds emanating in those frequencies that are most readily detected by normal human hearing. Table I.9.0.1 lists some common levels of sound and their corresponding dBA levels. Sound duration is another important factor in determining cumulative noise impacts. Noise levels often are reported as the equivalent sound level (L_{eq}) and expressed as a weighted average (dBA) over a specified period of time; the L_{eq}integrates noise levels over time and expresses them as steady-state continuous sound levels.

I.9.1 REGULATORY CONTEXT AND PREVIOUS NOISE STUDIES

The Hanford Site (including its unoccupied areas) is classified as a Class C Environmental Designation for Noise Abatement by Washington State on the basis of industrial activities (Table I.9.1.1). Because they are neither Class A (residential) nor Class B (commercial), unoccupied Hanford Site areas are also classified as Class C areas.

Because of the remoteness of the Hanford Site, only a limited number of studies have been conducted that document environmental noise levels. Two sources of measured environmental noise at Hanford Site are 1) measurements made in 1981 during Hanford Site characterization of the Skagit/Hanford Nuclear Power Plant Site; and 2) noise measurements at five Hanford Site locations performed in 1987 as part of the Basalt Waste Isolation Project.

I.9.1.1 Skagit/Hanford Studies

During preconstruction measurements of environmental noise associated with the Skagit/Hanford Nuclear Power Plant Site, 15 sites were monitored and noise levels ranged from 30 to 65 dBA (L_{eq}). The values for isolated areas ranged from 30 to 38.8 dBA (L_{eq}). Measurements taken at the proposed reactor sites ranged from 50.6 to 64 dBA. Measurements taken along the Columbia River near the proposed intake structures were 47.7 and 52.1 dBA, as compared to noise levels of 45.9 dBA measured at a more remote location about 5 km (3 mi) upstream from the intake structures. By comparison, community noise levels in North Richland (at Horn Rapids Road and the Bypass Highway) were 60.5 dBA (NRC 1982).

Table I.9.0.1 Common Sounds and Corresponding Noise Levels

Table I.9.1.1 Applicable State Noise Limitations for the Hanford Site [1]

I.9.1.2 Basalt Waste Isolation Project Studies

As part of the investigation for proposed Basalt Waste Isolation Project at the Hanford Site, background noise levels were determined at five locations. Noise levels can be expressed as L_{eq} for 24 hours (L_{eq}-24). Based on information provided in Cushing (Cushing 1994), wind was identified as the primary contributor to background noise levels with winds exceeding 19 km/hr (12 mi/hr), substantially impacting noise levels. As a result, it was concluded that background noise levels in undeveloped areas at the Hanford Site can best be described as having a mean L_{eq}-24 of 24 to 36 dBA. Periods of high wind, which normally occur in the spring, would elevate background noise levels.

I.9.1.3 Noise Levels of Hanford Field Activities

To protect Hanford Site workers and to comply with Occupational Safety and Health Administration standards for noise in the workplace, the Hanford Environmental Health Foundation monitors noise levels resulting from routine operations performed at the Hanford Site (DOE 1991 and Cushing 1992). Occupational sources of noise propagated in the field are summarized in Table I.9.1.2. These levels are reported because operations such as well sampling are conducted in the field away from established industrial areas and have the potential for contributing to environmental noise and disturbing sensitive wildlife.

Table I.9.1.2 Monitored Levels of Noise Propagated from Outdoor Activities at the Hanford Site[1]

I.9.2 HANFORD SITE NOISE CONDITIONS

Existing noise conditions produced by current, routine operations at the Hanford Site do not violate any Federal or State standards. Measurements show that even near the current operating structures along the Columbia River noise levels are less than experienced in part of the community of Richland (less than 52.1 dBA versus 60.5 dBA). Noise levels measured near intake structures at the Columbia River are well within the 60 dBA tolerance levels for daytime residential use. Five km (3 mi) upstream of the intake structures noise levels fell well within levels suited for daytime and nighttime residential use.

Moreover, the remoteness of the main areas of Hanford Site industrial activities from population centers means that there are no offsite populations within auditory range of Site industrial activities. However, Affected Tribal Nations use Site locations such as Gable Mountain for religious purposes.

I.10.0 TRANSPORTATION

The Tri-Cities area is served by air, rail, water, and road transportation networks. The majority of air passenger and freight services goes through the Tri-Cities Airport, located in Pasco (Cushing 1992). In addition, two smaller airports serving general aviation aircraft are located in Richland and Kennewick. No airport facilities are located on the Hanford Site.

Water-borne transportation is accommodated by docking facilities at the Ports of Benton, Kennewick, and Pasco (Cushing 1992). The commercial waterways of the Snake and Columbia Rivers provide access to the deep-water ports of Portland, Oregon and Vancouver, Washington. The Port of Benton is the port-of-call for all vessel traffic to the Hanford Site.

The Hanford Site rail system consists of about 210 km (130 mi) of railroad track. Approximately 140 km (87 mi) of the system are considered in service to active Site facilities. Approximately 64 km (40 mi) of track are in standby condition. The standby trackage serves Site areas that have no current rail shipping needs. Although the standby track is not currently maintained, it could be restored if needed. The Hanford Site rail system extends from the Richland Junction (at Columbia Center in Kennewick) south of the Columbia River where it joins the Union Pacific commercial railroad track, to an abandoned commercial right-of-way near the Vernita Bridge in the northern portion of the Site (Figure I.10.0.1). There are currently about 1,400 railcar movements annually Sitewide, transporting a wide variety of materials including fuels (e.g., coal and oil), hazardous process chemicals, and radioactive materials and equipment. Radioactive waste has been transported by rail on the Site without incident for many years (DOE 1995i).

Regional road transportation is provided by a number of major highways including State Routes 240 and 24 and U.S. Interstate Highway 82. State Routes 240 and 24 are both two-lane roads that traverse the Hanford Site. State Routes 240 is a north-south highway that skirts the easternmost side of the FEALE Reserve. State Routes 24 is an east-west highway located in the northern portion of the Hanford Site. These roads are maintained by Washington State (Cushing 1992).

A DOE-maintained road network within the Hanford Site provides access to the various work centers (Figure I.10.0.1). The majority of these roads are paved and are two lanes wide. The primary access roads on the Hanford Site are Routes 2, 4, 10, and 11A. The 200 East Area is primarily accessed by Route 4 South from the east and from Route 4 North off Route 11A from the north and from Route 11A for vehicles entering the Site at the Yakima Barricade. A new access road was opened in late 1994 to provide access directly to the 200 Areas from State Route 240. The 200 West Area is primarily accessed from Route 6 off Route 11A from the north. Public access to the 200 Areas and interior locations of the Hanford Site has been restricted by guarded gates at the Wye Barricade (at the intersection of Routes 10 and 4) and the Yakima Barricade (at the intersection of State Route 240 and Route 11A). None of the previously listed roadways have experienced any substantial congestion except Route 4 (WHC 1994c).

Figure I.10.0.1 Hanford Site Transportation Network

Route 4 carries most of the traffic from the City of Richland to the 200 Areas. Traffic volumes during shift changes at the Hanford Site create severe traffic congestion. July 1994 traffic counts along Route 4 South just to the west of the Wye Barricade showed an average daily traffic (ADT) of approximately 9,200 vehicles, with morning peak hour volumes of nearly 2,400. By mid-1995 with reductions in Site employment, and the opening of the State Route 240 Access Road (Beloit Avenue), morning peak hour traffic had declined to slightly above 1,700 (Rogers 1995). Farther to the southeast, near the 1100 Area where Route 4 becomes Stevens Road, the 1992 ADT was approximately 24,800 with a peak hour volume of over 2,900. Level of Service (LOS) is a qualitative measure of a roadway's ability to accommodate vehicular traffic, ranging from free flow conditions (LOS A) to extreme congestion (LOS F). LOS D is considered the upper end of acceptable LOS. A 1994 report indicated that Route 4 was operating at LOS E and a 1993 report indicated that Stevens Road was operating at LOS F (WHC 1994c and BFRC 1993). The factors indicated previously, namely, Site employment reductions, and the heavy use of the new State Route 240 Access Road (peak hour volume of nearly 900 vehicles by mid-1995), have reduced the traffic congestion in these areas (Rogers 1995).

Traffic counts along Route 11A, which is just to the east of the Yakima Barricade off of State Route 240, show an ADT of approximately 1,260. Traffic counts along Route 10, just to the north of its terminus at State Route 240, show an ADT of approximately 2,440 (WHC 1994c).

I.11.0 RADIOLOGICAL ENVIRONMENT: OVERVIEW AND POTENTIAL RADIATION DOSES FROM 1994 HANFORD SITE OPERATIONS

This section provides a brief introduction to the subject of radioactivity and to some of the common terms used in radiological health evaluation. It also summarizes 1994 data on radiation doses from operations at the Hanford Site and estimates the potential future fatal cancers attributable to these radiation exposures.

I.11.1 INTRODUCTION TO RADIOACTIVITY

Radioactivity is a broad term that refers to changes in the nuclei of atoms that release radiation. Radiation is an energetic ray or energetic particle. For ionizing radiation, the ray or particle has enough energy to cause changes in the chemical structure of the materials it strikes. These chemical structure changes are the mechanisms by which radiation can cause biological damage to humans.

Radiation comes from many sources, some natural and some man-made. People have always been exposed to natural or background radiation. Natural sources of radiation include the sun, and radioactive materials present in the earth's crust, in building materials and in the air, food, and water. Natural radioactivity can even be found within the human body. Some sources of ionizing radiation have been created by people for various uses or as by products of these activities. These sources include nuclear power generation, medical diagnosis and treatment, and nuclear materials related to nuclear weapons.

Radioactive waste is a result of the use and production of radioactive materials. At the Hanford Site, DOE manages radioactive waste that was generated primarily by the production of plutonium for nuclear weapons. These waste is classified as low-activity, high-level, or transuranic. When radioactive waste is combined with hazardous chemical wastes, it is referred to as mixed waste. High-level waste is the most dangerous type of radioactive waste and requires extensive shielding by materials such as lead and concrete and special handling. Transuranic waste is material contaminated with radioactive elements heavier than U. While long lasting, transuranic waste does not require the same degree of isolation as high-level waste. Low-activity waste is generally the least dangerous type of radioactive waste and requires fewer measures to isolate it from people and the environment. Depending on the particular radioactive material involved, radioactive waste can be harmful and thus require isolation for up to hundreds or even thousands of years. Plutonium-contaminated waste will be radioactive for thousands of years. Radioactive Cs, on the other hand, will be virtually gone in 250 years.

I.11.2 COMMON TERMS IN RADIOLOGICAL HEALTH EVALUATIONS

Radiation dose to individuals is usually expressed in rem or millirem (mrem), which is one-thousandth of a rem. The rem is a measure of the biological effects of ionizing radiation on people. It is estimated that the average individual in the United States receives an annual dose of about 300 millirem from all natural sources. The collective radiation dose to a population is termed the person-rem, which is calculated by adding up the radioactive dose to each member of the population.

Any dose of radiation can damage body cells. However, at low levels, such as are received from a medical x-ray, the damage to cells is so slight that the cells can usually repair themselves or can be replaced by the regeneration of healthy cells. Radiation exposures are often classified as acute (a dose received over a short time) or chronic (a dose received over a long time). Chronic doses are usually less harmful than acute doses because the body has time to repair or replace damaged cells; however, even low doses can have harmful effects.

Impacts from radiation exposure often is expressed using the concept of risk. The most substantial radiation-related risk is the potential for developing cancers that may cause death in later years. This delayed effect is measured in latent (future) cancer fatalities. The risk of a latent cancer fatality is estimated by converting radiation doses into possible numbers of cancer fatalities. For an entire exposed population group, the latent cancer fatality numerical value is the chance that someone in that group would develop an additional cancer fatality in the future because of the radiation exposure, (i.e., a cancer fatality that otherwise would not occur).

Radiological risk evaluations often refer to the maximally-exposed individual. This would be the member of the pubic or a worker who receives the highest possible dose in a given situation. As a practical matter, the maximally-exposed individual likely would be a person working with radiological or hazardous materials.

I.11.3 POTENTIAL RADIATION DOSES AND LATENT CANCER FATALITIES FROM 1995 HANFORD SITE OPERATIONS

Each year potential radiation doses to the public are calculated for exposure to Hanford Site effluents. The 1995 information presented here was taken from the Hanford Site Environmental Report for calendar year 1995 (PNL 1996). Doses are calculated from reported effluent releases, from environmental surveillance results, and from information about operations at specific Hanford Site facilities.

The 1995 potential dose from Hanford Site operations to the hypothetical maximally-exposed individual member of the public was 0.02 mrem , compared to 0.05 mrem reported for 1994 (PNL 1996) . The current DOE radiation dose limit for an individual member of the public is 100 mrem per year, and as stated previously, the national average dose from natural sources is 300 mrem per year. Thus, the maximally-exposed individual potentially received a small fraction of 1 percent of both the DOE dose limit and the natural background average dose.

The total population of the surrounding area (380,000 persons) received a potential dose from 1995 Hanford Site operations of 0.3 person-rem. The 1994 average dose to an individual member of the public was 0.0009 mrem. This is 0.001 percent of the 100 mrem/year standard and 0.0003 percent of the 300 mrem per year received from typical natural sources. Clean Air Act requirements specify a maximum radiation dose through the air of 10 mrem per year. The 1995 air emissions from the Hanford Site were 0.006 mrem, which is less than 0.1 percent of the 10 mrem standard.

Based on a dose-to-risk conversion of 0.0005 latent cancer fatalities per rem (each rem equates to 0.0005 latent cancer fatalities), there would be 0.0001 latent cancer fatalities in the general public attributable to exposure to effluents from 1995 Hanford Site operations.

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APPENDIX J

CONSULTATION LETTERS

The National Environmental Policy Act (NEPA) and the Washington State Environmental Policy Act (SEPA) implementing regulations require that Federal agencies consult with Federal, State, and local agencies and Tribes (as appropriate) regarding proposed actions addressed in Environmental Impact Statements (EIS). The U.S. Department of Energy (DOE) and the Washington State Department of Ecology (Ecology) have performed this consultation through informal meetings, discussions, and correspondence. DOE and Ecology have provided formal requests for information and consultations to Federal, State, and local agencies and Tribes that may have regulatory jurisdiction or special interest in the issues and alternatives to be addressed in the TWRS EIS. This appendix contains copies of the consultation letters sent by DOE and Ecology to agencies and Tribes and the responses by those agencies and Tribes.

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APPENDIX K

UNCERTAINTIES ANALYSIS

ACRONYMS AND ABBREVIATIONS

ARF	airborne release fraction
ARR	airborne release rate
AWF	Aging Waste Facility
Chi/Q	atmospheric dispersion coefficient
DOE	U.S. Department of Energy
DR	damage ratio
DST	double-shell tank
ED	exposure duration
EDTA	ethylenediaminetetraacetic acid
EF	exposure frequency
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERDF	Environmental Restoration Disposal Facility
FI	fraction ingested
HI	hazard index
HLW	high-level waste
HMS	Hanford Meteorological Station
HSRAM	Hanford Site Risk Assessment Methodology
HTI	Hanford Tanks Initiative
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ILCR	incremental lifetime cancer risk
IR	ingestion or inhalation rate

K_d	distribution coefficient
LAW	low-activity waste
LCF	latent cancer fatality
LPF	leak path factor
MEI	maximally-exposed individual
MRA	modular risk assessment
NOAEL	no observed adverse effect level
NCRP	National Council on Radiation Protection
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
PDF	probability density function
PF	pollutant-specific factor
PFP	Plutonium Finishing Plant
PUREX	Plutonium-Uranium Extraction
RCRA	Resource Conservation and Recovery Act
RF	respirable fraction
SGLS	spectral gamma logging system
SIF	summary intake factor
SST	single-shell tank
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TWRS	Tank Waste Remediation System
ULD	unit liter dose
URF	unit risk factor
VF	volatilization factor
VOC	volatile organic compound

NAMES AND SYMBOLS FOR UNITS OF MEASURE, RADIOACTIVITY, AND ELECTRICITY/ENERGY

Length		**Area**		**Volume**	
cm	centimeter	ac	acre	cm^3	cubic centimeter
ft	foot	ft^2	square foot	ft^3	cubic foot
in	inch	ha	hectare	gal	gallon
km	kilometer	km^2	square kilometer	L	liter
m	meter	mi^2	square mile	m^3	cubic meter
mi	mile			ppb	parts per billion
				ppm	parts per million
				yd^3	cubic yard

Mass

g	gram
kg	kilogram
lb	pound
mg	milligram
mt	metric ton

Radioactivity

Ci	curie
MCi	megacurie (1.0E+06 Ci)
mCi	millicurie (1.0E-03 Ci)
µCi	microcurie (1.0E-06 Ci)
nCi	nanocurie (1.0E-09 Ci)
pCi	picocurie (1.0E-12 Ci)

Electricity/Energy

A	ampere
J	joule
kV	kilovolt
kW	kilowatt
MeV	million electron volts
MW	megawatt
V	volt
W	watt

Temperature

C degrees Centigrade

F degrees Fahrenheit

APPENDIX K
UNCERTAINTIES ANALYSIS
K.1.0 INTRODUCTION

Uncertainty in risk analysis is a consequence of two factors: lack of data and natural variability (Figure K.1.0.1). The lack of data is reflected in the limited knowledge either about the value of constants, or about the statistical parameters (e.g., distribution shape, mean, variance) of things that are inherently variable (e.g., inhalation rates or body weights). Uncertainty due to the lack of data can be reduced in principle by more accurate measurements. Uncertainty due to natural variability cannot be reduced by improved measurement, but can be better estimated by acquiring data to characterize statistical distributions of measured variables and by using computer programs to simulate the effect of such variability in the components of equations on calculated values (e.g., risk estimates). These combined efforts can reduce systematic uncertainty in the Environmental Impact Statement (EIS) analyses and provide a more thorough understanding of the effects of the remaining uncertainty on the conclusions in the document.

The evaluation of systematic uncertainties is the most difficult aspect of determining the overall uncertainty of an analysis. A systematic error is the difference between the mean of an analysis and the true value. When true value is unknown, the systematic error only can be estimated. The estimated limit of the systematic error is called the systematic uncertainty of the analysis (Catland 1990). The systematic uncertainty is made up of multiple sources of systematic errors, each of which must be evaluated and quantified. When sources of systematic error are found and reduced, the systematic uncertainty is reduced.

Uncertainty in the conclusions of this EIS is a consequence of uncertainty in two major areas: the descriptions of the alternatives, with their associated assumptions about tank waste inventories, composition, and remediation technologies; and the consequences analyses, which include assumptions about waste source and release terms, future land uses, environmental transport parameters, and relationships between exposure and risk (Figure K.1.0.1). This appendix discusses the major sources of uncertainty in each of these areas. In addition, a less conservative (nominal) human health risk analysis is presented to illustrate the

implications of relating some of the conservative assumptions made for the bounding case risk analyses in the EIS.

Section K.2 describes the uncertainties and assumptions in the alternative descriptions, including engineering, schedule, staffing, resources, and costs. Section K.3 discusses uncertainties and assumptions in the source terms and in the release terms for acute (accident) and chronic (routine) scenarios. Section K.4 describes the uncertainties and assumptions in estimating contaminant transport through soil, ground and surface water, and air. Sections K.5 and K.6 present the uncertainties and assumptions in the human health risk exposure assessment and risk characterization, respectively. Section 5.7 describes the results of a less conservative (nominal) human health risk analysis, focusing on the Ex Situ Intermediate Separations alternative as an example. Section K.7 describes the uncertainties in the ecological risk assessment (ERA) and their effects on the conclusions in the EIS.

Figure K.1.0.1 Sources and Types of Uncertainty in the TWRS EIS

K.2.0 UNCERTAINTIES IN ALTERNATIVES

A full range of representative alternatives was developed for detailed analysis in the EIS. Upper, lower, and intermediate bounding alternatives were developed in terms of cost, risk, and technologies for the two primary decisions that affect environmental impacts: the amount of waste to be retrieved from the tanks and the degree of separations of retrieved waste into high-level waste (HLW) and low-activity waste (LAW).

The alternatives developed were chosen to be representative of many possible variations of the alternatives. The design information for all alternatives is at an early planning stage, and the details of the alternative ultimately selected and implemented are likely to change as the design process matures.

Each alternative developed for analysis in the EIS consists of a set of technologies, or building blocks, that have been engineered to work together, forming complete systems for accomplishing the remediation of the tank waste.

Engineering data were developed for each alternative in support of the environmental impact analysis. These data included the following major components:

- Conceptual design of the type and size of facilities required for waste treatment;
- Schedules and staffing requirements (radiological and nonradiological workers) for the construction and operation of waste treatment facilities;
- Resource requirements for the construction and operation of the waste treatment facilities;
- Air emissions for routine tank farm operations, waste treatment operations, and post remediation;
- Contamination releases to the soil during waste retrieval and during the post- remediation phase; and
- Land use requirements, both temporary and permanent, for the construction and operation of waste treatment facilities.

These major components were developed based on certain assumptions, general engineering information, and previous development work. The uncertainties associated with engineering assumptions for each alternative are presented in Section K.2.2, and the uncertainties related to general information such as schedule projection, staffing and resource prediction, and cost estimation are discussed in Sections K.2.3 through K.2.6, respectively.

K.2.1 OVERVIEW

There are many uncertainties associated with the alternatives for remediating the tank waste. These uncertainties involve the types of waste contained in the tanks, the effectiveness of the proposed retrieval techniques, and the processes used to separate and treat the waste. These uncertainties exist because some of the technologies that would be implemented are first-of-a-kind and have not previously been applied to the Hanford Site tank waste, or they have not been applied at the scale required for the tank waste.

K.2.2 UNCERTAINTIES FOR MAJOR ASSUMPTIONS

To develop the engineering data required to perform impact analyses for each of the alternatives discussed in the EIS, assumptions were made regarding the technologies that create a remediation alternative. These assumptions were based on either the best information available, applications of a similar technology, or engineering judgement. When an assumption is made, there is some level of uncertainty associated with it that can be expressed as a range that reasonably could be expected for the assumed value. This section identifies the major assumptions used for the alternatives, describes uncertainties associated with the assumptions, and presents the results of a waste loading sensitivity analysis for the Ex Situ Intermediate Separations alternative.

K.2.2.1 Long-Term Management and In Situ Alternatives

Tank Leakage

It was assumed that there would be no leaks from the single-shell tanks (SSTs) or double-shell tanks (DSTs) during the administrative control period for the No Action, Long-Term Management, or In Situ Fill and Cap alternatives because the ongoing process of removing the pumpable liquids from SSTs was assumed to be completed, and leaks would be recovered from the space between the inner and outer liners of the DSTs. The SSTs and DSTs were assumed to maintain their structural integrity throughout the administrative control period under the No Action and Long-Term Management alternatives. For the Long-Term Management alternative, replacement of the DSTs was assumed to be necessary to prevent leaks.

The uncertainty with this assumption is that a leak could develop or a structure failure could occur, resulting in a release of contaminants during the administrative control period. It is likely that corrective actions would be taken in the event of a leak or signs of structural deterioration. Corrective actions could include waste retrieval and retanking activities to minimize environmental releases. If these activities were to occur, increases in the release of contaminants of the air and vadose zone would be expected.

In Situ Vitrification

The In Situ Vitrification alternative is more conceptual in design and development than the ex situ vitrification alternatives and thus has a higher degree of uncertainty associated with the data developed for impact assessments. The in situ vitrification system was assumed to be capable of vitrifying each of the tanks to the required depth, resulting in a consistent waste form. It also was assumed that the variation in waste composition and inventory from tank to tank would not impact the ability to produce an acceptable waste form.

There is considerable uncertainty about the ability of the in situ vitrification system to vitrify the large volume required for the SSTs and DSTs. This uncertainty could be reduced through the use of smaller vitrification systems and the development of depth-enhancing techniques. This likely would result in increased staffing requirements and longer operating durations.

The air emissions estimates developed for the In Situ Vitrification alternative assumed that the entire inventory of iodine-129 (I-129) would be released to the atmosphere during the operating period. Off-gas treatment systems could be expected to remove part of the I-129 and reduce these emissions.

The long-term waste form performance for the vitrified waste was based on the assumption of a homogeneous waste form with properties similar to the glass produced by the Ex Situ No Separations alternative. Inspecting the final waste form to verify that all of the wastes were vitrified would be difficult and could result in undetected waste form variations. Variability in the waste form or fracturing of the waste form during cooling would be expected to result in increased contaminant release rates to the vadose zone.

The safety of drying some of the waste types is uncertain. Further evaluation of this issue could result in some tanks not being suitable for in situ vitrification.

In Situ Fill and Cap

Under the In Situ Fill and Cap alternative, the DST liquids would be concentrated using the 242-A Evaporator to remove as much water from the waste as possible, but the waste still would contain substantial volumes of liquid. It was estimated that concentration by the 242-A Evaporator would reduce the current liquid volumes contained in the tanks by approximately one-third (WHC 1995f). The concentrated liquid waste contained in the DSTs was assumed to be acceptable for gravel filling.

Additional development of this alternative could result in a requirement for additional liquid removal and drying of the waste in the tanks. If this were to occur, development of an in situ drying technology would be required and its use would result in increased volatile radionuclide and chemical emissions from the tanks, in addition to increases in staffing levels and operating schedule.

K.2.2.2 Ex Situ Alternatives

Waste Retrieval Efficiency

The waste retrieval function described for the ex situ alternatives was assumed to remove 99 percent of the waste volume contained in each tank during waste retrieval. Under this assumption, 1 percent of the tank volume would be left in-tank as residual. It was further assumed that the 1 percent waste volume represented 1 percent of the waste inventory on a chemical and radiological basis including soluble waste constituents. This assumption is conservative and will bound the impact from the tank residuals.

The amount and type of waste that would remain in the tanks after retrieval is uncertain. The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1994) set a goal for the SSTs that no more than 1 percent of the tank inventory would remain as residual following waste retrieval activities to the extent technically practicable. The engineering data for the waste retrieval and transfer function common to all ex situ alternatives was developed using 99 percent retrieval from SSTs and DSTs as an assumption.

It would be expected that the residual contaminants left in the tanks either would be insoluble and hardened on the tank walls and bottom or be of a size that could not be broken up and removed from the tanks without extraordinary measures. In either case, the residual waste would have low solubility because the retrieval technologies proposed would use substantial quantities of liquid to dissolve or suspend the waste during retrieval.

The effect of retrieving less than 99 percent of the waste volumes from the tanks during retrieval would be an increase in the amount of waste left in the tanks and corresponding increases in long-term contaminant releases. The in situ and combination alternatives would leave substantially more waste onsite for disposal and provide an upper bound on the impacts associated with the amount and type of waste that is disposed of onsite. Retrieval of more than 99 percent of the waste would reduce the impacts associated with residual waste.

A nominal case tank residual inventory was developed to evaluate the impacts that would result from a more nominal residual inventory. The nominal residual inventory was developed by accounting for the solubility of the mobile constituents of concern. The mobile constituents of concern were evaluated because of their contribution to post-remediation risk. The isotopes carbon-14 (C-14), technetium-99 (Tc-99), and I-129 were reduced for the nominal case to 10 percent of the bounding residual inventory. For additional information, refer to Volume Two, Appendix B.

The U.S. Department of Energy (DOE) currently is developing the Hanford Tanks Initiative (HTI) program that will provide information on the characteristics of the tank residuals and the capability of retrieval systems to handle difficult-to-remove SST wastes. This program will reduce the uncertainties associated with residual waste, demonstrate the capability to quantify residual waste volume, and demonstrate technologies for sampling and characterizing the residual waste.

Assumptions Affecting HLW Volume

The major factors that affect the volume of HLW produced by any of the ex situ alternatives include waste inventory, waste loading (glass specifications), blending, and the efficiency of the separations processes. The waste inventory that has been used for all alternatives is provided in Volume Two, Appendix A along with a discussion on data accuracy and uncertainty.

Waste loading is the mass fraction of the nonvolatile waste oxides in the vitrified waste. The waste oxide loading would be controlled by the amount of glass formers added during the vitrification process. The higher the waste loading, the more waste contained in the vitrified glass and the lower the waste volume.

Blending is the mixing of the waste from different tanks during retrieval to obtain an average waste feed stream for treatment. Because there are 177 tanks that contain waste, and the waste composition varies from tank to tank, it would be difficult to achieve a completely uniform blending of the waste during retrieval.

Separating the waste into HLW and LAW streams for treatment would involve various processes to physically or chemically separate specific constituents in the waste stream. The separations efficiency would be a measure of how well these processes work and would define the amount of each constituent that would be processed in the HLW and LAW treatment facilities.

The assumptions used for each of the previously described factors and their combined effect on the overall volume of HLW and LAW are discussed in the following sections.

Waste Loading

The waste loading for all ex situ treatment alternatives, except for the Ex Situ No Separations alternative was assumed to be 20 weight percent waste oxides for the HLW and 15 weight percent sodium oxide (Na_2O) for the LAW. The waste loading for the Ex Situ No Separations alternative was assumed to be 20 weight percent Na_2O.

Waste loading would affect the final volume produced from an initial amount of waste. This volume, along with the operating schedule and the assumed operating efficiency, would determine the size of the processing facilities and operating resources required to support the process. A decrease in waste loading would translate into a larger volume of vitrified waste, larger treatment facilities or longer operating schedules, increased resource requirements, and higher disposal cost.

Waste loading typically ranges from 20 to 40 weight percent waste oxides, with 30 to 35 weight percent loading used as a target value. The Savannah River Site Defense Waste Processing Facility glass has a design basis waste loading of 25 weight percent and a maximum waste loading of 38 percent (DOE 1995s).

The waste loading for all alternatives that would produce LAW was assumed to be 15 weight percent Na_2O. The volume of LAW produced would affect the size and number of LAW disposal vaults built onsite.

Waste Blending

Each of the ex situ alternatives that would use vitrification as an immobilization technology assumed a waste blending factor of 1.2 for the HLW to account for variations in the composition of the waste during retrieval operations. Variations in the waste feed composition would not affect the calcined product that would be produced by the Ex Situ No Separations (Calcination) alternative. Uniform blending would require simultaneous retrieval from specific groups of tanks to deliver a uniform average feed stream to the treatment facilities. The blending factor would be multiplied by the volume of HLW produced under uniform blending conditions to calculate the waste volume expected due to variation in the waste feed. One of the major sources of uncertainty associated with developing a retrieval sequence that would achieve a uniform blending is the lack of accepted tank-by-tank inventory data. Preliminary studies on retrieval sequences, waste blending, and the effects on HLW volume show that the volume of vitrified HLW with no blending would be approximately twice that with total blending (WHC 1995p).

The volume of HLW produced combined with the size of the HLW canisters would directly impact the number of HLW packages requiring disposal at the potential geologic repository, which in turn would affect the cost associated with disposal. The number of HLW packages produced would also determine the number of offsite shipments required to transport the immobilized HLW to the potential geologic repository. The waste loading would also determine the concentration of radiological contaminants in the waste form. There is a relationship between the waste loading, number of shipments (cumulative probability of an accident), and the concentration of contaminants in the waste form (consequence of an accident). As the waste loading increased, the cumulative probability of an accident would decrease because there would be fewer trips required to transport the waste. The consequences of an accident would increase because there would be a higher concentration of contaminants in the waste form (see Volume Four, Section E.16.0 for a discussion of accident uncertainties).

Releases to the Soil During Retrieval

Retrieval operations under each ex situ alternative was assumed to result in the release of 15,000 L (4,000 gal) of waste at full solution strength from each SST to the surrounding soil. No leakage from the DSTs was assumed to occur during retrieval operations. This assumption was based on the 67 known or suspected SSTs that have leaked in the past (Hanlon 1995) and no known or suspected leaks from DSTs to date. Most of the SSTs were built in the 1940's and now are about 50 years old. The leakage volume estimate assumed that the average leakage from an SST would be one order of magnitude lower than the maximum release estimated for tank 241-C-106 during sluicing operations. The maximum leak estimated from tank 241-C-106 during sluicing operations was 150,000 L (40,000 gal). This estimate also assumed that the leak occurred early in the sluicing operation, leak detection devices and controls failed, sluicing operations proceeded without these leak detection devices, the leak(s) occurred at the bottom of the tank, and the remaining sludge did not plug any leaks (DOE 1995d).

The most probable occurrence of a leak during sluicing would involve the sluicers opening a plugged leak in the tank wall. The waste leakage during sluicing would be any free-standing liquid above the level of the leak point and the sluicing stream as it impacted the tank wall.

A nominal retrieval release inventory was developed by assuming that the waste would be diluted by one-third by adding water during waste retrieval. Possible dilution ratios that would be used during waste retrieval range from 3:1 to 10:1, depending on waste type. The nominal retrieval release inventory accounts for partial dilution of the tank contents while retrieval operations are underway. The volume of waste released during retrieval was assumed to be the same for the nominal and bounding cases. There currently is insufficient basis to support a lower nominal case leakage estimate. DOE currently is developing criteria and technologies to identify leaks and limit releases during retrieval.

Sensitivity Analysis

A sensitivity analysis was performed for the Ex Situ Intermediate Separations alternative to show the range in the data expected if the volume of HLW and LAW produced were to increase or decrease based on waste loading assumptions. The following sensitivity parameters were assumed for analysis:

- HLW loading at 15 weight percent and 40 weight percent waste oxides;
- LAW loading at 10 weight percent and 25 weight percent Na_2O; and
- No variation in the separations efficiencies or the blending factor.

The results of the sensitivity analysis performed for the Ex Situ Intermediate Separations alternative are shown in Table K.2.2.1. Lower waste loading would require increased resources, land commitments, transportation, and cost. The facility sizes were held constant for the sensitivity analysis, resulting in constant capital cost and staffing levels and variable operating schedules. If the treatment schedule were held constant, the required treatment facilities, capital cost, and staffing levels would change.

K.2.3 SCHEDULE

Schedules for construction, operation, and closure were developed for each of the alternatives within the constraints of the Tri-Party Agreement (Ecology et al. 1994). Schedule constraints would affect the size of the treatment facilities required to process the waste. Following design and construction of a waste treatment facility, the major schedule uncertainty would be the operating duration.

Each of the ex situ alternatives was developed using 60 percent overall operating efficiency, except for Phase 2 of Phased Implementation, which used 70 percent overall operating efficiency. Operating at higher efficiencies would reduce the operating duration, and conversely, lower operating efficiencies would increase the operating duration. For the alternatives that would have multiple treatment components, such as retrieval, pretreatment, HLW treatment, and LAW treatment, the overall operating schedule would depend on the operating efficiency for each component.

Uncertainties in the operating schedule would be expected to result in longer operating durations. Previous analysis has shown that the operating duration for the ex situ alternatives would be sensitive to the rate at which waste can be retrieved from the SSTs. A low SST sludge retrieval rate could increase the operating duration by 50 percent (WHC

1995r).

K.2.4 STAFFING

Staffing estimates were developed for each alternative in support of risk, accident, and socioeconomic impact analysis. These staffing estimates were developed using conservative assumptions for both construction and operating staffing levels. The major uncertainty in overall staffing requirements would be associated with the operating schedule uncertainty. Staffing requirements would be affected by operating efficiencies because operating efficiency changes would increase or decrease the operating duration and the overall staffing requirements.

Table K.2.2.1 Ex Situ Intermediate Separations Sensitivity Summary

K.2.5 RESOURCES

The resources required to construct and operate waste treatment facilities were estimated for each alternative using a consistent methodology and common assumptions. The ex situ alternatives and the In Situ Vitrification alternative would have the largest uncertainty for estimated resources. The major uncertainties associated with the estimated resource requirements for the ex situ alternatives include the size and type of facilities required and the volume of LAW and HLW produced. Variations in operating resource requirements as a function of waste loading for the Ex Situ Intermediate Separations alternative are shown in Table K.2.2.1.

K.2.6 COST

Cost uncertainty for all of the tank waste alternatives has been evaluated and is discussed in Volume 2, Section B.8. Upper and lower ranges were estimated for the major cost components of each alternative. Upper and lower cost ranges were based on the technology, level of development, and degree of complexity. These cost ranges along with confidence levels were used as input to Decision Science Corporation's Range Estimating Program for personal computers to model the treatment cost range and total cost range including repository fee.

The cost uncertainty results in a cost range within which the alternative cost would be expected to fall. The cost range is the highest for the In Situ Vitrification alternative at 3.3 percent below to 66.5 percent above the target cost based on the uncertainties associated with implementing this technology for remediation of the tank waste. Cost ranges for the ex situ alternatives are generally 3 to 8 percent below to 20 percent above the target cost. The Ex Situ Extensive Separations alternative results in an upper cost range of 35 percent above the target cost based on the application of many first-of-a-kind technologies and the complexity of the separations process.

K.3.0 UNCERTAINTY IN SOURCE TERMS

Source terms refer to the waste inventory, which is the total quantity of the hazardous material within the tanks, and to the release term, which is the amount released to environmental media such as soil, groundwater, surface water, and soil under normal or accident conditions. The following sections describe the uncertainty associated with inventory and release terms.

K.3.1 WASTE INVENTORY DATA

There is considerable uncertainty associated with the inventory data used in the EIS. Tank waste data are available on a tank-by-tank basis, but the accuracy of these data are suspect because they primarily are based on historical records of transfers between tanks rather than statistically based sampling and analyses programs. However, while the inventory of any specific tank may be suspect, the overall inventory for all of the tanks combined is considered more accurate. The lack of accepted tank-by-tank inventory data would affect the Ex Situ/In Situ Combination 1 and 2 alternatives more than other alternatives because the tank selection criteria and the impact assessment of waste disposed of in situ are dependent on tank-by-tank data.

The waste inventory data used in developing the alternatives and their associated impacts are derived from model predictions and sample analysis. While the waste is currently undergoing additional characterization and the inventory may be revised as a result of ongoing analyses, the inventory used in the EIS is not expected to result in discrimination for or against any of the alternatives analyzed. DOE has identified the key radionuclides for tracking in development of a "best basis inventory" for Hanford tank waste. These include the radionuclides that dominate the risk estimates in this EIS: C-14, I-129, neptunium-237 (Np-237), protactinium-231 (Pa-231), selenium-79 (Se-79), Tc-99, and uranium (U) isotopes. This information will be incorporated into National Environmental Policy Act (NEPA) analysis of closure alternatives. For additional information on tank inventory data accuracy and its effect on the EIS see Volume Two, Section A.3.

K.3.2 RELEASE TERMS

Releases to the environment for both routine releases during remediation and acute releases during an accident are a function of the waste inventory. The inventory used for developing routine emissions is based on a nominal waste stream based on overall tank waste inventory. Acute releases were developed using both a nominal and bounding inventory.

K.3.2.1 Chronic Releases (Routine)

Chronic releases were developed for each alternative using average inventory data. The No Action and Long-Term Management tank waste alternatives include routine emissions from the tank farms. The In Situ Fill and Cap alternative includes routine tank farm emissions as well as tank emissions during tank filling. The In Situ Vitrification alternative includes routine tank farm emissions plus releases from the evaporator and vitrification processes. The ex situ alternatives include routine tank farm emissions, releases during waste retrieval, and releases during waste treatment.

The routine releases developed for the ex situ alternatives are based on material balance calculations and waste processing rates. Conservative assumptions were made for the release of certain volatile radionuclides. It was assumed for each alternative that included vitrification that the entire inventory of I-129 and C-14 would be released to the atmosphere during waste treatment. Some capture of the I-129 in the off-gas treatment system could be expected and would result in lower I-129 releases.

Uncertainties associated with the chronic releases are based on the available inventory data. Increased inventory of any constituent would be expected to result in some increase in chronic releases. This especially would be true for the volatile contaminants.

K.3.2.2 Acute Releases (Accident)

The respirable fraction of inventory released from an accident, from which the receptor dose is calculated, is referred to as the source term. The source term depends on a variety of release fractions associated with the mechanics of the accident scenario. Uncertainties associated with each of these release fractions are based on available data, and in some cases may depend on engineering judgement. For specific scenarios, nominal and bounding values were estimated for the applicable release fractions as follows:

- Damage ratio (DR) - The fraction of the material at risk impacted by the event;
- Leak path factor (LPF) - The fraction that escapes the confinement boundary by design, natural causes, or degradation caused by the event;
- Airborne release fraction (ARF) - The fraction of released material made airborne by the event;
- Airborne release rate (ARR) - The fractional airborne release rate of material from the accident. ARR is converted to ARF by integrating over the time available for release; and
- Respirable fraction (RF) - The fraction of airborne droplets or particulate matter with individual particle aerodynamic equivalent diameter less than or equal to 10 microns (μm).

For the spray release scenario, the nominal and bounding applicable release fractions are presented in Table K.3.2.1. When a particular release fraction is well understood, the uncertainty diminishes, decreasing the difference between the bounding and nominal values. For purposes of this analysis, the DR is the only parameter with uncertainty. Setting LPF, ARF, and RF equal to 1.0 maintains conservatism even for the nominal case. The difference between the bounding and nominal cases is a factor of 7.

Table K.3.2.1 Bounding and Nominal Release Fractions Used in the Spray Release Scenario

K.4.0 UNCERTAINTY IN ENVIRONMENT TRANSPORT

The estimated movement of contaminants through environmental media such as soil, groundwater, surface water, and air is associated with uncertainties. These uncertainties are described in Sections K.4.1 through K.4.4, respectively.

K.4.1 TRANSPORT IN SOIL

This discussion on potential transport mechanisms is provided because 1) there may be other vadose zone transport mechanisms in effect in addition to what has been calculated; 2) there is insufficient information to determine whether any or all of the other transport mechanisms are active. The available data indicate that the primary vadose zone transport mechanism is advective flow through the interstitial spaces of the porous media. Recent observations of relatively immobile contaminants at depths of up to 38 m (125 ft) below the tanks are not fully explained with interstitial flow and may indicate there are other transport mechanisms in effect. These observations are currently the focus of a DOE program. The initial phase of the program is to determine if the observations are representative of extensive vadose zone contamination beneath the tanks or if they are related to other phenomena such as borehole contamination. The results from this program including subsequent phases are not expected to be available for several months.

All of the remedial alternatives would result in some waste tank release to the vadose zone. The impacts of these releases were predicted using the approach described in Volume One, Section 5.2.1. This approach required the mathematical definition of the waste tank releases (source terms), calculation of when and at what rate the release would move through the underlying vadose zone (vadose zone modeling), and calculation of when and at what rate the release would move through the underlying groundwater system and ultimately discharge to the Columbia River (groundwater models). A one-dimensional model capable of simulating partially saturated conditions was selected to calculate the transport of a waste tank release through the vadose zone to the underlying groundwater. The impact assessment of all the alternatives relied on a common conceptual model of the vadose zone, which included the geometry of each site (i.e., number and thickness of strata) where the releases would occur, the assumption that each strata was an isotropic and homogenous porous medium, that contaminant transport would be driven primarily by advection downward through the interstitial spaces of the various strata, that contaminant transport would be an isolinear process (i.e., independent of contaminant concentration), and that contaminant mobility as expressed by the distribution coefficient (K_d) parameter would remain constant in the various strata of the vadose zone. The conceptual model is the basis of the one-dimensional model used in the assessment approach.

Provided in the following subsections are discussions of 1) data on migration of past tank leaks in the vadose zone; 2) calculated transport of a past tank leak from tank 241-T-106 using the impact assessment assumptions; 3) potential vadose zone transport mechanisms other than what is inherently assumed in the impact assessment analyses; and 4) how the other potential vadose zone transport mechanisms could impact each alternative.

K.4.1.1 Past Tank Leaks

Sixty-seven of the 149 SSTs are assumed to leak (Hanlon 1995). The assumed leaking tanks are fairly evenly distributed in the 200 Areas with 32 assumed leaking tanks in the 200 East Area and 35 in the 200 West Area. There are no reported leaks from the 28 DSTs. The range of leak volume is from approximately 1,300 liters (L) (350 gallons [gal]) from tank 241-C-204 in the 200 East Area to 435,000 L (115,000 gal) from tank 241-T-106 in the 200 West Area. Total leak volume from all 67 assumed leakers ranges from 2.27E+06 to 3.41E+06 L (600,000 to 900,000 gal). Interim stabilization has been completed on all but five assumed leaking tanks. The tank identification number, date the tank was declared a leaker, estimated leak volume, estimated activity of leak, and date the tank was stabilized are provided in Table K.4.1.1.

Cesium (Cs) and plutonium (Pu) were transported to the tank farms in various waste streams. Both contaminants are relatively immobile in subsurface materials at Hanford and because of this immobility, are expected to be found near waste disposal sites (especially under ambient infiltration conditions) dispersed throughout the unsaturated materials and in groundwater in some instances, depending on the volume of liquid associated with the waste discharge or leak.

Information has been emerging that associates migration of several radioisotopes, including Cs and Pu, to depths of 30 m (100 ft) or greater with leaks from the waste tanks. There are two major sources of this data as follows:

- Downhole logging of existing drywells; and
- Discrete samples from a borehole completed in multiple stages to avoid cross contamination.

Downhole Logging of Drywells

DOE has a system of monitoring wells called drywells installed in the vicinity of each waste tank. The depth of these drywells varies, but they do not extend to the water table of the unconfined aquifer.

Table K.4.1.1 Summary of Tank Leak Estimates from Single-Shell Tanks

These drywells were installed as a way of detecting gamma emissions and serve as an indirect means of detecting or confirming waste tank leaks and mobilization of existing contamination in the vadose zone by other waste sources such a potable water line leaks. Until recently, the gamma emissions that were detected were indicative of undifferentiated radioisotopes. Such emissions have been detected in many of the drywells at depths ranging from ground surface to depths up to 38 m (125 ft) belowground surface. Recent improvements in the borehole logging detection equipment has resulted in the identification of specific gamma-emitting radioisotopes. Thus, previously characterized gross gamma contamination is now specifically linked to several radioisotopes. The most prevalent radioisotope detected was Cs-137, while other gamma-emitting radionuclides such as cobalt-60 (Co-60), europium-152 (Eu-152), and Eu-154 were generally found near the surface and are believed to be the result of spills (Brodeur 1996).

The improved geophysical logging uses a spectral gamma logging system (SGLS) with high-purity intrinsic germanium detection device to provide assays of gamma-emitting radionuclides near the drywells. The approach, data, and interpretation are provided in Brodeur 1995. Application of the improved logging equipment has resulted in additional information on conditions at the SX Tank Farm. Application of the improved logging equipment has resulted in additional information on conditions at the SX Tank Farm.

Ten of the 15 tanks in the SX Tank Farm are assumed or verified as leaking. Tanks in the SX Tank Farm have been verified as leaking as early as 1962 (Table K.4.1.1). The last reported tank to leak in the SX Tank Farm was in 1988. Cumulative estimated leak volume from this tank farm ranges from 5.02E+05 L (132,000 gal) to 6.31E+05 L (167,000 gal) as shown in Table K.4.1.1. Ninety-five drywells ranging in depth from 23 m (75 ft) to 38 m (125 ft) from ground surface were logged with the SGLS in the SX Tank Farm. The most abundant and highest-concentration radionuclide detected was Cs-137, which was detected in virtually every borehole (Brodeur 1995). The Cs-137 was detected at the following depths in several drywells: 23 m (75 ft) in drywells 41-09-03 and 41-08-07; 32 m (105 ft) in 41-09-04; 27 m (90 ft) in 41-11-10, and 38 m (125 ft) in 41-12-02.

Other human-made gamma-emitting radionuclides detected include Co-60, Eu-152, and Eu-154, which generally were found near the surface and are believed to be the result of spills (Brodeur 1995). The Co-60 was found in drywell 41-14-06 only and was detected a depth of 17 m (55 ft) to 23 m (76 ft) below ground surface.

The transport of Cs-137 in the vadose zone sediments at the Hanford Site is believed to be greatly retarded due to adsorption. The Cs would not be expected to be found at depths of up to 38 m (125 ft) if it were being transported via interstitial flow through the sediment pore spaces and under ambient conditions that include neutral pH and infiltration rates ranging from 2 millimeters (mm)/year to 10 centimeters (cm)/year. The detection of Cs-137 at this depth raises several questions concerning the active transport mechanisms. These questions and others are being addressed by DOE in a Resource Conservation and Recovery Act Groundwater Assessment of the S and SX Tank Farms (Caggiano et al. 1996) has recently been implemented. The improved borehole logging detection equipment provides information on the specific contaminant in the vicinity of the drywells, but there is still uncertainty on the lateral distribution of these contaminants within the vadose zone.

Borehole Samples from Multiple-Stage Well

The borehole sample data were collected as a part of a 1993 investigation (Freeman-Pollard 1994) of contaminant migration from a leak from tank 241-T-106. The data from the 1993 investigation consist of 43 split-spoon samples from borehole 299-W10-196. These samples were taken for physical, chemical, and radiochemical analysis in addition to spectral gamma geophysical logging of the borehole on eight occasions.

The 1993 subsurface investigation of the tank 241-T-106 leak was the third to be performed since the initial leak was discovered in 1973. The first investigation was conducted from June to August 1973 in which 16 single-cased boreholes were drilled, the deepest to approximately 27 m (88 ft) below ground surface, as summarized in the 1993 investigation report (Freeman-Pollard 1994). Samples were collected at 1.5-m (5-ft) intervals as the boring was advanced. From this investigation, it was concluded that contamination penetrated to a maximum depth of about 27 m (88 ft).

Freeman-Pollard indicates that in 1979, a second investigation was completed based on numerous additional single-cased boreholes drilled between 1973 and 1978 (Freeman-Pollard 1994). One of the conclusions of this investigation was that there was no evidence that contaminants from the tank 241-T-106 leak had reached the underlying aquifer nor would it during the "hazardous lifetime" of the radionuclides. The 1993 investigation resulted in data on the vertical distribution of several radionuclides and chemicals. Most notably are the following results.

- The Pu concentrations increased greatly at the depth of the bottom of the tank 11 m (36 ft) below ground surface, reached a peak at 13 m (43 ft), decreased to less than 1 pCi/g at 28 m (92 ft), spiked at 29 m (95 ft), and then decreased to background at greater depths.
- The Cs-137 was the only radionuclide that had a high concentration within the fill around the tanks to a depth of 4 m (13 ft) below ground surface, above the presumed depth of the tank leak. The concentration decreased to a depth of 9 m (30 ft), then began to increase to a maximum at 14 m (46 ft), followed by a decrease to below background until two spikes were detected at 24 m (78 ft) and 30 m (100 ft).
- The spikes at approximately 30 m (100 ft) are observed for both mobile (e.g., Tc-99) and attenuated (e.g., Cs-137) contaminants and may be concentrated by a caliche layer that occurs at this depth. This may be due to a hydraulic conductivity contrast, adsorptive capacity from the increased clay content, and/or substitution of radionuclides in the calcium carbonate.

From the 1993 investigation, it was concluded that the mobile contaminants in the leading edge of the plume such as Tc-99 from the 1973 leak had penetrated to the contact with the Ringold unit E at 37 m (121 ft) below ground surface (Freeman-Pollard 1994). This represents a distance of 26 m (85 ft) over approximately 10 years. There was a spatial distribution of radioisotopes in the vadose zone that reflected the differences in their mobility (Freeman-Pollard 1994). At shallow depths, 10 to 24 m (33 to 82 ft), the less mobile or relatively immobile contaminants Cs-137, americium-241 (Am-241), Pu-239/240, Eu-154, strontium-90 (Sr-90), and C-14 were found. Carbon is assumed to be a mobile (K_d = 0) contaminant in Hanford Site sediments, thus its inclusion here is unclear.

K.4.1.2 Transport of Mobile Contaminants Associated with Past Tank Leaks

As stated previously, the groundwater impact assessments all are based on the assumption that contaminant transport occurs as the downward advection of water through the interstitial pores spaces of the various strata. It is difficult to provide an intuitive comparison between contaminant distribution from past leaks and contaminant distributions in the vadose zone calculated for the Tank Waste Remediation System (TWRS) alternatives because the volumes and rate of volume released from the TWRS alternatives generally would be much lower than the past tank leaks, specifically, the leak from tank 241-T-106. The leak from tank 241-T-106 was estimated to be approximately 435,000 L (115,000 gal) over a 52-day period. Contaminants from this leak have been identified in the vadose zone at depths of up to 30 m (100 ft) below ground surface. Scoping calculations consisting of two vadose zone simulations of the tank 241-T-106 leak were performed using the major assumptions used for the impact assessment described in Volume Four, Appendix F to provide a comparison of predicted contaminant distribution from the leak to observed contaminant distribution. A brief description of the simulations and the results follow.

The vadose zone model (VAM2D) was used to perform two axi-symmetric simulations of the vadose zone transport of contaminants due to a leak from tank 241-T-106. The upper boundary of the model was taken as the bottom elevation of the tank. The model domain extended a distance of 52 m (170 ft) from the upper boundary to the water table. Strata thicknesses and properties were the same as assumed for source area 1WSS for the impacts assessments in Volume Four, Appendix F. The axis of symmetry is the centerline of the tank, which has a radius of 11 m (37 ft). For both simulations, the flow field is first equilibrated to steady-state conditions, assuming no flow from the lateral boundaries, a zero pressure head along the bottom boundary, which represents water table conditions, and a spatially varying infiltration rate along the surface domain. The infiltration rate is zero for the domain from the centerline to 11 m (37 ft) radially to represent the umbrella effect of the tank. From 11 m (37 ft) to 111 m (365 ft), infiltration is 10 centimeters (cm)/year (4 inches [in.]/year) to represent enhanced infiltration due to the gravel surface around the tank. From 111 m (365 ft) to 161 m (530 ft), the infiltration rate drops linearly from 10 cm/year to 2 millimeters (mm)/year (4 to 0.08 in./year). Beyond 161 m (530 ft) to 1,500 m (4,900 ft), the infiltration rate is 2 mm/year (0.08 in./year), representing ambient conditions on relatively undisturbed land.

Both simulations assumed the leak to be 435,000 L (115,000 gal) over a 52-day period infiltrating into an area of 10 square meters (m^2) (1,000 square feet [ft^2]) at the centerline of the tank. The first simulation assumed the leak as described is superimposed on the infiltration scenario (no infiltration under the tank). The second simulation assumed that there would be an infiltration rate of 10 cm/year (4 in./year) over the domain from the tank centerline to 11 m (37 ft). Beyond this distance, the infiltration rate was assumed to be the same as described above. Table K.4.1.2 summarizes the calculated travel distance and elapsed time for the contaminant front from the tank 241-T-106 leak. This is for a mobile contaminant (K_d = 0) and the major assumptions used for the impact assessment.

Table K.4.1.2 Calculated Transport Distance and Time Based on Leak from Tank 241-T-106 for a Mobile Contaminant

For a mobile contaminant such as Tc-99, the above described simulations agree with the observation from the 1993 investigation of the tank 241-T-106 leak (Freeman-Pollard 1994) where it was found that Tc-99 had penetrated 37 m (120 ft) below ground surface. The 1993 investigation also indicates that normally much less mobile contaminants such as Cs-137 and Pu were found at nominal depths of 30 m (100 ft). This could be the result of an additional transport mechanism(s). Several potential transport mechanisms could be contributing to the transport of Cs-137 and Pu to depths of 30 m (100 ft). DOE currently has undertaken an investigation that should provide the information needed to ascertain if other transport mechanisms such as preferential flow paths and/or chemically enhanced mobility of selection contaminants are active.

K.4.1.3 Potential Vadose Zone Transport Mechanisms

In this section, potential vadose zone transport mechanisms are identified. The potential vadose zone transport mechanisms are divided into two categories: transport mechanisms controlled by physical processes and transport mechanisms controlled by chemical processes. Included in this discussion are occurrences or phenomena that could enhance or speed up contaminant transport in the vadose zone.

K.4.1.3.1 Potential Physical Vadose Zone Transport Mechanisms

Physical transport mechanisms can be either natural or human-made. Potential physical transport mechanisms and transport enhancing phenomena that could occur at the tanks include the following:

- Advective flow through clastic dikes and clastic sills that might naturally occur beneath and/or near the tank farms;
- Advective flow through breaks in the caliche layer (where it occurs) in the Plio-Pleistocene unit of the Ringold Formation that might naturally occur beneath and/or near the tank farms;
- Advective flow through the unsealed annular space surrounding the well casing and borehole in drywells/monitoring wells installed near the tanks;
- Infiltration of surface runoff into the unsealed annular space between the well casing and borehole in

drywells/monitoring wells installed near the tanks;
- Inflow of surface water into the top of drywells and discharge out through casing perforations at depth;
- Movement of contamination during drilling from near-surface sources to various depths; and
- Near surface leaks from water lines and/or waste transfer lines.

Each of the identified potential physical transport mechanisms listed are illustrated conceptually in Figure K.4.1.1. In the following paragraphs, a description of the potential transport mechanisms is provided.

Advective Flow Through Clastic Dike and Clastic Sills

Clastic dikes are ubiquitous in the 200 Areas and have been observed in the excavation of most major facilities in the 200 Areas including processing facilities and waste tanks (Fecht-Weekes 1996). Clastic dikes are lenses or tabular bodies, relatively narrow 18 to 38 cm (7 to 15 in.) (Fecht-Weekes 1996), with textural characteristics similar to the host sediment (clay and sand). Clastic dikes occur as near-vertical sediment-filled structures that cut across bedding planes of the Hanford Formation. Clastic sills are tabular structures of sedimentary material similar to clastic dikes but they are oriented parallel to the plane of the surrounding sediments. Figure K.4.1.1 depicts a conceptual cross section under a tank farm and includes an illustration of what a clastic dike and clastic sill would look like if exposed in an excavation. Clastic dikes have been observed to form polygons, based on observations of the Environmental Restoration Disposal Facility (ERDF) excavation (Fecht-Weekes 1996). A multisided polygonal cell encloses the host sediments. Individual polygonal cells are bounded by other polygons to form what is described as a honeycomb pattern when viewed from the air. The genesis of clastic dikes in not certain. There are several theories but the evidence is limited and does not conclusively support one theory. As with the genesis of clastic dikes, little is known about their hydraulic characteristics. Some inferences can be made from material descriptions where they have been intercepted by excavations and the lack of discernable impacts to groundwater levels and quality. The margins or vertical boundaries of clastic dikes are characterized by "clay skins," which are thin silt laminae that vary in thickness from 0.2 to 1 cm (0.08 to 0.4 in.). Internally, the dikes are composed of unconsolidated sedimentary infilling that trend parallel to the dike walls (Fecht-Weekes 1996).

The degree to which clastic dikes would function as a conduit (preferential flow path) or barrier to flow would depend on the relative amounts of clay and sand in the clastic dike and the continuity of any sand stringers within the clastic dike. Based on the observations of clastic dikes in excavations on the 200 Areas Plateau, the inferred hydraulic nature of the dikes is that of potentially a minor barrier to flow perpendicular to the dike. The clay content and lack of sand stringer continuity suggests that clastic dikes do not function as preferential flow paths for vertical flow.

Figure K.4.1.1 Conceptualization of Potential Vadose Zone Contaminant Transport Mechanisms

Advective Flow Through Breaks in the Caliche Layer in the Plio-Pleistocene Unit

Caliche layers generally would be a barrier to downward migration of contaminants in the vadose zone, if the layers were sufficiently extensive. Caliche layers were not included as discrete layers in the vadose zone modeling of contaminant transport. The Plio-Pleistocene unit, in which caliche layers generally are found, was included in the modeling assessment for source areas in the 200 West Area, and appropriate average material properties for this unit were used (Wood et al. 1995).

The presence of an intact, laterally extensive caliche layer would promote lateral spreading of infiltrating water. As a potential transport mechanism, breaks in the caliche layer in the Plio-Pleistocene unit would result in less lateral spreading and could allow for faster downward contaminant transport. Such breaks would function as a preferential flow path but only over a relatively short vertical distance. The overall thickness of the Plio-Pleistocene unit assumed for the vadose zone modeling assessments varies from approximately 4 to 5 m (13 to 16 ft) and caliche layers within this unit would be expected to be from 0 to 1 m (0 to 3 ft) thick.

Advective Flow Through the Unsealed Annular Space in Drywells and Groundwater Monitoring Wells

The unsealed annular space between the well casing and borehole in drywells affords the potential for 1) mobilizing contaminants that may be located at various elevations adjacent to the drywell; and 2) providing an additional driving force that could mobilize contaminants from past tank leaks that have migrated deeper into the vadose zone but not necessarily adjacent to the drywell.

Drywells and older groundwater monitoring wells have been installed near each tank for environmental monitoring and were drilled through near-surface contamination from tank leaks and other releases. These wells all were constructed with a cable tool drilling method in which the steel casing was driven down as the bottom of the borehole was cleaned out with the cable tool. A hardened steel drive shoe with a outside diameter larger than the casing diameter (diameters vary with driller and with available materials) by approximately 1.3 cm (0.5 in.) was attached to the bottom of the casing as it was being driven down the borehole. The annular space between the casing and borehole was not sealed. In the drywells, perforations in the steel casings have been made at various depths. The groundwater monitoring wells were installed with a screened section at the bottom that typically extended from 3 m (10 ft) above the water table to 6 m (20 ft) below the water table.

Drywells are similar to the older groundwater monitoring wells (Figure K.4.1.1) in the tank farm area except that drywells do not extend to the groundwater table and perforations in the drywells were made at various elevations. Drywells were installed to allow for periodic monitoring of radioactivity in the vadose zone from ground surface to the depth of the drywell. Increases in radioactivity detected in the drywells were indicative of a tank leak or migration of existing radioactivity in the vadose zone in response to another water source such as a leaking water line.

The hydraulic characteristics of the annular space between the well casing and borehole are not known. Because this space was not sealed and a drive shoe with larger outside diameter than the casing was used, there exists the potential of voids and loosely packed sand and gravel that potentially could function as a preferential flow path for contaminant migration vertically through the vadose zone.

Infiltration of Surface Runoff into the Unsealed Annular Space of Drywells/Monitoring Wells

Infiltration of surface water or other near-surface liquid sources such as from a leaking water line (Figure K.4.1.1) has the potential for 1) mobilizing the near-surface contamination through which some of the wells were drilled; and 2) providing an additional driving force that could mobilize contaminants from past tank leaks that have migrated deeper into the vadose zone.

Large volumes of water, such as flooding of drywells, have been known to occur at some of the tank farms and water line leaks have been extensive enough to cause surface subsidence. Water sources such as described, combined with potential preferential flow paths created by unsealed annular spaces of drywells and monitoring wells could result in the mobilization of near-surface contaminants to greater depths within the vadose zone. Contaminants such as Cs-137, which are immobile in Hanford-type sediments under ambient conditions, would be expected to travel down the annular space with the saturation front and remain relatively close to the drywell. Mobile contaminants such as Tc-99 also would travel down the annular space with the saturation front but would be able to move farther laterally than less mobile contaminants, especially if lower conductivity units such as a caliche layer were encountered, which would promote lateral spreading. This potential phenomena is illustrated in Figure K.4.1.1.

The potential mobilization of near-surface contaminants as described also could apply to contaminants that are deeper in the vadose zone such as might occur from a past tank leak. The Cs is not expected to migrate far from the tank under ambient conditions and advective flow through the interstitial pore spaces of the sediments. Thus, a Cs plume from a past tank leak would have to intercept the annular space near the leak for Cs-137 to be mobilized and transported deeper in the vadose zone via the potential annular space pathway (Figure K.4.1.1).

Inflow of Surface Water into the Top of Drywells

This potential transport mechanism entails pipe flow down the inside of the drywell casings. The construction of drywells is discussed previously. Inflow of surface water into the drywell casings has the potential of mobilizing the deep-seated contaminants from past tank leaks or other sources by providing an addition driving force.

As discussed, large volumes of water such as flooding of drywells, which has been known to occur at some of the tank farms potentially could enter drywell casings. If sufficient water from sources such as this enter the drywell casings, they would flow out of casing perforations and/or the bottom the casing if unsealed. This could result in the mobilization of deep-seated contaminants. This potential transport mechanism would not affect contaminants such as Cs-137, which are immobile in Hanford-type sediments under ambient conditions unless there are casing perforations near the elevation of the bottom of the tank leak and/or the Cs-137 was transported to a greater depth via a transport mechanism such as one involving a preferential flow path or chemically enhanced movement.

Movement of Contamination During Drilling

This potential transport mechanism involves the physical movement of particles during the drilling process from a higher elevation to a lower elevation. Many of the drywells were drilled through near-surface contamination. In addition, the drilling was not staged to prevent cross-contamination, the annular space between the single casing and the borehole was not sealed, and the cable tool drilling method potentially could carry near-surface contaminants to a greater depth. The impact on the underlying groundwater would be expected to be insignificant. Such occurrences could complicate data analyses or cause misinterpretation of data collected from the drywell monitoring programs.

Near-Surface Leaks from Water Lines And/Or Waste Transfer Lines

Even in the absence of potential preferential flow paths such as the annular space between well casings and boreholes or clastic dikes, large volumes of water such as from water line leaks, construction activities, or surface flooding could provide a driving force to quicken the transport of contaminants at all elevations.

K.4.1.3.2 Potential Chemical Vadose Zone Transport Mechanisms

As discussed in the introduction to this section, potential chemical-related transport mechanisms are the least understood of all the transport mechanisms especially considering the extremely high pH liquors present in the waste tanks. However, as will be discussed in the following paragraphs, chemical-related transport mechanism(s) may be responsible in part for the observation of contaminants such as Cs-137 at 38 m (125 ft) below the SX Tank Farm, which is deeper in the vadose zone than would have been expected based on the present understanding of the leak volume and contaminant mobility in the near-tank environment.

Potential chemical transport mechanisms may be associated with 1) sodium (Na) from the waste tanks and its effect on the mobility of some contaminants; 2) the reaction of hydroxide in the waste tanks with minerals in the vadose zone resulting in greater mobility of otherwise relatively immobile contaminants; and 3) the reaction of complexing agents that may be in the waste tanks with otherwise relatively immobile contaminants such as Co-60 and Sr-90 causing them to be more mobile. Potential chemical transport enhancing phenomena that could be in effect at the tanks include enhanced mobility resulting from; Na exchange, dissolution, and formation.

Enhanced Mobility Resulting from Sodium Exchange

Many of the defense mission processes involved acid dissolution. The resulting waste was neutralized with sodium hydroxide before being routed to the waste tanks. This practice has resulted in the presence of Na in the tank wastes at high concentrations and high pH (e.g., pH 12). As a consequence, Na may exchange for naturally occurring divalent cations such as calcium (Ca) and magnesium in the soil column. At high pH values, such as would occur when the tank contents had first exited the tanks, the surfaces of the mineral particles would be negatively charged and would attract cations. The presence of high Na concentrations near these mineral surfaces could cause the desorption of other ions from the mineral surfaces as shown in the following equation modified from Caggiano 1996:

mNa^{+} (bulk solution) + nCa^{++} (mineral surface double-layer) =
xNa^{+} (mineral surface double-layer) + yCa^{++} (bulk solution)

This exchange process could result in more divalent cations reaching the groundwater and less Na than expected. This is consistent with observations and groundwater quality analyses from a well downgradient of the S and SX Tank Farms. An important consequence is that, under high Na conditions, Sr-90, which is chemically similar to Ca, may likewise be mobilized and migrate to a greater extent than previously expected. Other waste tank constituents may be affected similarly.

Enhanced Mobility Resulting from Silicate Mineral Dissolution

The neutralization of the wastes with sodium hydroxide meant that the tank contents were high pH, sometimes approaching a pH of 12. Many studies have shown that dissolution of silicate minerals such as those in the underlying vadose zone sediments would be accelerated at high pH and high temperature (Caggiano 1996). The dissolution reactions would occur when leaks from the tanks, some of which were self-boiling, contacted the mineral particles in the vadose zone. Such dissolution processes potentially could result in gelatinous reaction products that could cover the mineral exchange sites, which would enhance the mobility of contaminants such as Cs-137 that normally are retarded by exchange. However, the gelatinous reaction products could have the opposite effect by impeding moisture migration through the soil. This potentially could cause the soil permeability to be lower than that of the unaltered material, resulting in slower contaminant movement.

Another possible effect of silicate mineral dissolution is the leaching of previously adsorbed Cs-137. If the surface of silicate minerals in the vadose zone was dissolved, micro- and macropores could be opened. This in turn could lead to the leaching of Cs-137 that previously had been adsorbed. Heat from the tanks and the heat of leaking waste could increase the rate of silicate mineral dissolution and increase the Cs-137 release rate.

Enhanced Mobility Resulting from Complex Formation

Metal-organic complexes are compounds with a cyclic structure in which the organic components are bonded to the central metal ion. Millions of pounds of complex-forming organic chemicals such as citrate, glycolate and ethylenediaminetetraacetic acid (EDTA) were used for the recovery of U and Sr and subsequently discharged to the tanks. Once in the tanks, it would be possible for these complex-forming chemicals to react with other cationic constituents of the tank waste. Not all contaminants will react with organic complexing agents such as EDTA; generally, this interaction does not take place with monovalent cations such as Na, potassium, or Cs (Hill 1992). The Cs has very little potential for complexing with the organic chemicals found in the waste tanks. Complexing reactions may take place with other cations including the actinides and lanthanides. While it is known that metal-organic complexes will remain in solution under conditions where the metal ion itself would precipitate, there is a lack of data on the mobility of these complexes. Presumably, the complex would move relatively further and faster than the ion, but K_d values for metal-organic complexes remain a subject for future study and investigation. Also, the ability of the complexing agents to remain active in the presence of high temperature and ionizing radiation is uncertain.

K.4.1.4 Potential Impact on TWRS Alternatives

Most of the potential vadose zone transport mechanisms, if active, would result in earlier contaminant first arrival at the vadose zone/groundwater interface, earlier peak concentrations, and higher peak concentrations for some or all of the contaminants, depending on the mechanisms. The following provides a qualitative description of the potential impact of the vadose zone transport mechanisms on each alternative and mitigation measures where applicable.

Preferential flow through clastic dikes and sills would result in earlier contaminant first arrival and peak times and higher peak concentrations in groundwater for all alternatives and contaminants and would be difficult to mitigate directly. The dikes first would have to be located with methods that possibly could include surface geophysics and test pits. Then, a sealing material that would withstand the chemicals in the tank waste would have to be injected effectively into the structure. Alternatively, a grout barrier could be considered. Overall, it may be unlikely that clastic dikes and sills could be directly mitigated. For ex situ alternatives, an effective indirect mitigation would be to reduce retrieval loss volume and contaminant concentrations.

Flow through breaks in a caliche layer is not expected to impact any of the alternatives because "credit" was not taken for caliche layer attenuation in the impacts analyses. Flow through drywell annular space from TWRS releases would have an effect on the No Action and Long-Term Management tank waste alternatives similar to that described for clastic dikes and sills. Mitigating the effect of flow through drywells would be relatively easily accomplished with a drywell removal (plugging) and/or drywell rehabilitation program. The other in situ and ex situ alternatives presumably would not be impacted because the drywells would be removed and plugged prior to installation of a cap over the tank farms.

Inflow of surface water into the drywell casings and annular space could decrease vadose zone contaminant transport time for the No Action and Long-Term Management alternatives. The effect on peak concentrations is uncertain. Peak concentrations could be reduced due to the dilution effect of surface water in flow. Mitigation such as plugging could be performed as described previously. The other in situ and ex situ alternatives would presumably not be affected because the drywells would be removed prior to installation of a cap over the tank farms. Cross contamination during drywell construction would not have an impact on any of the TWRS alternatives. Near-surface leaks from potable waste and waste water could decrease vadose zone contaminant transport time for the No Action and Long-Term Management alternatives. Mitigation would be relatively easy and would involve the removal of all utility lines from the tank farms area. The other in situ and ex situ alternatives would not be impacted because the utility lines would be removed prior to installation of a cap over the tank farms.

The three identified chemical transport mechanisms would result in earlier contaminant first arrival at the vadose zone/groundwater interface, earlier peak concentrations, and higher peak concentrations for some of the otherwise relatively immobile contaminants for all of the alternatives except the In Situ Vitrification alternative. The potential effects of the Na exchange and sediment dissolution transport mechanisms could be limited to near-tank due to the dilution of Na and hydroxide with natural water and would be rendered totally inactive at the saturated water located at 65 to 85 m (210 ft to 270 ft) below ground surface. The potential effect of enhanced mobility from complexing agents and the extent into the vadose zone and groundwater remain a subject for future study and investigation.

Depending on the resolution of the transport mechanisms that are currently active, it might or might not be necessary to take additional measures to control leaks during retrieval and remediate contaminants in the soil during tank farm closure.

It is not known if any of the potential transport mechanisms are active. Further, the potential transport mechanisms involving chemical enhancement are poorly understood. Mitigation of the chemical-related transport mechanisms could include indirect approaches such as reducing the volume and concentration of contaminants released during retrieval. Direct mitigation may be effective but much more information is needed about this type of potential transport mechanism.

K.4.2 TRANSPORT IN GROUNDWATER

The analyses of potential impacts on groundwater required several assumptions to address uncertainties. The major assumptions and uncertainties either are related to natural variables (e.g., vadose zone and aquifer parameter values) or are inherent to the assessment approach. Modeling assumptions are described in Section 4.2.1.

Post-remediation health risks to the public from TWRS alternatives would result from contaminants in the groundwater. The first arrival of any contaminant at the interface between the vadose zone and groundwater would occur between 140 and 250 years following remediation with the Long-Term Management and No Action alternatives. The tank inventory would be released faster for these alternatives than for any of the other alternatives, because it is assumed that there would be no engineered barriers to reduce infiltration or any attempt to remove or stabilize the tank waste. The first arrival of contaminants from the other alternatives would occur at about 2,000 years and the peak concentrations at about 5,000 years in the future.

Cumulative radionuclide concentrations that could occur in the groundwater from a potential combination of contamination from past disposal practices, currently anticipated future waste disposal, and the contamination from the TWRS alternatives are discussed in Volume Four, Appendix F.4.5. Peak groundwater concentrations from the various potential sources may occur at different times and different locations. However, to maximize the potential cumulative impacts, the peak concentrations of the past and reasonably foreseeable future sources were assumed to combine with the peak concentrations from the TWRS alternatives. This results in a conservative bounding of the maximum potential cumulative groundwater impact for each TWRS alternative. A more detailed modeling of the potential cumulative impacts will be done in a future Hanford Site EIS. The results of the future analysis likely would indicate lower cumulative groundwater impacts than presented in this bounding analysis.

The highest cumulative groundwater concentrations occur for the No Action and Long-Term Management alternatives. The tank waste is the dominant contributor to the predicted concentrations. The other alternatives result in much lower cumulative radionuclide concentrations, and the dominant contributor is contamination from past disposal practices. The radiation dose and risk to the potential future user of the contaminated groundwater, the time at which it could occur, and the percent attributable to TWRS waste for each alternative are presented in Volume One, Table 5.13.5. The table is based on a hypothetical onsite farmer who is assumed to use the groundwater at the maximum cumulative point of concentration for each alternative. The groundwater is assumed to be used for all purposes, including drinking, washing, and gardening for 30 years. Future solid waste disposal at the 200 West Area solid waste burial ground and the ERDF collectively would contribute about 5 rem of the hypothetical 30-year resident farmer dose presented. Less than 10 mrem of the hypothetical 30-year resident farmer dose would be attributed to past and future solid waste disposal at the US Ecology solid waste burial ground.

K.4.2.1 Modeling Assumptions

Volume Four, Appendix F provides the basis of the groundwater impact analysis for the TWRS alternatives. The groundwater assessments in Volume Four, Appendix F required several assumptions to address uncertainties in some of the data. The major assumptions and uncertainties are related to either the natural system (i.e., an understanding and ability to assign vadose zone and aquifer parameter values) or uncertainties inherent to the assessment approach.

The most important assumptions and uncertainties are as follows:

- The rates of infiltration into natural ground and through a cap;
- Distribution coefficient (K_d) of contaminants;
- Uncertainty in future groundwater flow direction due to decay of groundwater mounds onsite and future land-use changes;
- Uncertainty in future groundwater flow direction and vadose zone thickness due to climate change;
- Uncertainty in vadose zone transport due to use of one-dimensional flow and transport simulation; and
- Uncertainty due to calculation of releases during retrieval.

Infiltration

Infiltration is one of the key driving forces for contaminant movement through the vadose zone. It affects the time of contaminant transport through the vadose zone: a higher rate results in a faster flow rate within the vadose zone and a shorter contaminant transport time.

Infiltration varies temporally and spatially. The temporal variation occurs seasonally with changes in temperature, plant activity, and precipitation and over longer periods as a result of climatic change. The spatial variation occurs with changes in vegetation type, surficial soil type, and human-made structures, such as paved parking lots. The vadose zone flow field varies temporally and spatially in response to infiltration rate changes. However, it is not directly measurable with conventional techniques and is modeled based on vadose zone parameters and the assumed infiltration rate. There is also a lag time between a change in infiltration rate at the surface and a change in the flow field in the vadose zone as the water percolates into the ground.

For each alternative, the initial infiltration rate (i.e., the rate before implementing remediation or no action) is assumed to be 5 cm/year (2 in./year). This rate is within the range of reported values for the Hanford Site and is appropriate given 1) the recent ground cover changes in the tanks vicinity; 2) the uncertainties in future ground cover conditions; and 3) the one-dimensional vadose zone flow and transport model used for the simulations. Infiltration in the 200 Areas is reported to range from near zero, where the ground cover is a shrub-steppe type characteristic of predevelopment conditions, to 10 to 13 cm/year (4 to 5 in./year), where the ground is unvegetated sand and gravel, characteristic of conditions around the tank farms since the mid-1940's or later (Gee et al. 1992). For alternatives that incorporate a cap, limited sensitivity analysis has shown that the contaminant transport through the vadose zone is not sensitive to the initial infiltration rate (Volume One, Section 4.3.5).

The higher infiltration in the vicinity of the tanks is a relatively recent occurrence in response to ground cover modifications in the last 50 years. These modifications are not expected to have changed the flow field at depth within the vadose zone from that of predevelopment conditions. For alternatives involving a cap, conditions after the cap is installed are assumed to be representative of predevelopment conditions in that the infiltration in the tank vicinity would be low. Infiltration is assumed to remain at 5 cm/year (2 in./year) for the No Action and Long-Term Management alternatives.

Spatially, the rate would be expected to be lower away from the tanks where vegetation is present and surficial soils are of a finer texture. The one-dimensional model used for contaminant transport simulations through the vadose zone does not account for these infiltration changes with time and space. Thus, the assumed infiltration rate of 5 cm/year (2 in./year) was chosen as a conservative estimate.

The No Action and Long-Term Management alternatives are the only two tank waste alternatives that would not involve placement of a cap over the tanks. If a higher infiltration rate was assumed (i.e., greater than 5 cm/year [2 in./year]), the result would be earlier contaminant arrival in the groundwater with higher peak concentrations. Conversely, use of a lower infiltration rate would result in a delayed effect with somewhat lower peak contaminant concentrations.

Distribution Coefficients

The various contaminants in the tank waste each have their own chemical characteristics and would interact with the groundwater and geologic materials differently. An indication of a contaminants mobility in the vadose zone and groundwater aquifer is the distribution coefficient (K_d). A contaminant moves with the speed of water if its K_d is zero and progressively slower than water as the K_d value increases. This difference would result in different rates of contaminant movement in the vadose zone and groundwater, ranging from that of groundwater to no measurable movement over a period of hundreds of years.

The tanks contain more than 100 radioactive and nonradioactive contaminants that potentially would impact groundwater. Contaminants that are insoluble were assumed not to leach to groundwater. The K_d values for the contaminants range from zero (in which the contaminant's movement in water is not retarded) to more than 100 (in which the contaminant moves much more slowly than water). Therefore, the contaminants were grouped as follows based on their mobility in the vadose zone and underlying unconfined aquifer:

- Group 1 - Nonsorbing (K_d = 0); K_d values in this group ranged from 0 to 0.99 mL/g;
- Group 2 - Slightly sorbing (K_d = 1); K_d values ranged from 1 to 9.9 mL/g;
- Group 3 - Moderately sorbing (K_d = 10); K_d values ranged from 10 to 49.9 mL/g; and
- Group 4 - Strongly sorbing (K_d = 50); K_d values are 50 mL/g or greater.

Contaminant transport simulations were performed for each group, using the lowest value of the range. These results were used to design a limited sensitivity analysis (Volume Four, Section F.4.3.5).

The distribution coefficient for a given contaminant depends not only on the chemical characteristics of the contaminant but also on the chemistry of the aquifer (or vadose zone) and the water within. For example, a contaminant with a K_d value of 0 in saturated sands might have a nonzero K_d value in a clay-rich zone. There is a large uncertainty with regard to contaminant mobility in all the different material and water types at the Hanford Site. For example, the K_d value of U has a reported experimental value that varies from a low estimate of 0 to a high estimate of 79.3 mL/g (best estimate value is 0.6 mL/g) in Hanford Site sediments with waters of neutral to high pH, low ionic strength, low organic content, and toxic solutions. In Hanford Site sediments with waters of neutral to high pH levels, low ionic strength, low organic, and anoxic solutions, this same contaminant has a reported experimental value that varies from a low estimate of 100 to a high estimate of 1,000 mL/g (best estimate value is 100 mL/g) (Kaplan et al. 1994).

Given the uncertainty in the mobility of U, U was initially assumed to have a zero K_d. Assuming a high K_d would mean the contaminant did not reach groundwater within the 10,000-year period of interest.

Vadose zone simulations show that U with an assumed K_d of zero does reach groundwater within the 10,000-year period of interest for all the alternatives and that drinking water standards are potentially exceeded. Based on these results, the sensitivity of the U mobility assumption can be better understood with additional simulations with slightly higher values of K_d. Vadose zone simulations indicate that contaminants with a K_d of 0.125 mL/g do not reach the groundwater within the 10,000-year period of interest, using the Ex Situ Intermediate Separations alternative as the base case.

Future Groundwater Flow Direction

Under present land use conditions, groundwater flow direction and gradient on the Hanford Site is dynamic and changes primarily in response to wastewater disposal to the vadose zone and future land-use changes. Other factors could influence groundwater flow and gradient to a lesser degree. These factors include irrigation to the west of the Site and water level in the Columbia and Yakima Rivers.

The groundwater impact assessment for the TWRS EIS was based on a conceptual model with the following salient features: 1) water movement from surface infiltration, tank releases, and other near-surface sources is through the vadose zone, into the underlying aquifer, and ultimately to the Columbia River, 2) flow and transport of water and contaminants in the vadose zone and underlying aquifer are by advection through the interstitial pore spaces of the sediments, 3) the Columbia and Yakima Rivers form hydraulic boundaries: the Yakima River recharges the unconfined aquifer in the southern part of the Site and the Columbia River receives discharge from the unconfined aquifer, 4) the Cold Creek and Dry Creek valleys recharge the unconfined aquifer, part of which is derived from infiltrating irrigation waters to the west of the Site, 5) the Rattlesnake Hills to the west of the Site are a no-flow boundary, and 6) natural infiltration on the Hanford Site is assumed to be zero. This resulted in an expectation that most of the contaminants from the tank sources would move in a west to east/southeast direction with a small amount flowing northerly through the gap between Gable Butte and Gable Mountain. The December 1979 groundwater level data on which the impact assessments were based are the most recently available groundwater levels consistent with the conceptual model and have been extensively used and tested by other investigators (Wurstner-Devary 1993).

The December 1979 groundwater level data represent a period of relative steady conditions but also a period in which there were major groundwater mounds on the Site. These mounds are associated with wastewater disposal to B Pond, U Pond, and Gable Mountain Pond. Gable Mountain Pond has been closed, and waste disposal to the U and B Ponds has diminished. Both of these ponds ultimately will be closed. The groundwater mounds present in December 1979 have diminished with these changes and ultimately will totally dissipate.

The appropriateness of the December 1979 groundwater level data as a basis for impact analysis was tested in two ways: 1) qualitatively, by comparing the December 1979 groundwater level surface with predicted Site groundwater levels prior to Site development (i.e. hindcast) and 2) quantitatively, by calculating future Site groundwater levels using the VAM2D model and the same assumptions of boundary conditions and infiltration as used for the impact analysis, except that there was no water inflow from Site wastewater disposal to the vadose zone. Contaminant concentrations and associated risks were predicted for the Ex Situ Intermediate Separations alternative using this "no mound" predicted future flow field.

The differences among the December 1979 groundwater levels as simulated by the CFEST model (Volume Four, Figure F.2.4.2), the interpolated and contoured groundwater levels based on individual groundwater levels measured in site monitoring in December 1979, and the December 1979 groundwater levels as simulated by the VAM2D model were insignificant. The inferred groundwater flow directions in the hindcast (Figure K.4.2.1) were similar to the December 1979 simulated groundwater levels (Volume Four, Figure F.4.3.1). Groundwater flow directions inferred in the December 1979 representation were generally southeast/east, with a small component flowing northeast through the gap between Gable Butte and Gable Mountain. Groundwater flow directions inferred in the hindcast were due east, with a slight component of flow to the southeast and a slight component flowing northeast through the gap between Gable Butte and Gable Mountain.

The appropriateness of the December 1979 groundwater levels as a basis for impact analysis was examined quantitatively by predicting future groundwater levels assuming no impacts (e.g., groundwater mounds) from Site wastewater disposal and analyzing the associated risks for the Ex Situ Intermediate Separations alternative. Future groundwater levels were predicted by a steady-state simulation of the groundwater flow system assuming no inflow from Site wastewater discharges. These wastewater discharges were active in December 1979 and their estimated flow rates are provided in Volume Four, Table F.2.4.1. All the sites listed in this table, except the Rattlesnake Mountain Springs site, are waste disposal sites. The predicted future groundwater levels for these assumed conditions are provided in Figure K.4.2.2.

The future predicted groundwater levels, the December 1979 groundwater representation, and the hindcast all were very similar. As expected, the groundwater mounds from U Pond and B Pond evident in the December 1979 groundwater levels are not evident in Figure K.4.2.2. Recharge on the western portion of the Site from the valley out of the Rattlesnake Hills, coupled with the relatively low hydraulic conductivity of the sediments west of the 200 West Area, resulted in a relatively large groundwater gradient as indicated by the close contour spacing in that area. The gradient magnitude and direction in the area midway between 200 West and 200 East to the Columbia River on the east side of the Site were similar to the hindcast, which indicated a primary easterly flow direction from the 200 Areas.

The dissipation of the groundwater mounds, which would occur when the wastewater discharge was terminated, and the overall groundwater level drop, resulted in a larger area of Gable Mountain extending above the groundwater table. This difference in the Gable Mountain area above the groundwater table for the December 1979 groundwater levels and the forecasted "no mound" groundwater levels is illustrated in Figure K.4.2.2. This resulted in a slightly smaller aquifer area in which contaminants released from the waste tanks would dilute. The change would tend to prevent contaminants from diluting as quickly in the area immediately east of the 200 East Area, compared to the prediction based on the December 1979 groundwater levels. The larger Gable Mountain area above the groundwater table was predicted to extend to the northern portion of the 200 East Area, including the area around waste tank source area 1ESS. For comparison purposes, the aquifer in this area (Figure K.4.2.2) was assumed to be thicker by approximately 1 to 3 m (3 to 10 ft). This was necessary to simulate the transport of contaminants from the 1ESS source area through the aquifer. This adjustment to aquifer thickness may have artificially resulted in higher contaminant concentrations in the area near 1ESS.

Figure K.4.2.1 Hindcast of Water Levels in the Unconfined Aquifer

Figure K.4.2.2 Calculated Future Groundwater Levels in the Unconfined Aquifer After Effects from Discharge of Waste Water Have Dissipated

Section K.7.5 compares the calculated risks for the Ex Situ Intermediate Separations alternative based on December 1979 groundwater levels with those based on the predicted future groundwater levels shown in Figure K.4.2.2.

Climate Change

A climate change scenario was examined that included the return of an ice age. At present, the earth is in an interglacial phase. A transition to a glacial climate during the next few thousand years is highly unlikely. Such a transition during the next 10,000 years is more probable. Over a million-year time scale the global climate is virtually certain to pass through several glacial-interglacial cycles (National Research Council 1995).

Three potential changes associated with an ice age would likely impact waste disposed of onsite. These include 1) a cooler, wetter climate during early and late phases of the ice age that would increase infiltration through the waste and cause a faster movement of contaminants from onsite disposal locations to the Columbia River; 2) a cold, dry climate during the middle phase of the ice age that would reduce infiltration through the waste and slow migration of waste to the Columbia River; and 3) a catastrophic flood that would reach the Central Plateau and dislodge and scatter waste from the disposal site. During previous ice ages, ice dams have formed on upper tributaries of the Columbia River. These dams, when broken through, have resulted in floods of up to 2E+06 m^3 (5E+08 gal) of water in a period of a few weeks compared to the present average flow of the Columbia River of about 1E+05 m^3/year (3E+07 gal/year).

Such floods would be likely to impact any waste disposed of near the surface on the Hanford Site, scouring out waste sites to a depth of several meters and then redepositing waste from the tanks throughout the Pasco Basin.

Radioactive decay would have reduced the hazard from wastes disposed of onsite under all of the alternatives by the time of the postulated glacial flood in the next 40,000 to 50,000 years. For all of the alternatives, peak impacts on groundwater beneath the 200 Areas would have occurred at 210 to 350 years from the present for the No Action and Long-Term Management alternatives for K_d=0 and at 3,600 to 8,900 years from the present for all other alternatives. Because of the low concentrations of Pu and other radionuclides that would remain at the time of the postulated flood, the radiological consequences of a glacial flood would be small in comparison to the effects of the flood itself (DOE 1987).

One-Dimensional Flow

Two-dimensional or three-dimensional simulations of contaminant flow and transport in the vadose zone could provide more accurate estimates of contaminant arrival time, peak time, and peak concentrations (compared to one-dimensional simulations), provided that the spatial vadose zone hydraulic and transport properties were known. However, adequate knowledge of these parameters for two- or three-dimensional modeling currently is not available.

The one-dimensional simulations provided for this assessment were conservative and resulted in comparable estimates for each alternative. The simulations were conservative compared to two- or three-dimensional simulations using the same vadose zone properties. Because two- or three-dimensional flow and transport simulations allow for lateral flow and transport (slowing vertical movement), the transport times for the one-dimensional simulations were as fast or faster and the peak concentrations were higher because all transport and flow were in one direction only: downward within a uniformly porous medium.

Contaminants were assumed to move downward by advection with infiltration from precipitation and dissolution and leaching from tanks. The flow of water and transport of contaminants in the vadose zone would principally be in the vertical direction because of the hydraulic gradient and geologic structure (layering) in the vadose zone, which was assumed insufficient to result in extensive lateral spreading. Therefore, only one-dimensional modeling was performed in the vadose zone assuming a uniformly porous media and uniform hydraulic gradient.

Releases to the Soil During Retrieval

The ex situ alternatives were all assumed to result in contaminant releases from SSTs during retrieval operations. Each SST was conservatively assumed to lose 15,000 L (4,000 gal) during retrieval for a total of 2E+06 L (6E+05 gal) from the 149 SSTs. This assumption was based on current information from the waste retrieval program and the assumption that the average leakage volume from an SST would be one order of magnitude lower than the maximum release volume estimated for tank 241-C-106 during sluicing operations (DOE 1995d).

Based on the nominal retrieval scenario, all of the ex situ alternatives would have a contaminant first arrival time at the vadose zone/groundwater interface of approximately 1,000 years because of losses during retrieval. The lower bounding retrieval scenario would not change the time of release, and the contaminant first arrival time would not be expected to change either.

The rising limb of the concentration versus time curves at the vadose zone/groundwater interface (see Volume Four, Figure F.3.5.1 for characteristics of the ex situ alternatives) would shift to the right and calculated peak concentrations would be lower and could occur slightly later. Even though retrieval releases occur early compared to residual releases, the maximum peaks for the lower bounding scenario could be somewhat lower because the total mass released would be lower.

The following general alternative-specific assumptions were made for the modeling effort.

General Assumptions

- For the radioactive contaminants, the mass was estimated for each isotope based on the decay of that isotope to

December 31, 1995.

- Some contaminants in the tank inventory are of little importance and were not considered further in the groundwater assessment (Volume Four, Table F.2.2.3 provides a list of these contaminants).
- Contaminants were assumed to be released by their desorption and dissolution into pore fluids (this assumption holds for tank saltcake/sludge (No Action), grouted, and vitrified waste forms) and then moved by advection and diffusion from the waste source into the surrounding natural material or engineered barrier. Contaminants that are insoluble were assumed not to leach to groundwater.
- The LAW disposal facility was considered one source area even though 41 vaults are anticipated. The vaults would be covered with a continuous Hanford Barrier and the contents of each vault were assumed similar.
- The 177 tanks were divided into eight source areas based on configuration, tank proximity, and groundwater flow direction.
- Ingrowth of decay products was not calculated.
- No preferential flow paths (e.g., macropore flow) exist in the vadose zone.

1. No Action (Tank Waste) and Long-Term Management alternatives assumptions included the following.

- Releases to the groundwater system were associated with the complete inventory of contaminants in the waste tanks (Volume Four, Table F.2.2.2) except for insoluble contaminants.
- Infiltration would be 5 cm/year (2 in./year) initially and throughout the period of interest.
- Contaminant releases for the five SST source areas were assumed to begin at the end of institutional control.
- Contaminant releases from the three DST source areas were assumed to begin 100 years after the end of institutional control.
- The duration of this release was based on a congruent dissolution model. In this model, all constituents in the waste inventory were assumed to be released in proportion to the most abundant material in the waste inventory, nitrate. The concentration of nitrate is 360 g/L (Serne-Wood 1990). The initial unit concentration assumed in modeling for K_d groups 1 and 2 (K_d equals zero and one) was 400 g/L. The only difference between these alternatives is that under the Long-Term Management alternative, DSTs would be replaced during the institutional control period and assumed to begin leaking 100 years after the institutional control.

- In Situ Fill and Cap alternative assumptions included the following.

- Releases to the groundwater system were associated with the complete inventory of contaminants in the waste tanks (Volume Four, Table F.2.2.2).
- The initial vadose zone flow field was based on an infiltration rate of 5 cm/year (2 in./year).
- In 1997, the infiltration rate was assumed to decrease to 0.5 cm/year (0.2 in./year) in response to Hanford Site activities and decrease again to 0.05 cm/year (0.02 in./year) after the Hanford Barrier was installed. The Hanford Barrier was assumed to have lost integrity 1,000 years after installation, which would cause infiltration to increase to 0.1 cm/year (0.04 in./year) throughout the remainder of the 10,000-year period of interest.
- Five hundred years after the Hanford Barrier was installed, contaminant releases for the eight tank source areas were assumed to begin (NRC 1994).
- The principal constituent of the waste would be nitrate and the congruent dissolution release model was used to estimate release from the waste, which was the same approach as described for the No Action and Long-Term Management alternatives. The dissolution concentration of nitrate was assumed to remain constant at 360 g/L (Serne-Wood 1990), regardless of the water flux. The initial unit concentration assumed in modeling was 400 g/L.
- The initial contaminant inventory and concentrations were the same as for the No Action and Long-Term Management alternatives.

- In Situ Vitrification alternative assumptions included the following.

- Releases to the groundwater system were associated with the contaminants in the waste tanks, but the vitrification process would result in a different waste form (Volume Four, Table F.2.2.4).
- The initial vadose zone flow field was based on an infiltration rate of 5 cm/year (2 in./year).
- The infiltration rate was assumed to decrease to 0.05 cm/year (0.02 in./year) after the Hanford Barrier was

installed. The Hanford Barrier was assumed to lose integrity 1,000 years after installation, which would cause infiltration to increase to 0.1 cm/year (0.04 in./year) throughout the remainder of the 10,000-year period of interest.

- Five hundred years after the Hanford Barrier was installed, contaminant releases for the eight tank source areas were assumed to begin (NRC 1994).
- The release model for the vitrified mass was based on a constant total mass loss rate of 1.0E-03 g/m^2 per day (Shade et al. 1995). The mass loss rate was independent of the water flux from recharge. The composition of the vitrified mass was assumed to be identical to the soda-lime glass formed in the Ex Situ No Separations alternative (WHC 1995c). The release concentration of contaminants was then assumed to be proportional to their concentration in the soda-lime glass. Because the total mass loss rate would be constant, the composition of the released solution would be unaffected by the recharge rate. Because the infiltration rate would double after the barrier lost integrity, the mass flux would increase proportionately. The low value of the total mass loss rate, combined with the very large quantity of vitrified mass, would result in a release time measured in millions of years.

- Ex Situ Intermediate Separations alternative assumptions included the following.

- Releases to the groundwater system were associated with 1) releases during retrieval from the SSTs; 2) releases from residuals that could not be removed from the waste tanks; and 3) releases from the LAW disposal facility.
- The amount of liquid released from each SST during retrieval operations would be 15,000 L (4,000 gal). The mass associated with retrieval operations at each source area is provided in Volume Four, Table F.2.2.5.
- The tank residual materials were assumed to be 1 percent of those for the No Action and Long-Term Management alternatives (Volume Two, Appendix A).
- The mass associated with the contaminants in the LAW vaults was based on the vitrified form of the retrieved waste (Volume Four, Table F.2.2.6).
- The initial vadose zone flow field was based on an infiltration rate of 5 cm/year (2 in./year) for tank source areas and the LAW source area.
- In 1997 the infiltration rate was assumed to decrease to 0.5 cm/year (0.02 in./year) in response to Site activities and decrease again to 0.05 cm/year (0.02 in./year) after the Hanford Barrier was installed at tank source areas and the LAW source area. The Hanford Barrier was assumed to lose integrity 1,000 years after installation, which would cause infiltration to increase to 0.1 cm/year (0.04 in./year).
- Contaminant releases for the five SST source areas were assumed to occur 1) during retrieval in 1997; and 2) from residual materials 500 years after Hanford Barrier construction.
- Contaminant releases for the three DST source areas were assumed to result from releases from residual materials 500 years after Hanford Barrier construction.
- Contaminant releases for the LAW facility were assumed to begin 500 years after the Hanford Barrier was constructed over the vaults (NRC 1994).
- The solubility of each contaminant for retrieval releases and tank residuals would be proportional to the solubility of nitrate. For the tank source areas, the initial unit concentration assumed in modeling was 400 g/L.
- The release model for the glass cullet was based on a constant corrosion rate of 3E-06 cm/year (1E-06 in./year) (Jacobs 1996). This corrosion rate would be independent of the water flux from infiltration. The composition of the LAW glass was taken from the engineering data package for this alternative (WHC 1995j). The release concentration of the contaminants was assumed to be proportional to their concentration in the LAW glass. Because the total mass loss rate would be constant, the composition of the released solution would be unaffected by the infiltration rate. Because the infiltration rate would double after the barrier lost integrity, the mass flux would increase proportionately. The low value of the corrosion rate, combined with the large quantity of vitrified mass, would result in a calculated release time of 170,000 years.
- For the tank source areas, the initial contaminant concentrations were the same as for the No Action and Long-Term Management alternatives. The initial concentrations for the LAW disposal facility are provided in Volume Four, Table F.2.2.17.

- Ex Situ No Separations alternative assumptions included the following.

The assumptions for this alternative were the same as for the tank retrieval and tank residual components of the Ex

Situ Intermediate Separations alternative (i.e., 1 percent of tank waste was assumed to remain as a residual in the tanks).

- Ex Situ Extensive Separations alternative assumptions included the following.

The assumptions for this alternative were the same as for the tank retrieval and tank residual components of the Ex Situ Intermediate Separations alternative (i.e., 1 percent of tank waste was assumed to remain as a residual in the tanks). For this alternative, the contaminant inventory in the LAW vaults would be smaller than estimated for the LAW vault component of the Ex Situ Intermediate Separations alternative (see Volume Four, Table F.2.2.7).

- Ex Situ/In Situ Combinations 1 and 2 alternatives assumptions included the following.

These alternatives would incorporate all of the assumptions listed for the Ex Situ Intermediate Separations alternative and the In Situ Fill and Cap alternative except as noted as follows. For the tanks remediated ex situ:

- Releases to the groundwater system would be due to losses during retrieval (Volume Four, Table F.2.2.8).
- Residual waste that could be left in a tank after retrieval was assumed to be 1 percent of the initial tank inventory.
- The 1 percent residual waste was added to the inventory of tanks remediated in situ.

For the tanks remediated in situ:

- Releases to the groundwater system would be due to leaching from the waste form within the tanks (Volume Four, Table F.2.2.9). Table F.2.2.9 contains the initial waste inventory.
- Phased Implementation alternative assumptions included the following.
- There would be no groundwater impacts associated with the first phase of this alternative because there would be no contaminant releases from the tanks.
- The assumptions for the total alternative would be the same as those for the Ex Situ Intermediate Separations alternative.

K.4.2.2 Parameter Sensitivity

Parameter sensitivity was investigated for the following areas:

- The effect of higher glass surface areas for the In Situ Vitrification alternative;
- The effect of changing the performance period of the Hanford Barrier from 1,000 to 500 years;
- The effect of the decay of the potentiometric head from groundwater mounding due to discharge to the Hanford Site ponds;
- The effect of variations in infiltration rate; and
- The effect of variations in distribution coefficient (K_d).

In Situ Vitrification Surface Area

As part of the parameter sensitivity analysis, the vitrified glass surface area was assumed to have doubled to represent the case where extensive cracking of the waste form occurred. This higher surface area doubled the corrosion rate. The predicted U-238 concentrations in groundwater at 5,000 and 10,000 years, respectively, at the higher corrosion rate are provided in Figures K.4.2.3 and K.4.2.4. Comparing these figures with Volume Four, Figures F.4.3.4 and F.3.4.5, which were based on the original corrosion rate, shows that the estimated contaminant concentrations in groundwater at the higher surface area are almost indistinguishable from those calculated for the base case analysis.

500-Year versus 1,000-Year Hanford Barrier

There is some uncertainty concerning the long-term performance of the Hanford Barrier that would be placed over the tanks and the LAW vaults. This uncertainty was investigated using the In Situ Fill and Cap alternative as a basis for comparison. The Hanford Barrier was assumed to degrade 500 years after placement instead of after 1,000 years as assumed in Volume Four, Section F.3.3. At 500 years, the water flux through the Hanford Barrier was assumed to double from 0.05 to 0.1 cm/year (0.02 to 0.04 in./year). The calculated nitrate concentration at selected locations within the unconfined aquifer is provided in Figure K.4.2.5. Comparing Figure K.4.2.5 with Volume Four, Figure F.3.3.3 shows no significant difference in peak concentrations of nitrate, the most abundant and mobile contaminant. The time of arrival of contaminants (using nitrate as an example) is slightly earlier for the 500-year Hanford Barrier. A comparison of Figures K.4.2.6 and Volume Four, Figure F.3.3.16 indicates that U-238 concentrations in groundwater at 10,000 years from the present are low for both cases, and for the 500-year Hanford Barrier, U-238 concentrations are lower by a factor of approximately 5 to 10. This occurs because the higher water flux through the 500-year Hanford Barrier would allow U-238 to travel faster through the vadose zone and the groundwater system.

Variations in Infiltration Rate

An infiltration rate of 5 cm/year (2 in./year) was assumed as the initial condition for all the alternatives. For those alternatives involving active remediation, such as the In Situ Vitrification and Ex Situ Intermediate Separations alternatives, the infiltration rate was assumed to be reduced to 0.5 cm/year (0.2 in./year) during the remediation period (e.g., during waste removal and cap construction).

The assumed infiltration rate of 5 cm/year (2 in./year) is an appropriate value that is within the range of reported values. Prior to Site development in the early 1940's, the infiltration rate was likely much lower, on the order of a few millimeters per year, characteristic of the 200 Areas Plateau under naturally vegetated conditions. As the tank farms were constructed, the natural vegetation was removed and the vicinity around the tanks was covered with sand and gravel. The current infiltration rate in the vicinity of the tanks is believed to be on the order of 10 cm/year (4 in./year). This higher infiltration rate would be greatly reduced with the installation of a cap or return to natural shrub-steppe type ground cover.

Figure K.4.2.3 Predicted Uranium-238 Concentrations in Groundwater at 5,000 Years for the In Situ Vitrification Alternative (High Glass Corrosion Concentration)

Figure K.4.2.4 Predicted Uranium-238 Concentrations in Groundwater at 10,000 Years for the In Situ Vitrification Alternative (High Glass Corrosion Concentration)

Figure K.4.2.5 Predicted Nitrate Concentration in Groundwater at Selected Locations for the In Situ Fill and Cap Alternative (500-Year Cap)

Figure K.4.2.6 Predicted Uranium-238 Concentrations in Groundwater at 10,000 Years for the In Situ Fill and Cap Alternative (500-Year Cap)

To estimate the sensitivity of the overall results (e.g., concentration of tank wastes predicted in groundwater) to the initial infiltration rate of 5 cm/year (2 in./year), an alternative infiltration scenario was developed for the In Situ Fill and Cap alternative. For this scenario, the initial infiltration rate was assumed to be 1 cm/year (0.4 in./year) for the 200 Areas Plateau under natural vegetation. It was assumed that in 1955, the infiltration rate increased to 10 cm/year (4 in./year) and would remain at this rate until 2023, after the cap construction was complete for all source areas. At this time, the infiltration rate would be reduced to 0.05 cm/year (0.02 in./year) and would remain at this level for 1,000 years. All other aspects of the In Situ Fill and Cap alternative are the same as assumed in Volume Four, Section F.2.2.3.3. Contaminant flow and transport through the vadose zone were simulated using this infiltration scenario for three of the eight source areas. The source areas and their total vadose zone thicknesses (from the base of the tanks to the water table) are as follows:

Source Area	Vadose Zone Thickness m (ft)
1WSS	51 (170)
2WSS	48 (160)

5EDS	68 (220)

These source areas were chosen because they bound the range of vadose zone thicknesses. When the results of this alternative infiltration scenario, graphed as concentration versus time, were compared to the nominal case (i.e., initial infiltration rate of 5 cm/year [2 in./year]), they were nearly identical, with less than a 1 percent difference between estimated concentrations.

Variations in Distribution Coefficients

As explained in earlier sections, the distribution coefficient (K_d) for a specific contaminant is an indication of the mobility of the contaminant within the aquifer system. Contaminants with lower K_ds are more mobile, and contaminants with higher K_ds are less mobile. Contaminants with K_ds of 0 and 1 mL/g have been calculated to arrive at the interface between the vadose zone and groundwater within the 10,000-year period of interest for both the No Action and Long-Term Management alternatives. For the other alternatives, only contaminants in K_d Group 1 (K_d equal to 0) have been calculated to arrive at the vadose zone groundwater interface within 10,000 years because the influx of precipitation into the waste would be greatly reduced by the cap. Not all the contaminants in K_d Group 1 have a K_d of zero. Uranium is an example of a contaminant that, while conservatively placed in K_d Group 1, likely has a K_d between zero and one. The Ex Situ Intermediate Separations alternative was selected as representative of alternatives that incorporate a cap and was used as the basis for estimating the sensitivity of contaminant transport for K_d values between zero and one.

The sensitivity of contaminant travel time through the vadose zone to various K_d values was evaluated by varying K_d for this alternative and for the 1WSS source area and then tabulating the arrival time at the vadose zone/groundwater interface. The range of K_d values selected for analysis and the times of first arrivals calculated by the model is as follows:

K_d Value (mL/g)	First Arrival at Vadose Zone/ Groundwater Interface (years)
0.00	1,500
0.05	5,300
0.075	7,000
0.10	8,600
0.125	10,000

For K_d greater than 0.125 mL/g, first arrival did not occur until just after 10,000 years. This is important for contaminants such as U that are reported to have K_d values of approximately 0.6 mL/g at the Hanford Site, as they would not reach the groundwater within the period of interest for alternatives that include a cap.

K.4.3 TRANSPORT IN SURFACE WATER

The primary sources of uncertainty in estimating surface water transport are associated with the rate of dilution of contaminants in groundwater entering the Columbia River. These sources are the turbulence of river flow, which depends on the velocity; irregularities in the stream channel, including bends; and the width of the river. All these factors ultimately depend on the total flow in the river at the point(s) where contaminated groundwater would be discharged.

K.4.4 TRANSPORT IN AIR

Various assumptions and other factors can introduce uncertainty into air dispersion modeling studies. With regard to the modeling performed to analyze air impacts from the various EIS alternatives, these uncertainties can be separated broadly into the following categories:

- Uncertainty inherent in the air dispersion models;
- Uncertainty in data used as model inputs; and
- Uncertainty in interpretation of model output.

These categories are discussed in more detail in the following text.

K.4.4.1 Air Dispersion Modeling

Air dispersion models are mathematical tools designed to estimate pollutant concentration and/or deposition at specific locations. These predictions are based on various input parameters and physical assumptions, such as the following:

- Pollutant release characteristics (emission rate, temperature, flow rate);
- Meteorological conditions (ambient temperature, mixing height, stability, wind speed and direction, atmospheric temperature, and wind speed profile); and
- Pollutant transport behavior (dispersion, plume rise, interaction with terrain).

In an ideal case, the values entered into the model for these known parameters will closely duplicate the range of conditions that exist for a particular scenario. However, the stochastic nature of the atmosphere results in other unknown factors (e.g., wind perturbations) that influence the dispersion at a particular time or place. It has been estimated that even when the known conditions are exactly duplicated in the model, the unknown factors can contribute to variations in concentration as much as ±50 percent.

Gaussian air dispersion models are accurate within a factor of two when properly executed with accurate data. In general, models are more reliable when estimating long-term average concentrations as opposed to short-term averages, and are reasonably reliable in estimating the highest concentration occurring, but are not capable of predicting the exact time or position of the occurrence. In other words, the highest concentration that can be expected in an area can be predicted with reasonable accuracy; the location and time that the maximum concentration will occur are less reliably predicted.

The air dispersion models used in this study are considered to be state-of the-art for regulatory modeling and are recommended by the U.S. Environmental Protection Agency (EPA) for this type of analysis. To compensate for the uncertainties in model results, conservative input values were used that provide conservative (higher than might occur under average conditions) results.

K.4.4.2 Model Input Data

Two types of input data were used for the air dispersion models: meteorological data and source data. Both types of input data are discussed in the following text.

Meteorological Data

Two types of meteorological data (i.e., long-term and short-term) were used in the dispersion modeling study. Long-term (i.e., annual) average concentrations were estimated using meteorological data collected at the Hanford Meteorological Station from 1989 to 1993. The assumption inherent in this choice is that these data represent future meteorological conditions. A 5-year record is generally accepted as an adequate sample set for modeling purposes. Although long-term climatic shifts may occur, many of the air pollutant emitting activities analyzed in this study are expected to occur within several decades of project initiation, which is a relatively short time frame on a climatic scale.

Therefore, the use of these data is not expected to adversely affect the results.

Typically, short-term average (i.e., 1- 3- 8- and 24-hour) concentrations are predicted using hourly meteorological measurements from a station located at or near the site of interest. Because appropriate data were not available for this study, a screening approach was taken, and a standard set of hourly meteorological conditions were incorporated in the modeling. These standard conditions are accepted by the EPA to encompass the range of atmospheric stabilities and wind speeds that could be expected to occur anywhere. Each combination of wind speed and atmospheric stability was assumed to occur in every possible wind direction. The predicted concentrations represent the highest value that could reasonably be expected to occur anywhere. This approach is conservative because the meteorological conditions leading to the reported result may not occur at the site for all wind directions.

Source Data

Data describing the location, emission rate, and emission characteristics of the sources were input to the models. Information concerning pollutant emission rates was derived from data packages supplied by the Site Management and Operations contractor and analyzed by the EIS contractor. In general, conservative values were used to develop emissions estimates.

The location of the pollutant emitting sources was not known with complete certainty in all cases. Pollutant emitting activities associated with the existing tank farms will occur in the present locations. However, the exact location of future facilities is subject to some uncertainty. In general, the closer a source to a receptor, the higher the predicted concentration at that receptor. As a consequence, if the eventual location of an emitting activity is closer to a plant boundary than depicted in the model, the impacts may be higher. Of course, if the activity is located farther from the boundary than depicted in the model, the impacts may be lower.

The temporal arrangement of the pollutant emitting activities affects the predicted concentrations as well. The predicted concentration at any receptor includes the contributions from each individual emitting source. To properly analyze a scenario, all the pollutant emitting activities that could occur at the same time must be considered. In general, most of the scenarios analyzed involved a period of facility construction followed by an operational period.

In some cases, an emitting source is expected to move from place to place as the project progresses. An example of this would be emissions related to remedial activities at tank farm locations. In most cases at a given time, work would be occurring at one or two of the possible 17 locations. Given these uncertainties, a conservative analysis was ensured by assuming that activities that may or may not overlap would occur simultaneously. In addition, activities that are expected to move from place to place were modeled as if occurring in the location producing the highest potential impact.

Sources were modeled as either point or area sources. Point sources were used to approximate pollutant releases from a stack or other fixed, functional opening, or vent. The dispersion algorithms used for point sources modify the effective release height to take into account plume buoyancy (from a heated release) and momentum (from vertical release velocity). Typically, area sources were used to approximate pollutant releases that would not occur at a single, well-defined point, but instead can be defined as occurring within a defined area. For instance, an area source could include many small fixed point sources that were too numerous to model individually, or could be made up of several mobile sources that could move about within the fixed area. In this study, the construction activities were represented as area sources. The classification of the sources into these two categories involved some degree of uncertainty as well as some assumptions. The models used different algorithms to represent dispersion from point and area sources, and the predicted concentration at a receptor could vary depending on the algorithm chosen. In general, these effects would be more noticeable at locations close to the source and tend to diminish as the distance between source and receptor increased.

K.4.4.3 Interpretation of Model Output

The short-term model was run using screening meteorology to produce predicted maximum 1-hour average concentrations. These 1-hour average values were converted to 3- ,8-, and 24-hour average concentrations, when appropriate, to compare to applicable standards. This was accomplished by applying conversion factors to the 1-hour average values. Consistent with modeling guidelines (EPA 1988), the factors of 0.9, 0.7, and 0.4 were applied to convert to 3-, 8-, and 24-hour averages, respectively. These factors involve an implied assumption regarding the persistence of the meteorological condition producing the highest 1-hour impact. In other words, conservative meteorological conditions that produced the highest 1-hour concentration can be expected to persist for most of a 3-hour period, and to a lesser degree over an 8- or 24-hour period. The modeling guidelines indicate a range of values for each conversion factor: the 3-hour conversion factor can range from 0.8 to 1.0, the 8-hour factor from 0.5 to 0.9, and the 24-hour factor from 0.2 to 0.6. Use of the midpoint values was considered appropriate for this study.

Chronic (Routine) Air Dispersion

In the routine risk assessment, the airborne transport is based on the 9-year average (1983 to 1990) wind data measured at 10 m (33 ft) and 61 m (200 ft) at the Hanford Meteorological Station (HMS) in the 200 Areas. The variation in the chronic atmospheric dispersion coefficient (Chi/Q) was estimated using wind data collected at 10 m (33 ft). The values for joint frequency were computed by GXQ Version 4 (Hey 1993 and 1994).

The locations of the onsite maximum individuals were taken to be 100 m (330 ft) from the release point for ground level releases, and 800 m (2,640 ft) for stack releases. The locations of the site boundary maximum individuals were averages of the distances from the Plutonium Finishing Plant (PFP) and the Plutonium-Uranium Extraction (PUREX) Plant. These distances are shown in Table K.4.4.1.

The maximum normalized time-integrated exposures (Chi/Q) for each year estimated with available data are listed in Table K.4.4.2. The observed variation in the annual Chi/Q at the chosen locations is approximately a factor of 2. Population weighted Chi/Q values are subject to similar variation. The observed variation in population-weighted Chi/Q values is less than a factor of 2 (Table K.4.4.3).

Acute (Accident) Air Dispersion

Bounding Chi/Q values were generated consistent with the methods described in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.145 (NRC 1982). The Chi/Q values were calculated assuming the receptor was located at the peak concentration. Because atmospheric conditions fluctuate, a bounding atmospheric condition was considered to be that which causes a downwind concentration of airborne contaminants that is exceeded for only a small fraction of time due to weather fluctuations. Regulatory Guide 1.145 defines this fraction as 0.5 percent for each sector or 5 percent for the overall site. The site is broken up into 16 sectors, which represent 16 compass directions (e.g., S, SSW, SW, ESE, SE, SSE). Chi/Q values are generated for weather conditions that result in downwind concentrations that are exceeded only 0.5 percent of the time in the maximum sector, or 5 percent of the time for the overall site. These Chi/Q values also are referred to as 99.5 percent maximum sector or 95 percent overall site Chi/Q values. The greater of these is called the bounding Chi/Q value and was used to assess the bounding dose consequences for accident scenarios presented in this EIS (Table K.4.4.4). These bounding Chi/Q values represent minimum dispersing conditions that result in maximum downwind concentrations (i.e., concentrations that are exceeded only a small fraction of the time). These Chi/Qs will result in conservative estimates of potential accident consequences.

Table K.4.4.1 Site Boundary Distance from PFP and PUREX

Table K.4.4.2 Maximum Individual Annual Chi/Q for Selected Receptor Locations

Table K.4.4.3 Maximum Population - Weighted Annual Chi/Q for Selected Receptors Locations

Annual average Chi/Q values also were generated for each sector. The sector with the highest annual average Chi/Q value was selected as presented in Table K.4.4.5. These values were used in conjunction with nominal source terms to calculate nominal dose consequences. The annual average Chi/Q values were calculated assuming the receptor was located at the peak concentration. The dose calculated using the annual average Chi/Q value for a particular sector represented the average dose to an individual located in that sector, accounting for the frequency of time that the wind blew in that direction during the year. This, it accounted for the fact that the receptor in a particular direction would experience no dose if the wind was blowing in a different direction at the time of the accident, and would receive a dose higher or lower than the annual average if the wind was blowing in the direction of the receptor. In summary, the dose based on annual average meteorology represented the average that an individual in a particular sector would receive for all meteorological conditions over the year. The ratio between the bounding and the annual average meteorology is presented in Table K.4.4.6.

Table K.4.4.4 Bounding Meteorology Chi/Q Values Generated for Ground Level Releases from Tank Farms

Table K.4.4.5 Annual Average Meteorology Chi/Q Values Generated for Ground Level Releases from Tank Farms

Table K.4.4.6 Ratio of Bounding and Annual Average Meteorology Chi/Q Values Generated for Ground Level Releases from Tank Farms

K.5.0 UNCERTAINTIES IN HUMAN EXPOSURE ASSESSMENT

In addition to source terms and contaminant transport, exposure assessment contributes to uncertainty in the risk estimates. Some of the contributing parameters are lifestyle, diet, land use patterns, exposure pathways, exposure frequency and duration, and biotransfer/bioaccumulation factors. These uncertainties are discussed in the following sections.

Humans may be exposed to hazardous substances in many ways, which may cause some degree of risk to health. The uncertainty in risk for each receptor increases as the variety of potential exposures increases. The risk analysis in the TWRS EIS includes multiple exposure scenarios that cover a wide spectrum of exposure pathways. Therefore, the likelihood that real future exposures lie outside the range estimated in the EIS is small.

The post-remediation land user scenario describes the long-term risk to an individual and the whole population from restricted to unrestricted use of the land. The Native American and residential farmer receptors use land without any restrictions, and the industrial worker and recreational users use land with some limited restrictions. The health impacts of short-term exposure (routine and accidental) that would occur during remediation add a layer to the analysis that reduces the systematic uncertainties in the risk assessment. Another health impact, exposure to hazardous substances by inadvertent intrusion, characterizes a different exposure category.

The uncertainty in exposure assessment is more fully characterized by incorporating several exposure scenarios and categories. The uncertainties within each of these scenarios and categories are diverse and can be large. There is a need to analyze each scenario and category on an individual basis. The following sections discuss the uncertainty in the risk assessment for post-remediation land use, routine and accidental exposures during remediation, and post-remediation intrusion.

K.5.1 POST-REMEDIATION LAND USER

This section describes the uncertainty analyses for the risks to potential post-remediation land users. Scenarios evaluated under the post-remediation land user scenario include: the Native American, residential farmer, industrial worker, and intruder.

K.5.1.1 Modular Risk Assessment Approach

The method used to assess the post-remediation risk at the Hanford Site was a modular risk assessment (MRA) approach. The MRA approach separates the four basic components of the risk assessment (i.e., source, transport, exposure, and risk) into discrete modules that can be assessed independently and then combined. This process is described by the following equation:

Risk = Source Unit Transport Factor Unit Risk Factor

This section focuses on the results of the uncertainty and sensitivity analysis as they pertain to the unit risk factor (URF). The uncertainty analyses with respect to the source term and the unit transport factors are presented in other sections of this appendix.

The calculation of the URF is simplified by dividing the equation into two terms, one term containing parameters independent of contaminant properties (i.e., summary intake factors) and the other term containing parameters dependent on contaminant-specific properties.

URFs are described in terms of exposure pathways, toxic endpoint (carcinogenic chemical, noncarcinogenic chemical, and radionuclide carcinogen), and exposure parameters (i.e., intake rate, exposure frequency, and exposure duration).

The URF approach involved structuring the intake equations for each receptor and exposure pathway so that contaminant-independent parameters were separated from the contaminant-specific parameters.

The pathway-specific slope factor is a toxicological contaminant-specific parameter that is specified by the regulatory agencies and generally not subjected to an uncertainty analysis, although there is considerable uncertainty associated with this parameter.

The intake term may be further described in terms of the following equation:

Where:

Intake = average daily intake of pollutant
C = concentration of pollutant
PF = pollutant-specific factor for media of concern
SIF = summary intake factor for given scenario

The uncertainties associated with the concentration term and other pollutant-specific factors are discussed in other sections of this appendix. The uncertainty associated with the SIF or intake term is the subject of this section of the report.

The SIF is a scenario-specific term and generally is derived from exposure factors published by the EPA for generating upper-bound (i.e., 95th percentile) point estimates of exposure. The use of these upper-bound estimates in calculating point estimates for human health exposure has been shown to result in "compounding conservatisms," which often has led to risk estimates that are highly unlikely to be experienced by anyone in a population near a site (Burmaster-Harris 1993). Therefore, a knowledge of the uncertainty associated with the SIF and exposure factors used to generate risk estimates is important to place the risk estimates in perspective.

One approach for establishing the uncertainty in the SIF and exposure parameters is to use a Monte Carlo-based approach (PNL 1993). In this approach, the Monte Carlo technique adds several steps to estimate both point values and full distributions for the exposures. These extended techniques make the analyses more informative to risk managers and members of the public by giving some perspective on the uncertainty behind the point estimates.

K.5.1.2 Monte Carlo Uncertainty Analysis

The first step in the Monte Carlo uncertainty analysis was to identify the exposure medium (air, soil, groundwater) and exposure pathway (e.g., ingestion, inhalation, vegetable consumption) driving the risk. The next step involved constructing equations that would both represent the shortcomings identified in EPA methodology and correspond with the site-specific conditions. These preliminary equations were used, along with readily available input ranges, to conduct a sensitivity analysis to determine which inputs should be focused on in characterizing input distributions for use in the Monte Carlo-based approach.

The results of the sensitivity analysis allowed the inputs to be ordered in terms of their impact on the intake term or SIF using the Monte Carlo methodology. The magnitude of the impact that an input had on the intake term or SIF was a function of both the inputs mathematical relationship to the SIF and the range identified for that input. The results of the sensitivity analysis were combined with an assessment of the quality of information available from the literature for characterizing each input. The final result of the sensitivity analysis was a list of those inputs that will receive special focus in characterizing distributions.

The next step in the Monte Carlo methodology was to generate continuous or discrete probability functions (PDFs) for all relevant inputs. In the Monte Carlo approach, each of many input variables can become a random variable with known or estimated PDF. Within this framework, a variable would take on a range of values with known probability. Some distributions, for instance, were based on known human variability and came into play in the analysis because of the uncertainty as to who will be involved in the scenario. Once the exposure models, variables, and constants for the models were defined, the next step was to use a suitable software to make a large number of realizations of the set of random variables in each model. For each realization, the computer drew one random value from the appropriate distribution for each of the random variables in the model and computed a single result. This computation was repeated a large number of times to produce complete distributions of modeled variables. Finally, the distributions were plotted and various statistical summaries of the results were produced to help interpret the data.

The final step in the development and evaluation of the Monte Carlo methodology was the generation of the SIF or intake distribution. The SIF generated using the EPA point estimate methodology then was compared to the distribution generated using the Monte Carlo approach. This comparison was useful in that the relative position of the point estimate on the probability density function provided a perspective as to the conservatism of the point estimate.

The computer software used in this Monte Carlo uncertainty analysis was Crystal Ball software program, which is an add-on to the Microsoft Excel spreadsheet program. The use of Crystal Ball software allows Excel spreadsheets to be incorporated directly into the Monte Carlo approach. The Crystal Ball program allows either Latin Hypercube Sampling or the default conventional sampling method usually used in Monte Carlo simulations. The default method generates random values for each distribution over the entire range defined for that distribution. This approach can accurately reflect the shape of distributions if enough iterations are completed in order to allow values in the more obscure tail regions of distributions to be sampled. The Latin Hypercube method divides distributions into regions of equal probability. Latin Hypercube Sampling was used in this evaluation to quickly stabilize the tail regions of the output distribution. This approach ensured that all regions of a distribution were sampled with equal frequency. Table K.5.1.1 provides a summary of the PDFs used in the Monte Carlo-based uncertainty analysis.

The number of iterations used in the Monte Carlo simulation was based on the work of Thompson (Thompson 1992). In this approach, a simulation is run twice, each time using 10,000 iterations. If the 95th percentiles from the resulting distributions differ by more than 1 percent from each other, the number of runs used in the simulation is increased until the differences between 95th percentile values falls below the arbitrary 1 percent mark. Runs of 10,000 iterations were found to produce stable risk distributions in this analysis.

Sections K.5.1.3 through K.5.1.9 provide the results of the Monte Carlo uncertainty analysis and sensitivity analysis as they pertain to the individual receptor of the specific exposure scenarios analyzed in the EIS. The uncertainties associated with the cumulative risk over 10,000 years for each exposure scenario are discussed in Section K.5.1.1.6.

K.5.1.3 Native American Scenario

The Native American scenario was intended to include a wide range of activities from traditional lifestyle activities (i.e., hunting and fishing) to contemporary lifestyle activities (i.e., irrigated farming). Specific activities include hunting, gathering, collecting, fishing, and processing of the catch along the shoreline, and pasturing of livestock, as well as ceremonial, educational, seasonal, social, and trade activities. A detailed description of the Native American scenario is provided in DOE (DOE 1996).

The focus of this section of the report is to evaluate the uncertainty associated with the SIF as it pertains to exposure pathways specific to the Native American scenario. The SIFs evaluated for the Native American scenario were based on Tribal input because currently there are no standards or data regarding Tribal-specific intake factors. Therefore, the SIFs for the Native American scenario were compared against the ICRP recommendations (e.g., ICRP 1975) or EPA standards (e.g., EPA 1989) for humans. This could result in more uncertainty than for the other scenarios that were based on EPA standards. The exposure pathways that would contribute the greatest risk to a Native American include: groundwater ingestion, meat and fish ingestion, and the inhalation of volatile compounds (i.e., while in a sweat lodge). Please refer to Volume Three, Section D.2.1.3 for a complete discussion of the risk associated with each exposure pathway in the Native American scenario.

Table K.5.1.1 Summary of Probability Density Functions

Uncertainty in the Groundwater Ingestion Summary Intake Factor

The Native American scenario groundwater ingestion SIF was based on exposures over a 70-year duration to an individual residing onsite. The exposed individual was assumed to ingest 3 L (0.8 gal) of water a day 365 days a year (DOE 1996). The groundwater ingestion SIF is expressed by the following equation:

Where:

SIF = Summary intake factor (liters)
IR = Ingestion rate (liters/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)

Substitution of the fixed point estimate for IR, EF, and ED resulted in a groundwater ingestion SIF of 7.67E+04 L (DOE 1996).

The U.S. Army and EPA historically have used 2 L/day (0.5 gal/day) as an average water consumption rate (EPA 1989). However, the scientific literature suggests an average drinking water consumption rate of 1.4 L/day (0.37 gal/day) (EPA 1989). Burmaster has shown that drinking water ingestion rates follow a lognormal distribution with a mean value of 1.12 L/day (0.30 gal/day) and a standard deviation of 1.63 L/day (0.430 gal/day) (Burmaster 1992). For purposes of this uncertainty analysis, the drinking water ingestion rate was approximated by a triangular distribution. The maximum value was assumed to be 3 L/day (0.8 gal/day) (DOE 1996); most likely value 2 L/day (0.5 gal/day) (EPA 1989); and minimum value 1.1 L/day (0.29 gal/day) (Rosenberry-Burmaster 1992).

The exposure duration and exposure frequency parameters for the Native American scenario were assumed to follow distributions similar to those of United States populations. The time spent at a residence followed a lognormal distribution with a mean value of 4.55 years and a standard deviation of 8.68 years (Israeli-Nelson 1992). The exposure frequency for ingestion of drinking water was approximated using a triangular distribution with a maximum of 365 days/year, most probable value of 345 days/year and a minimum of 180 days/year (Smith 1994).

Monte Carlo uncertainty and sensitivity analyses were performed on the groundwater ingestion SIF. The sensitivity analysis indicated that the parameters that contributed the most to the uncertainty in the groundwater ingestion SIF as measured by rank order were exposure duration, ingestion rate, and exposure frequency. The results of the Monte Carlo analysis are summarized in Table K.5.1.2.

Table K.5.1.2 Native American Scenario Groundwater Ingestion SIF Estimates [1]

Table K.5.1.2 contrasts the mean and percentile estimates of the PDF for the groundwater ingestion SIF for the Native American scenario with the value derived using upper-bound fixed point estimates for IR, EF, and ED. The results show that the SIF derived using the upper-bound values lies above the 95th percentile of the SIF PDF. The mean of the SIF probability distribution was one order of magnitude lower than the fixed point estimate. This result suggests that the Native American scenario drinking water SIF derived using default parameters is an upper-bound estimate and may not be representative of the typical intake of a hypothetical future Native American resident.

Uncertainty in the Fish Ingestion Summary Intake Factor

The Native American scenario fish ingestion SIF was based on exposures over a 70-year duration to an individual residing onsite. The exposed individual was assumed to consume 1,080 g/day (2.4 lb/day) of fish for 365 days/year (DOE 1996). The fish ingestion SIF is expressed by the following equation:

Where:

SIF = Summary intake factor (kg)
IR = Ingestion rate (kg/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)

Substitution of the default estimates for IR, EF, and ED resulted in a fixed point estimate for the fish ingestion SIF of 2.76E+04 kg (6.1E+04 lb) (DOE 1996). Consumption rates for recreationally caught fish from large bodies of water have a 50th percentile average of 30 g/day (1 oz/day) and a 90th percentile average of 140 g/day (0.3 lb/day) (EPA 1989). Therefore, for purposes of this scenario, the fish ingestion PDF was approximated by a triangular distribution. The maximum value was assumed to be 1,080 g/day (2.4 lb/day) (DOE 1996); most likely value 140 g/day (0.3 lb/day) (EPA 1989); and minimum value 30 g/day (1 oz/day) (EPA 1989).

The time spent at a residence followed a lognormal distribution with a mean value of 4.55 years and a standard deviation of 8.68 years (Israeli-Nelson 1992). The exposure frequency for ingestion of fish was approximated using a triangular distribution with a maximum of 365 days/year, most probable value of 345 days/year and a minimum of 180 days/year (Smith 1994).

Monte Carlo uncertainty and sensitivity analyses were performed on the fish ingestion SIF. The sensitivity analysis indicated that the parameters that contributed the most to the uncertainty in the fish ingestion SIF as measured by rank order were exposure duration, ingestion rate, and exposure frequency. The results of the Monte Carlo analysis are summarized in Table K.5.1.3.

Table K.5.1.3 Native American Scenario Fish Ingestion SIF Estimates [1]

Table K.5.1.3 contrasts the mean and percentile estimates of the SIF for the fish ingestion PDF for the Native American scenario with the fixed point estimate derived using the upper-bound values. The results show that the SIF derived using the upper-bound values lies above the 95th percentile of the SIF probability distribution. The mean of the SIF probability distribution was one order of magnitude lower than the fixed point estimate. This suggests that the Native American Scenario fish ingestion SIF derived using default parameters is an upper-bound estimate and may not be representative of the typical intake by a Native American resident.

Uncertainty in the Groundwater Volatile Organic Compound Inhalation Summary Intake Factor

The Native American scenario groundwater volatile organic compound (VOC) inhalation SIF was based on exposures over a 70-year duration to an individual residing onsite. The exposed individual was assumed to have an inhalation rate of 15 L/day (4 gal/day) 365 days/year (DOE 1996). The VOC inhalation SIF is expressed by the following equation:

Where:

SIF = Summary intake factor (liters)
IR = Inhalation rate (cubic meters/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
VF = Volatilization factor (liters/cubic meter)

The volatilization factor (VF) was used to approximate the quantity of water in indoor air based on the absolute humidity (Andelman 1990). This factor was used to account for activities such as showering, cooking, and time spent in a sweat lodge. The VF was assumed to be 0.1 for the purposes of this calculation (DOE 1996). The groundwater VOC inhalation SIF fixed point estimate using default parameters was 3.84E+04 L (1.01E+04 gal) (DOE 1996).

Indoor air inhalation rates have been shown to vary depending on the activity level of the exposed individual (Layton 1993). On average, inhalation rates for time spent indoors during showering have been shown to vary from a maximum value of 30 m^3/hr (1,060 ft^3/hr) to an average of 11 m^3/hr (390 ft^3/hr) to a minimum of 2 m^3/hr (71 ft^3/hr) (EPA 1989). For the purposes of this evaluation, a triangular distribution with these limits was used to describe the Native American scenario VOC inhalation SIF.

The exposure duration and exposure frequency parameters for the Native American scenario were assumed to follow distribution similar to those of populations in the rest of the United States. Israeli-Nelson (1992) showed that the time spent at a residence follows a lognormal distribution with a mean value of 4.55 years and a standard deviation of 8.68 years (Israeli-Nelson 1992). The exposure frequency for ingestion of drinking water was approximated using a triangular distribution with a maximum of 365 days/year, most probable value of 345 days/year, and a minimum of 180 days/year (Smith 1994).

Monte Carlo uncertainty and sensitivity analyses were performed on the groundwater VOC inhalation SIF. The sensitivity analysis indicated that the parameters that contributed the most to the uncertainty in the SIF as measured by rank order were exposure duration, inhalation rate, volatilization factor, and exposure frequency. The results of the Monte Carlo analysis are summarized in Table K.5.1.4.

Table K.5.1.4 Native American Scenario VOC Inhalation SIF Estimates [1]

Table K.5.1.4 contrasts the mean and percentile estimates of the PDF for the groundwater VOC inhalation SIF for the Native American scenario with the fixed-point estimate derived by using the upper-bound values. The results indicated that the SIF derived using the upper-bound values lies at approximately the 95th percentile of the SIF probability distribution. Furthermore, the mean of the SIF probability distribution function was approximately one-third the magnitude of fixed-point estimate. This suggests that the groundwater VOC inhalation SIF derived using default parameters is an upper-bound estimate.

K.5.1.4 Residential Farmer Scenario

The residential farmer scenario was based on a 30-year exposure of an individual residing onsite. The individual was assumed to be exposed to contaminated soil, air, surface, and groundwater, and homegrown fruits and vegetables 365 days per year. The evaluation for the residential scenario indicated that the site risk to a resident was driven by the drinking water ingestion exposure pathway. The exposed individual was assumed to ingest 2 L (0.5 gal) of contaminated water per day, 365 days per year for 30 years. The drinking water ingestion SIF may be expressed by the following equation:

Where:

SIF = Summary intake factor (L)
IR = Ingestion rate (L/day)
EF = Exposure frequency (day/year)
ED = Exposure duration (year)

The point estimate for the SIF for ingestion of drinking water was 2.2E+04 L (5.8E+03 gal) (DOE 1995). Drinking water ingestion rates were shown by Burmaster to following a lognormal distribution with a mean value of 1.12 L/day (0.3 gal/day) and a standard deviation of 1.63 L/day (0.43 gal/day) (Rosenberry-Burmaster 1993). Similarly, the time spent at a residence follows a lognormal distribution with a mean value of 4.55 years and a standard deviation of 8.68 years (Israeli-Nelson 1992). The exposure frequency for ingestion of drinking water was approximated using a triangular distribution with a maximum value of 365 days/year, most probable value of 345 days/year and minimum value of 180 days/year (Smith 1994).

A Monte Carlo uncertainty and sensitivity analysis was performed on the SIF for drinking water ingestion. The results of the sensitivity analysis indicated that parameters that most influence the SIF for drinking water ingestion were in rank order: ingestion rate, exposure duration, and exposure frequency. The results of the Monte Carlo-based analysis are summarized in Table K.5.1.5.

Table K.5.1.5 contrasts the PDF percentile estimates of the SIF for groundwater ingestion for the residential farmer scenario with the point estimate derived using the EPA upper-bound values. The results show that the point estimate lies above the 95th percentile of the SIF probability distribution. The mean of the SIF probability distribution was approximately one order of magnitude lower than the EPA point estimate. This result demonstrates that the drinking water SIF derived using EPA default parameters is an upper-bound estimate and may not be representative of the typical intake of any hypothetical future resident.

Table K.5.1.5 Residential Farmer Scenario Drinking Water Ingestion SIF Estimates [1]

K.5.1.5 Industrial Worker Scenario

The industrial exposure scenario was based on worker exposure over a 20-year duration. The scenario involved mainly indoor activities, although outdoor activities (e.g., soil contact) also were included. Latent cancer fatalities (LCFs) for this scenario were shown to result principally from the inhalation of radiological atmospheric emissions. The SIF for the inhalation exposure route may be expressed by the following equation:

Where:

SIF = Summary intake factor (m^3)
IR = Inhalation rate (m^3/day)
ED = Exposure duration (years)
EF = Exposure frequency (days/year)

The SIF using EPA default factors assumed that the air inhalation rate was 20 m^3 per day for a worker and external exposure occurred for 8 hours per day. Inhalation of radionuclides occurs 250 days per year and external exposure would occur 146 days per year. The point estimate SIF for inhalation of radionuclides was 1.0E+05 m^3 (3.5E+06 ft^3) (DOE 1995).

A Monte Carlo uncertainty and sensitivity analysis was conducted using the above algorithm for calculating the industrial worker SIF. The results of the sensitivity analysis indicated that parameters that most influence the industrial worker SIF were in rank order: exposure duration, inhalation rate, and exposure frequency. The results of the Monte Carlo-based analysis are summarized in Table K.5.1.6.

Table K.5.1.6 Industrial Worker Scenario Inhalation SIF Estimates [1]

Table K.5.1.6 contrasts the PDF percentile estimates of the air inhalation SIF distribution for the industrial worker scenario with the point estimate derived using the EPA upper-bound values. The results show that the point estimate is equal to the 95th percentile of the inhalation SIF probability distribution. The 50th percentile of the inhalation SIF probability distribution was one order of magnitude lower than the EPA point-estimate. This result demonstrates that the worker inhalation SIF derived using EPA default parameters is an upper bound estimate and may not be a realistic estimate of the true intake or exposure to an industrial worker at the Hanford Site.

K.5.1.6 Recreational Shoreline User and Recreational Land-User Scenarios

The recreational shoreline user scenario represented exposure to contamination in the Columbia River and shoreline from recreational swimming, boating, and other shoreline activities. The scenario involved mainly outdoor activities and would occur from exposure 14 days/year for 30 years.

The total adverse health impacts to a hypothetical future recreational shoreline user were expressed as the incremental lifetime cancer risk (ILCR) from the present to sometime in the future. The uncertainty associated with the adverse health effects predicted from this scenario can be attributed to the uncertainties in the source concentration, transport modeling, exposure parameters, and toxicological factors used to predict the total ILCR. However, the results of the risk analysis (Volume Three, Table D.5.1.2) indicated that the ILCR would be insignificant (i.e., less than 1E-10) for a period of 10,000 years. The uncertainties in the source concentration, and transport modeling would have to have had a combined uncertainty on the order of 1E+04 to 1E+06 to have a significant effect on the final result. This degree of conservatism is not likely to have been introduced into the final risk calculation.

The total adverse health impacts to a hypothetical future recreational land user scenario were expressed as total cancer incidence from the present to a time 10,000 years in the future. The uncertainties in the exposure factors alone have been shown for other scenarios (i.e., residential farmer) to be a least one order of magnitude too high when compared to the mean of the exposure term. Factoring this uncertainty into the final cancer risk predictions for the future recreational land user would result in mean cancer incidences at least one order of magnitude less than the predicted incidence rate. This conclusion seems justified given the fact that there was considerable uncertainty in the intermittent exposure terms used for this scenario.

K.5.1.7 Intruder Scenario

The potential consequences of intrusion into a Hanford Site solid waste burial ground at some time in the future were estimated by assuming a "post-drilling resident" scenario in which someone has a vegetable garden in the soil resulting from the drilling of a 30-cm (1-ft) diameter well. Furthermore, in order to represent the potential dose from all pathways via irrigation, a combination of farming and garden irrigation was used. In this scenario, a farm over the waste site was assumed to have 1 percent of the plant roots in the waste. One-fourth (25 percent) of the farmers vegetable intake and all (100 percent) of his meat and milk intake were assumed to be locally produced (i.e., contaminated). Furthermore, a well near the waste site was assumed to irrigate the vegetable garden. A more detailed description of the intruder scenario is presented in Volume Three, Section D.7.0. and in Rittman (Rittman 1994).

The results of the dose estimates for the intruder scenario (Rittman 1994) indicated that of the three principal routes of exposure (i.e., external, ingestion, and inhalation) the external would be the principal route of exposure followed by inhalation and ingestion. Thorium-232 (Th-232) was shown to be the radionuclide of concern (see Volume Three, Table D.7.3.1). The point estimate for the intruder scenario dose factor for Th-232 was 1.2E+04 mrem per year per curie exhumed. This point estimate was derived by assuming conservative upper-bound intake parameters. A Monte Carlo uncertainty and sensitivity analysis then was conducted on the algorithm used to calculate the intruder scenario effective dose factor (Rittman 1994). The sensitivity analysis indicated that parameters that contributed the most to the uncertainty in the intruder effective dose were in rank order: soil concentration, external exposure time, soil density, contamination depth, inhalation exposure time, and residential lot surface area. The results of the Monte Carlo analysis are summarized in Table K.5.1.7.

Table K.5.1.7 Intruder Scenario Dose Estimates [1]

Table K.5.1.7 contrasts the PDF percentile estimates of the dose estimates for the intruder scenario with the point estimate derived using the upper-bound values. The point estimate lies at approximately the 100th percentile of the dose probability distribution function. The mean of the intruder dose probability distribution function was approximately an order of magnitude lower than the point estimate. These results demonstrated that the dose estimates predicted for the intruder scenario by using default EPA exposure factors were conservative and could be an unrealistic estimate of the effective dose received by a hypothetical intruder.

Source terms from intrusion were probabilistic. The probability and consequences associated with the intruder scenario would be as follows: the intruder scenario in the TWRS EIS is the same as the intruder scenario in the Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes Final EIS, Sections R.3 and R.5. Both are based on Aaberg and Kennedy (Aaberg-Kennedy 1990). The Disposal of Hanford Defense High-Level, Transuranic, and Tank Wastes Final EIS conducted a comprehensive probability and consequence analysis of radionuclide release and transport after disposal as a result of human intrusion. The results of this study were applied directly to the TWRS EIS intruder scenario uncertainty analysis.

The existing estimated risk to the intruder was based on the consequences only. The basic advantage of a probabilistic approach is that the probabilities of events occurring and the consequences are both taken into account. This gives a broader perspective of the performance assessment than a consequence analysis alone.

The amount of waste exhumed was estimated for each aggregated area. Estimates of annual probabilities for drilling into a tank or capsule are given in Table K.5.1.8. Source terms (initial exhumed inventory) were estimated for each drilling for each alternative (Volume Three, Tables D.7.1.1 to D.7.1.6). The following equation was used for calculating the y^{th} percentile value of the accumulated release of constituent n from waste class w to the land surface due to drilling:

Where:

RQ_n = initial inventory (Ci) of radionuclide n in waste class w
T_{drill} = time of drilling (year) after the year 1995 (100 years)
A_W = surface area of waste class w (km^2)
A_{BH} = surface area of borehole (7.0E-08 km^2)
$I_W(y)$ = the y^{th} percentile value of the number of boreholes in waste class w

The term in the previous equation is the exhumed inventory as presented in Volume Three, Tables D.7.1.1 to D.7.1.6. Therefore, the y^{th} percentile value of the exhumed waste for each radionuclide and each alternative can be calculated as:

$$RQ_n\,[I_W(y)] = I_{exhumed} \cdot I_W(y)$$

The percentile values for each class of waste are presented in Table K.5.1.9. These values were estimated using the Poisson distribution.

Table K.5.1.8 Annual Probabilities of Drilling into the Waste and Waste Surface Area

Table K.5.1.9 Percentile Values of Number of Boreholes in Each Waste Class (in a 10,000-year period)

Secondary sources of uncertainty are the transport and accumulation of radionuclides in the food chain, exposure pathways, and dose conversion factors. The exposure pathway parameters are the most easily quantified of these sources. The expected ranges and selected values for the exposure pathway parameters for drilling and post drilling are shown in Table K.5.1.10.

K.5.1.8 Total Health Impacts for Post-Remediation Land Users

The total adverse health impacts to a hypothetical future land user were expressed as the total calculated cancer fatalities over a 10,000-year period. The cancer fatalities were calculated by first computing the total cancer risk for a given population then dividing by the dose to risk conversion factor for cancer incidence and cancer fatalities (ICRP 1991). As shown in Volume Three, Section D.5.14.1, the total cancer fatalities for a given time span may be computed by the following equation:

Table K.5.1.10 Selected Parameter for Intruder Scenario

Where:

F = Total cancer fatalities (persons)
A = Area corresponding to ILCR (km^2)
P = Population density (persons/km^2)
D = Duration of each generation (years)
T = Time span (thousand years)
ILCR = Incremental cancer risk for a given area
1.2 = Dose to risk conversion factor for cancer incidence and cancer fatalities

The total cancer fatalities for a given time span may be computed as shown in the example problem of Volume Three, Section D.5.14.1. Using the previous equation and the sample problem of Section D.5.14.1, the point estimate for total cancer fatalities (F) may be computed as follows:

The uncertainty associated with the total cancer fatalities to a post-remediation residential farmer may be estimated using the Monte Carlo approach. The previous equation assumed that both population density (P) and duration of each generation (D) were fixed values when in fact there would be considerable uncertainty associated with each of these parameters. The Monte Carlo approach assumed that population density (P) would be a triangular distribution with a maximum value of 5 persons per km^2, most probable value of 3 persons per km^2, and a minimum value of 1 person per km^2. The expected life span of a generation was represented as a lognormal distribution with mean of 75 years and standard deviation of 7.5 years (EPA 1989). The results of the Monte Carlo analysis are summarized in Table K.5.1.11.

Table K.5.1.11 Post-Remediation Land Users Fatality Estimates [1]

Table K.5.1.11 contrasts the percentile estimates of the post-remediation land users fatality estimates with the point estimate value derived using the EPA upper-bound values. The total fatalities derived using the upper-bound values were greater than the 95th percentile of the fatality probability distribution. The mean of the fatality probability distribution was approximately 56 percent of the point estimate.

A note of qualification is appropriate with regard to the long-term, post-remediation collective doses and risks presented in the EIS. The National Council on Radiation Protection (NCRP) (NCRP 1995) cautions that the application of the concept of collective dose as a means of estimating prospective risks to populations from potential radiation exposures is subject to practical limitations. A calculated collective dose may contain such large inherent uncertainties that it would be a poor indicator of risk and therefore should not be considered as a basis for decision. The NCRP notes that neither population size and characteristics nor environmental exposure pathways for most radioactive elements are predictable with any degree of confidence for more than a few generations into the future (NCRP 1995). The NCRP also cautions that the summation of trivial average risks over very large populations or time periods into a single value may produce a distorted image of risk that is completely out of perspective with risks accepted every day, both voluntarily and involuntarily. In many instances, the collective dose increases with increasing size of the exposed population, but the benefits and risks to individuals remain nearly constant. Population exposure pathways and other assumptions have been projected for this EIS out of 10,000 years using the best available data and considered judgment but clearly are subject to the considerable uncertainty suggested by the NCRP. Therefore, the collective dose projections presented in the EIS should not be considered an exact measure of the true (absolute) quantity of dose or risk for any alternative. However, they are useful for comparison of the relative risk of the alternatives because the parameters that contribute large uncertainties are constant across the alternatives.

Finally, the NCRP suggests that whenever the collective dose is smaller than the reciprocal of the relevant risk coefficient, the risk assessment should note that the most likely number of consequences (e.g., cancer deaths) is zero. For example, the most likely ILCR for a cumulative population dose of 1,000 person-rem would be zero because the reciprocal of the relevant risk factor of 5E-04 (i.e.,1/5E-04 = 2,000).

K.5.1.9 Total Health Impacts Along the Columbia River

This scenario was used to estimate the dose to a population of people exposed to contamination from the Columbia River. The contamination would enter the Columbia River as a result of groundwater flow into the river. Different contaminants would enter the groundwater and reach the Columbia River at varying times in the future. Transport of contaminants through the groundwater is described in detail in Volume Four, Appendix F.

Total cancer fatalities were calculated using factors that relate the number of fatal cancers to the curies of each contaminant released to the river. These factors were calculated using a computer program that estimated the time integral of collective dose over a period of up to 10,000 years for time variant radionuclide release to surface waters, such as rivers (DOE 1987). The results of the dose estimates for the Columbia River scenario indicated that of the three principal routes of exposure (i.e., external, ingestion, and inhalation), ingestion would be the principal route, followed by inhalation and external exposure. The Np-237 was shown to be the radionuclide of concern to hypothetical receptors along the Columbia River (Rittman 1994). The point estimate for the Columbia River scenario dose equivalent factor for Np-237 is 1.0E+04 person-rem. A Monte Carlo uncertainty and sensitivity analysis was conducted on the algorithm used to estimate the dose for the Columbia River scenario. The sensitivity analysis indicated that parameters that most influenced the equivalent dose were in order: root uptake factor, root ingestion rate, Columbia River flow rate, total population exposed, months per year of irrigation, and soil area density. The results of the Monte Carlo analysis are summarized in Table K.5.1.12.

Table K.5.1.12 contrasts the percentile estimates of the dose estimates for a hypothetical Columbia River receptor with the point estimate derived using the upper-bound values. The point estimate lies at approximately the 100th percentile of the probability distribution function. The mean of the Columbia River probability distribution was approximately one order of magnitude less than that of the point estimate. Again, these results suggested that the dose estimates predicted for the Columbia River scenario were upper-bound estimates. The typical dose to a receptor could be an order of magnitude less than that predicted by the fixed-point estimate.

Table K.5.1.12 Columbia River Scenario Dose Estimates [1]

K.5.2 REMEDIATION ROUTINE EXPOSURE

The range of possible unit dose factors for offsite receptors would primarily depend on individual consumption rates and environmental transport factors such as the soil-to-plant concentration ratio. Age-dependent variations were considered to have less effect because the generally higher internal dose factors for the lower age groups (ICRP 1975) were offset by the lower breathing and food consumption rates. Thus, age dependence was not expected to be as important as the factors mentioned.

To analyze the bounding range for the individual consumption rates, the standard maximum individual in GENII was considered to have the highest likely consumption rate. The lower end was taken to be the consumption rates used in recent low-level waste performance assessments at the Hanford Site (Kincaid et al. 1995; Wood et al. 1995). These were 25 percent of the average annual dietary intakes of garden produce and 50 percent of the average annual dietary intakes of meat, poultry, milk, and eggs. In the calculation of population dose, this variation disappeared in the population average consumption rates. Thus, for estimating the range of possible population unit dose factors, the only contributor was assumed to be the variation in agricultural transfer factors.

To analyze the bounding range for the various agricultural transfer factors, the values found in NUREG/CR-5512 (Kennedy-Strenge 1992) were used with scale factors. For the soil-to-plant concentration ratios, the scale factors were selected to be 0.1 and 10 to accommodate the large variation in the published values. The variation of the equilibrium transfer factors into animal products was taken to be 0.3 and 3, because there is more consistency in the reported values. To account for the smaller variation over population averages, these variations were reduced by a factor of 2. The food consumption rates (kg/year) from EPA and GENII are listed in Table K.5.2.1.

Scenario dose factors were computed using GENII Version 1.485 (Napier et al. 1988) with two exposure scenarios. The first was the air pathway chronic dose for the MEI at the site boundary. The normalized integrated exposure (Chi/Q) was set equal to 1 and unit activities of each nuclide of interest were used. The second exposure scenario was for the total population, again with a unit Chi/Q. The dose results are shown in Table K.5.2.2.

Table K.5.2.1 Food Consumption Rates (kg/year) for 25 Percent of EPA and for GENII

Table K.5.2.2 Dose Factor for the Offsite MEI and Population Using Best Estimates

Table K.5.2.2 compares the effect of changing food transfer factors from those currently in GENII to those in NUREG/CR-5512. The most significant change occurs for Tc-99, which would contribute little to the overall air pathway dose. Thus, for the TWRS comparisons, the two sets of food transfer factors can be considered the same.

Table K.5.2.3 shows the dose factors that resulted when the low consumption rates were combined with the low transfer factors, as well as when the high consumption rates were combined with the high transfer factors. The unit release dose factors for the offsite maximally-exposed individual (MEI) differed only in these two assumptions. The exposure times, average breathing rate, and other agricultural parameters were held constant.

Using the dose factors listed in Tables K.5.2.2 and K.5.2.3, the estimated dose factor range were reduced to a ratio of the low or high value divided by the expected value using the NUREG/CR-5512 transfer factors. These ratios are shown in Table K.5.2.4.

Table K.5.2.3 Dose Factors for the Offsite MEI and Population Using Adjusted Food Transfer Factors from NUREG/CR-5512

Table K.5.2.4 Ratios of Bounding [1] and Expected [2] Dose Factor

The above ratios could not be used to determine the bounding range of doses for mixtures of nuclides unless one nuclide gives nearly all the dose. For other cases, the doses must be computed for the mixture and then the bounding ratios can be calculated from the total dose. An example is given in Table K.5.2.5. From this table, the MEI dose factor ranged from 0.1 to 2.3 times the reported dose, while the offsite population dose ranged from 0.7 to 1.3 times the reported dose. These ratios were calculated by dividing the low or high dose value for each receptor by the best dose estimate.

These results show small uncertainties in the estimated dose calculations. The overall uncertainties associated with airborne transport, accumulation of constituents in food products, and dose conversion factors were not as significant as the source and release terms.

Table K.5.2.5 Comparison of Routine Dose Calculation for Mixtures of Nuclides

K.5.3 REMEDIATION ACCIDENTAL EXPOSURE

Radiological exposure to the receptor groups was based on the radiological activity concentrations in the source term. Activity concentrations for six composite inventories were used as the radiological source terms in the tank farms accident analyses. The bounding composite inventory bounds 100 percent of all the tank characterization sample data. The nominal inventory was a total tank farm average by volume based on the inventory of radioactive materials contained in the fuel from the single-pass reactors and N Reactor and transferred to the tank farms. GENII was used to generate a single unit liter dose (ULD) value for each composite source term. The bounding ULDs for the six composite inventories and the nominal ULD used in the accident analyses are presented in Table K.5.3.1. The greatest difference between bounding and nominal is the Aging Waste Facility (AWF) solids inventory with a ratio of 6.00E+02.

Table K.5.3.1 Accident Source Term Unit Liter Dose Values for Bounding and Nominal Scenarios

In Volume Four, Section E.15, analysis is presented regarding uncertainties associated with the accident analysis for the tank waste alternatives. For the operation accidents, uncertainties were associated with the inventory of waste in the tanks and the atmospheric conditions that would transport the waste released as a result of an accident. The tank waste inventory used in this EIS is presented in Volume Two, Appendix A along with uncertainties associated with the quality of the data. Because of this uncertainty, for tank farm accidents, a composite inventory was developed. This composite incorporated estimates of the historical tank contents, the results from prior individual tank analyses, and the results of recent tank characterization programs (Shire et al. 1995). This composite provided a bounding tank waste inventory for the accident analysis.

Atmospheric conditions would influence the dispersion of contaminants in air to potential receptors. The bounding case analyzed in the EIS used conservative atmospheric conditions (99.5th percentile). The uncertainty analysis compared the results of these bounding case conditions to typical atmospheric conditions (50th percentile).

There also were uncertainties associated with the analysis of consequences of an accident involving the transportation of vitrified HLW to the potential geologic repository under certain tank waste alternatives. The potential consequences would be influenced by the weight percent of HLW that would be mixed in the glass. The baseline analysis in the EIS assumed a 20 percent waste loading. However, waste loading could be as low as 15 percent or as high as 40 percent. Uncertainties associated with waste loading are discussed further in Volume Two, Section B.8. To address this uncertainty in Volume Four, Section E.15, the impacts of a transportation accident involving the baseline waste loading were compared to an accident involving vitrified glass with a 15 percent waste loading and with a 40 percent waste loading. In addition to the uncertainties associated with the accident analysis, a number of important assumptions influenced the results. These assumptions include the following:

- The offsite general public population for operation accidents was based on 1990 census data. While it is unlikely that the population would be constant throughout the operation phase of each alternative, the 1990 census provided a uniform basis for comparison of impacts among the alternatives.
- The onsite worker population for operation accidents was based on the 1995 Hanford Site work force. In the future, the Site work force would likely decline, resulting in proportionately lower impacts than presented in the EIS. However, use of the existing worker population provided a bounding analysis in terms of total impacts and provided a basis for uniform comparison of impacts among the alternatives.
- For transportation of HLW to a potential geologic repository, the accident scenarios were based on transportation of the waste from the Hanford Site to Yucca Mountain, Nevada by rail.
- For nonradiological occupational construction, operation, and transportation accidents, it was assumed that injuries, illnesses, and fatalities would occur at rates similar to historical rates for each activity.
- It was assumed that there would be no evacuation of Hanford Site personnel in the event of an accident. Emergency planning and evacuation programs are in place at the Hanford Site to mitigate potential consequences resulting from an accident.

The uncertainties in calculating the radiological doses and the toxicological exposures resulting from operation accidents included the tank inventory concentration and the atmospheric dispersion once the source term is in the air. A sample accident scenario is presented in Table K.5.3.2 to illustrate these uncertainties. The illustration shows the difference between the bounding and nominal parameters; the concentration of the inventory was a factor of 30; and the atmospheric dispersion coefficient was a factor of 12 for the MEI noninvolved worker, 30 for the noninvolved worker population, 22 for the MEI general public, and 15 for the general public population. For the noninvolved worker population, a bounding dose of 2.52E+03 person-rem was estimated. This was 3 orders of magnitude higher than the estimated nominal dose of 2.89E+00 person-rem.

Table K.5.3.2 Table K.5.3.2 Uncertainty Evaluation for Mispositioned Jumper - Common to All Tank Alternatives

The main uncertainty associated with estimating the radiological doses resulting from accidents while transporting vitrified HLW to a potential geologic repository was the weight percent of the waste that could be mixed with the glass matrix. A sample accident scenario is presented in Table K.5.3.3 to illustrate these uncertainties. The baseline analysis used in the EIS assumed a 20 percent loading. A range from 15 to 40 weight percent was used in the uncertainty evaluation in Table K.5.3.3. The population dose was calculated by RADTRAN 4 (Neuhauser-Kanipe 1992) and was based on the worst credible accident parameters in the urban population zone.

Table K.5.3.3 Uncertainty Evaluation for HLW Glass Transport Accident - Ex Situ Intermediate Separations

Alternative

The accident initiator frequencies were established using currently accepted sources such as natural phenomena statistics for the Hanford Site or recent analysis of the initiators from safety assessment reports. The frequencies of these accidents were presented as estimates and were provided as an aid in screening accident scenarios. Only 10-fold differences in frequencies would be significant. For example, accident frequencies of 1E-6 and 5E-05 should not be considered significantly different.

The nonradiological injuries and fatalities resulting from construction and operation accidents were based on incidence rates in the occupational injuries summary report (DOE 1994j). The transportation injuries and fatalities from trucks and trains were based on incidence rates in statistics compiled by the U.S. Department of Transportation (Rao et al. 1982). Injuries and fatalities resulting from employee vehicle accidents were based on incidence rates in the Washington State Highway Accident Report (WSDT 1993). Because these are widely accepted, statistically based incidence rates, there was no attempt to evaluate the uncertainties.

K.6.0 UNCERTAINTY IN HUMAN HEALTH RISK

Human health risk assessment results are conditional estimates that depend on the assumptions made to account for uncertainties in biological processes or a lack of information on source data, transport, or receptor behavior. It is important to recognize these uncertainties to place the risk estimates in proper perspective. The uncertainties associated with the TWRS EIS risk estimates include parameters involved in the models used and historical data on worker risks and accidents. Volume Three, Appendix D presents some parameter uncertainties associated with remediation risk (Section D.4.14), anticipated post-remediation risk (Section D.5.14), ecological risk (Section D.6.5), and intruder risk (Section D.7.5), which are briefly discussed as follows.

To estimate risk, information must be available on dose-response relationships, which define the biological response from exposure to a contaminant. Although human epidemiological data are used for developing radiological and nonradiological chemical dose-response models, this information also is developed in laboratory tests using animals exposed to relatively high doses. Therefore, uncertainty is inherent in dose-response relationships, including extrapolating from effects in animals at high doses to potential effects in humans that most often are exposed at much lower doses.

Another important component of risk assessment is estimating exposure concentrations. Uncertainties associated with this component include estimating releases of contaminants from emission sources to different environmental media such as groundwater, soil, air, and surface water, the transport and transformation of contaminants in these media, and the pathway, frequency, and duration by which humans contact the contaminants.

The risk associated with the release of radionuclides or chemicals to ambient environmental media during routine operations was estimated using models. The risk estimates determined by these models have a greater uncertainty than those based on historical data. However, it is reasonable to assume that releases would occur on a routine basis over the operational lifetime of the facility. The risk estimates for post-remediation and intruder scenarios are associated with more uncertainty than facility routine operation risk and involve uncertainties associated with the hypothetical land use and intrusion in addition to modeling. Finally, the MEI risk estimates generally involve a greater level of uncertainty than population risk estimates.

K.6.1 POST-REMEDIATION LAND-USER RISK

The uncertainty analyses for post-remediation risk assessment were based on the Hanford Site Risk Assessment Methodology (HSRAM) uncertainty analysis. The carcinogenic and noncarcinogenic risks presented in the post-remediation risk evaluation were estimates based on multiple assumptions about exposures, toxicity, and other variables. Therefore, discussion of uncertainty was provided for this risk assessment. The uncertainties are inherent (e.g., toxicity values, default exposure parameters) or specific (e.g., data evaluation, contaminant identification) in the risk assessment process. Specific considerations in evaluating uncertainty were Site-specific factors, exposure assessment factors, toxicity assessment factors, and risk characterization factors, which are discussed as follows.

K.6.1.1 Site-Specific Uncertainty Factors

Uncertainty related to the source inventory, Site contamination, availability of information on Site-specific environmental conditions (e.g., climate, geology, and hydrogeology), and uncertainties in model application to the Site were important in assessment of risk associated with the Site. These uncertainties are addressed in Appendices A, B, and F.

K.6.1.2 Exposure Assessment Uncertainty Factors

Exposure assessment requires multiple assumptions that can affect the outcome of a risk assessment. Key factors contributing to uncertainty in the exposure assessment included the following:

- Identification of land use;
- Likelihood of future land use actually occurring;
- Model assumptions that affect exposure point concentrations;
- Use of standard default parameters (e.g., upper 95th percentile values for intake/contact rates, exposure frequency, and exposure duration);
- Uncertainty related to biotransfer factors;
- Uncertainty related to production and distribution of food; and
- Uncertainty related to lifestyle and diet of specific or referenced individuals.

K.6.1.3 Toxicity Assessment Uncertainty Factors

A high degree of uncertainty was associated with data used to derive toxicity values and resulted in less confidence in assessment of risk associated with exposure to a substance. Sources of uncertainty associated with published toxicity values include:

- Use of dose-response information from effects observed at high doses to predict effects at the low levels expected in the environment;
- Use of data from short-term exposure studies to extrapolate to long-term exposure or vice-versa;
- Use of data from animal studies to predict human effects; and
- Use of data from homogenous animal populations or healthy human populations to predict effects in the general population.

K.6.1.4 Risk Characterization Uncertainty Factors

The summation of cancer risk across pathways or for multiple pathways would result in more conservative risks. This is because the slope factor for each chemical carcinogen is an upper 95th percentile estimate and such probability distributions are not strictly additive. The risk values calculated for the post-remediation scenario in the TWRS EIS were a conservative bounding estimate. The uncertainty in the risk values for certain receptors would increase as the time in the future increased. Less uncertainty would be associated with the risk values at 300 years than the risk estimates at 500, 2,500, 5,000, and 10,000 years.

The best approach to more fully characterize the uncertainty would be to conduct a probabilistic risk assessment from the start of the evaluation. A probabilistic assessment uses the range of variation in contaminant information, exposure parameters, and toxicity data to provide a risk distribution curve. This appendix examines the effect of variations on these parameters on the risk estimates to provide a better understanding of the uncertainties.

K.6.2 POST-REMEDIATION INTRUDER RISK

The greatest uncertainty in calculating the intruder risk was associated with the source data. Source terms were based on the estimated inventory and an average tank within the eight aggregated tank farms of the 200 Areas. Additional information regarding the source term would decrease the uncertainty in the risk estimate.

The relative uncertainty associated with the dose conversion factor was not as important as the source data, source terms, and exposure pathway parameters. The GENII computer code was used for the intruder dose calculation. GENII used the dosimetry model recommended by the International Commission on Radiation Protection (ICRP), in ICRP Publication 26 (ICRP 1977) and ICRP Publication 30 (ICRP 1979-1982), with updates from ICRP Publication 48 (ICRP 1986). The dose conversion factors used were equivalent to those currently recommended by the (DOE 1988). External dose factors were equivalent to Kocher (Kocher 1981; ORNL 1981). The overall uncertainty associated with risk in respect to GENII is discussed in Volume Three, Section D.4.14.

K.6.3 REMEDIATION ROUTINE RISK

By far the greatest uncertainty in the routine remediation risk was associated with the source data, which were based on the estimated inventory and source terms (i.e., the amount of chemicals and radionuclides released into the environment). The uncertainties associated with the source and source terms are discussed in Volume Two, Appendices A and B. Other contributors to the routine risk uncertainty were the airborne transport of the released chemicals and radionuclides, accumulation of contaminants in food products, production and distribution of food products, and lifestyle and diet of specific individuals, food consumption rates, and dose conversion factors which are discussed in this section.

Routine chemical emissions from the tank farm during remediation were based on existing tank farm emissions data (Jacobs 1996). Operational emissions from the tank farm, such as would occur while retrieving waste from tanks and gravel-filling the tanks, were appropriately scaled for potential increased emission rates during remediation.

The hazard index (HI) approach conservatively assumed that the noncarcinogenic health effects were additive for all chemicals (i.e., all chemicals would have the same mechanism of action and affect the same target organ). The HI is the sum of the hazard quotients (estimated intake/reference dose) for all chemicals. A HI greater than or equal to 1.0 indicates potential adverse health effects in the population of concern. Conversely, a HI less than 1.0 suggests that adverse health effects would be unlikely.

Carcinogenic risks were assumed to be additive. Consequently, the total ILCR is the sum of individual chemical cancer risks from each emission source for each alternative analyzed. Regulatory agencies have defined an acceptable level of risk to be between 1 in 10,000 (1.0E-04) and 1 in 1,000,000 (1.0E-06), with 1.0E-06 being the point of departure and referred to as de minimis (below which there is minimal concern) risk. For the purpose of this EIS, a risk below 1.0E-06 was considered low, and a risk greater than 1.0E-04 was considered high.

K.6.4 REMEDIATION ACCIDENT RISK

The objective of this section is to summarize the results of the Monte Carlo uncertainty and sensitivity analyses of the LCF predictions associated with the potential accidental release of contaminants from each TWRS EIS remedial alternative.

A detailed description of the general methodology used in the Monte Carlo approach is presented in Section K.5.0. The methodology used to estimate the uncertainty in the LCF predictions was similar to that used to predict the uncertainty in the human health exposure factors (see Section K.5.0). In this approach, the variables used to predict the LCF were separated into variables which can be described as PDFs and those having constant or fixed point estimates. A computer simulation was then run in order to produce a PDF for LCF. The results of the computer simulation were then compared to the results of the fixed point estimate. The equation used to predict LCF from an accidental release is:

Where:

LCF = latent cancer fatality
Chi/Q = atmospheric dispersion coefficient (second/m^3)
V = release volume (rem/liter)
IR = inhalation rate (m^3/second)
ULD = unit liter dose (committed effective dose equivalent/liter)
C = conversion factor (LCFs/rem)

The Monte Carlo analysis described each of the variables in the above equation (i.e., Chi/Q, V, IR, ULD and C) as PDFs and not as a single value.

K.6.4.1 Accident Release Scenarios

This uncertainty analysis evaluated the consequences to four receptors as a result of the spray release accident scenario presented in Volume Four, Appendix E:

- MEI noninvolved worker;
- Noninvolved worker population;
- MEI general population; and
- General public population.

The radiological dose to a receptor would depend on the receptors location relative to the point of release of the radioactive material. Doses for a MEI and population dose were computed for each receptor (noninvolved worker and general public). Noninvolved workers would be onsite workers not involved in the proposed action. The general public would be people located off the Hanford Site. The MEI for each of these receptor categories would be a single individual assumed to receive the highest exposure in the category. Volume Four, Appendix E of this report contains a more detailed description of the receptors associated with each accidental release scenario.

K.6.4.2 Monte Carlo Uncertainty Analysis

The PDFs for the variables in the equation used to calculate LCF were assumed to be triangular distributions (Finley et al. 1994). Triangular distributions can be viewed as conservative characterizations of truncated normal or lognormal distributions. The triangular distribution was conservative in that it resulted in more frequent selection of values in the extremes of the factor's distribution.

The inhalation rate triangular PDF was assumed to have a minimum value of 6.9E-05 m^3/s (6 m^3/day), mean value of 2.1E-04 m^3/s (18.9 m^3/day), and maximum value of 3.7E-04 m^3/s (32 m^3/day) based on worker ventilation rates under light activity levels (EPA 1985).

The remaining variables in the equation for calculating LCF were also assumed to have a triangular PDF. The values were chosen to correspond to conditions associated with a nominal accidental release value as well as an upper bounding value for accidental release. A more detailed description of the accidental release scenarios and the rationale for the selection of the nominal and bounding values is presented in Section K.6.5.

A Monte Carlo analysis was conducted based on the above algorithm for calculating the LCF. The sensitivity analysis indicated that the parameters which contributed the most to the uncertainty in the LCF were as measured by rank correlation: the unit limit dose, the atmospheric dispersion coefficient, the release volume, the inhalation rate, and the conversion factor. The detailed results of the Monte Carlo analysis are presented in Attachment 1 and are summarized in Table K.6.4.1.

Table K.6.4.1 contrasts the mean and percentile estimates of the LCF distributions for the four accidental release scenarios with the fixed point estimate derived using the upper-bound values. The results show that the LCF derived using the upper-bound values is in all cases greater than the 100th percentile of the LCF PDF. The mean of the LCF PDF was approximately one order of magnitude less than the upper-bound fixed point estimate. These results demonstrate that the predicted LCF estimates would be upper bound estimates of cancer probability and/or fatality rates. The true probability of contracting cancer or fatalities as a result of cancer could actually be much less than the predicted value.

K.6.5 ANALYSIS OF NOMINAL VERSUS BOUNDING RISK ESTIMATES

The bounding risk estimates in the TWRS EIS used a series of conservative assumptions about source and release terms, environmental transport parameters, and the effects of a given exposure on cancer risk and noncancer health effects to account for the uncertainties involved in the alternatives. This section analyses the effect of using less conservative values for several of the source term, release term, and environmental transport assumptions on the risk estimates. No change was made in the SIFs used to estimate the risk from each exposure.

Based upon available data, the assumption for the distribution coefficient (K_d) for Np-237, a major contributor to the groundwater risks, was changed from zero, which implies that Np would move at the same rate as water, to 1.0, which implies that interaction with the soil would slow its movement to and through the aquifer. For the ex situ alternatives, assumptions about tank residuals were changed, as described in the following sections.

Table K.6.4.1 Comparison of Monte Carlo-Based and Fixed Point Estimates

K.6.5.1 Tank Residuals Nominal Case

A nominal case retrieval release and residual tank inventory was developed to assess the impacts that would result from nominal assumptions for tank releases during retrieval and the residual waste left in the tanks following retrieval. Details are presented in Volume Two, Appendix B. The nominal release inventory was developed by assuming that the waste would be diluted by one-third by adding liquids for sluicing during retrieval. Possible dilution ratios that would be used during waste retrieval ranged from 3:1 to 10:1. Thus, the dilution factor of one-third assumed for the nominal case was a conservative assumption. These dilution ratios represent the amount of liquid required to mobilize the waste solids and would be made of existing tank liquids and water additions. The nominal case retrieval release volume was assumed to be 15,000 L (4,000 gal) from each SST, and the contaminant concentrations were assumed to be two-thirds of the bounding case. The average volume of waste released from each SST during retrieval was not reduced for the nominal case, because insufficient information was available to support a lower average release volume. The volume released would depend on the ability to detect a leak and take corrective action.

The nominal tank residual inventory was developed by modifying the bounding tank residual inventory to reduce the mobile constituents of concern based on solubility. The mobile constituents of concern were evaluated because of their contribution to post-remediation risk. The isotopes C-14, Tc-99, and I-129 were reduced to the nominal case residual inventory to 10 percent of the bounding residual inventory. This was based on the assumption that 90 percent of the residual inventory of these isotopes would be soluble in the retrieval liquids and would be retrieved from the tanks for ex situ treatment. Typical sludge wash factors, representing the water solubility of these isotopes, were as high as 99 percent. The nominal case residual was limited to 90 percent to account for conditions in which the scale and hardened sludges would not see the sluicing liquid during retrieval. Table K.6.5.1 shows the nominal and bounding residual inventories for select mobile constituents.

Table K.6.5.1 Tank Residual Inventory, Curies

K.6.5.2 Nominal vs. Bounding Risk Results

The ILCR and HI results for the nominal and bounding cases are presented in Volume One, Table 5.11.7. The overall effect of the changes in the nominal case was to reduce the estimated risks. The size of the effect would vary with the exposure scenario, the alternative, and the future time examined (Volume One, Table 5.11.7). For some scenarios, for some points in time, the nominal case risks were higher than those for the bounding case. For example, the No Action alternative showed higher risks for the nominal than the bounding case for all scenarios at 2,500 years. This occurred because one of the key assumptions, decreasing the mobility of Np-237, caused the exposure to Np in groundwater to be delayed, but did not change its ultimate impact on the risk. In the bounding case, the risk from Np occurred early, because the Np was assumed to move quickly, and then decreased as the Np was removed by attenuation and ultimate loss to the Columbia River. Thus, relaxing a conservative assumption about contaminant mobility could have more effect on the timing than on the degree of risk. Nonetheless, Volume One, Table 5.11.8 demonstrates that the total cancer incidence over the 10,000-year period of interest is decreased in the nominal case.

K.7.0 NOMINAL CASE ANALYSIS FOR EX SITU INTERMEDIATE SEPARATION ALTERNATIVE

This section describes the results of the nominal case risk analysis for the Ex Situ Intermediate Separation alternative. The primary changes in the nominal, compared to the bounding case, were that the distribution coefficient (K_d) for Np-237, a major contributor to the groundwater risk, was assumed to be 1.0 rather than zero, which slows its movement through interaction with the soils. In addition, the residual inventory of isotopes C-14, Tc-99, and I-129 were reduced to 10 percent of the bounding residual inventory. These changes are described in more detail in Section K.6.5. The inventory of contaminants assumed to be released during retrieval for the nominal case analysis is presented in Tables K.7.0.1 and K.7.0.2. Differences from the bounding case are shown in bold.

Table K.7.0.1 Nominal Case Inventory of Contaminants Released During Retrieval for the Ex Situ Intermediate Separations Alternative

Table K.7.0.2 Inventory of Contaminants for the Low-Activity Waste Vaults Ex Situ Intermediate Separations Alternative

Atmospheric releases during remediation may be chronic or acute. A nominal case was analyzed only for the acute (accident) case, because risks for the chronic bounding case were already very low.

K.7.1 EX SITU INTERMEDIATE SEPARATIONS ALTERNATIVE EXPOSURE ASSESSMENT

Uncertainties in the Ex Situ Intermediate Separations alternative human health exposure assessment can be divided into two parts. The first part discusses the uncertainties associated with the exposure parameters used in the post remediation land use scenarios. The second part discusses the uncertainties associated with the accidental release scenarios. In both cases, a Monte Carlo approach was used to evaluate both the uncertainty in the exposure assessment and to establish the parameters which contribute the most to the uncertainty in the exposure assessment (i.e., sensitivity analysis).

In the Monte Carlo analysis, PDFs were used to represent the range of values of a given parameter. The Crystal Ball computer software was then used to simulate a large number of realizations of the set of random variables in each model. This computation was repeated a large number of times to produce complete PDFs of the output function. Statistical summaries of the results were then plotted to interpret the data.

K.7.2 POST-REMEDIATION LAND-USE SCENARIOS

The results of the uncertainty analysis of exposure parameters for the post-remediation land-use scenarios in the Ex Situ Intermediate Separations alternative are summarized in Table K.7.2.1. The mean or nominal value of the Monte Carlo result was computed and compared to the bounding or fixed-point estimate of the same function. The nominal (Monte Carlo) results were generally approximately one order of magnitude less than the bounding estimates. This result supports the statement that the bounding value used in the exposure assessment in the EIS is an upper bound estimate.

The ILCR for the nominal and bounding estimates are provided in Table K.7.2.2. These risk estimates reflected the changes in the source and transport assumptions only. They do not incorporate the Monte Carlo estimates of variation in exposure parameters. The changes in source and transport assumptions for the nominal case decreased the ILCR by one to two orders of magnitude for most of the exposure scenario - future time combinations considered (Table K.7.2.2). These risk probability differences decreased the total accumulative cancer risk incidence by approximately an order of magnitude over the 10,000-year period of analysis. Although using less conservative assumptions for the bounding case altered the distribution of the risk through time for some alternatives, especially No Action (see Section K.6.5); for Ex Situ Intermediate Separation, the two cases followed the same general pattern, with the nominal case covering a smaller area, consistent with its lower accumulative risk (Figure K.7.2.1). The spatial pattern of risk onsite was generally similar in the two cases, as illustrated for the residential farmer scenario in Figures K.7.2.2, K.7.2.3, and K.7.2.4. At 2,500 years, the nominal case risk would be confined to the 200 East Area (Figure K.7.2.2), but at 5,000 and 10,000 years, the spatial distributions of the bounding and nominal cases were similar. The bounding case risk at 5,000 years had a higher risk area between 200 West and 200 East Areas, and occupied more area to the north and west (Figure K.7.2.3), but at 10,000 years, the areas for the two cases were essentially identical (Figure K.7.2.4).

K.7.3 ACCIDENTAL RELEASE SCENARIOS

A Monte Carlo uncertainty and sensitivity analysis was also conducted on the parameters used to compute LCFs or the probability of contracting cancer as a result of an accidental air releases associated with the remedial actions. The sensitivity analysis indicated that the parameters which contribute the most to the uncertainty in the LCF for the accidental release scenarios were, as measured by rank correlation: the ULD, the atmospheric dispersion coefficient (Chi/Q), the release volume, the inhalation rate, and the LCF conversion factor. Table K.7.2.1 compares the mean value of the LCF distributions for the four accidental release scenarios with the bounding estimate derived using upper-bound exposure factors. The results indicated that the LCFs predicted using the upper-bound values were in all cases one to two orders of magnitude greater than the mean of the Monte Carlo result. These results demonstrated that the predicted LCF estimates were upper bound estimates of cancer probability and/or fatality rates. The true probability of contracting cancer or fatalities resulting from cancer could actually be much less than the predicted value.

Figure K.7.2.1 Bounding and Nominal Case for the Ex Situ Intermediate Separations Alternative Post Remediation Risk to the Residential Farmer

Figure K.7.2.2 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals and LAW Vaults at 2,500 Years from Present

Figure K.7.2.3 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals and LAW Vaults at 5,000 Years from Present

Figure K.7.2.4 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals and LAW Vaults at 10,000 Years from Present

Table K.7.2.1 Summary of the Bounding and Nominal Exposure Parameters of Ex Situ Intermediate Separations Alternative

Table K.7.2.2 Bounding and Nominal Point Maximum and Total Accumulative Incremental Lifetime Cancer Incident for Ex Situ Intermediate Separations Alternative

K.7.4 EFFECT OF ASSUMPTIONS ABOUT GROUNDWATER FLOW AND DIRECTION

As described in Section K.4.2.1, Future Groundwater Flow Direction, the groundwater modeling and risk assessment in the EIS assumed groundwater levels equivalent to those recorded in December 1979. The appropriateness of these data as a basis for impact analysis was tested quantitatively by running the model and calculating consequent risks for the Ex Situ Intermediate Separations Alternative using the same assumptions as in the bounding case analysis except that there was no water inflow from site waste water disposal to the vadose zone. This scenario was called the no mound case.

The effects of changing the assumptions for the Ex Situ Intermediate Separations alternative are illustrated for the residential farmer scenario in Figures K.7.4.1 through K.7.4.3. These changes eliminated the future risk north and west of the 200 Areas, consistent with the similar changes in groundwater flow, described in Section K.4.2.1 and Volume Four, Appendix F. However, the total risk increased in the no mound case (Table K.7.4.1). This effect was most pronounced at 5,000 years, when the risk for the bounding case was spread over a long southeast to northwest diagonal across the site, with a higher risk area between 200 West and East Areas (Figure K.7.4.2). The no mound case risk at 5,000 years was confined to a band running east from the Central Plateau, and most of the risk above 1.0E-06 was within the higher isopleth, above 1.0E-04 (Figure K.7.4.2, Table K.7.4.1). At 10,000 years, the areas of risk were comparable in the two cases, although the no mound risk occupied a smaller area with a higher risk level than the bounding case (Figure K.7.4.3, Table K.7.4.1). The total estimated cancer incidence over the 10,000 year period of interest was approximately four times higher in the no mound case than in the case used in the EIS (Table K.7.4.1).

The predicted flow field for this scenario tended to have a more pronounced west to east flow direction with similar gradient magnitude, compared to the December 1979 flow field on which the impact assessments were based. This resulted in a smaller groundwater contaminant plume. Figures K.7.4.1 through K.7.4.3 illustrate the risk that would be associated with the bounding case and no mound case.

Table K.7.4.1 Areas of Risk Contours and Total Concern Incidence, Bounding and No Mound Cases

Figure K.7.4.1 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals and LAW Vaults at 2,500 Years from Present

Figure K.7.4.2 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals and LAW Vaults at 5,000 Years from Present

Figure K.7.4.3 Ex Situ Intermediate Separations Alternative, Residential Farmer Scenario, Post Remediation Risk from Tank Residuals and LAW Vaults at 10,000 Years from Present

Generally, a smaller contaminant plume would translate to higher contaminant concentrations and greater risk; however, the small plume would translate into few people being exposed. This effect would be partially offset by the longer vadose zone travel time and contaminant dispersion within the vadose zone.

K.8.0 ECOLOGICAL RISK UNCERTAINTY

This section provides a qualitative discussion of the uncertainties in the ERA. The ERA for this EIS used a screening level methodology to estimate potential radiological and chemical hazards to a suite of representative terrestrial receptors: the Great Basin pocket mouse, coyote, mule deer, red-tailed hawk, and loggerhead shrike (Volume Three, Section D.6). Pathways considered for the No Action alternative were food and water ingestion (all receptors except the mouse, which was assumed to obtain all water from metabolic sources), incidental soil ingestion (mouse and mule deer, coincident with consumption of vegetation), inhalation of routine releases (all), and direct external exposure (mouse, while in a burrow). Potential hazards to aquatic organisms were evaluated using the CRITRII program developed at the Pacific Northwest National Laboratory.

K.8.1 SOURCE TERMS

The source terms used for the ERA were the same as those used for the human health risk assessment. For the No Action alternative, the source terms were the inventory in the tanks for direct contact and food chain uptake, routine releases for air inhalation, and groundwater reaching the Columbia River in the future for water ingestion. Uncertainties in the source terms are described in Section K.3. The estimated ecological risks were directly proportional to the source contaminant concentrations, and uncertainty about these terms was considered relatively high. Therefore, the source terms were considered likely major contributors to the uncertainty in the ecological risk estimates. However, for the pathways involving direct exposure to stored wastes, radionuclide concentrations would have to have been overestimated by a factor of at least 10,000 for the "true" radiation doses to approach the 0.1 rad/day benchmark recommended by International Atomic Energy Agency (IAEA1992) for protection of terrestrial organisms, since most of the estimated doses were greater than 1,000 rad/day (Volume Three, Table D.6.4.1). Chemical concentrations would have to have been overestimated by a factor of 10 to 1,000 for the true HI to approach the benchmark value of 1.0, since most of the estimated HIs were between 10 and 1,000. If the inventories used for the existing risk estimates were underestimates, the corresponding true risks would be even greater than stated. Therefore, although the source terms were probably important contributors to the uncertainty in the absolute values of the risk estimates, it is not likely that better or more data would alter the conclusion that direct contact with the waste, either externally or through food chain uptake, would be very hazardous to ecological receptors.

Similar but converse arguments would apply to the estimates of inhalation and groundwater ingestion pathway risks to ecological receptors under the No Action alternative. Estimated radiation doses from these two pathways were very low compared with the two benchmarks used [0.1 rad/day for terrestrial organisms and 1.0 rad/day for aquatic organisms (IAEA 1992, NCRP 1991)] (Volume Three, Tables D.6.4.2, D.6.4.3, and D.6.4.6). The true radionuclide concentrations in air and water would have to be higher than those estimated by at least a factor of 10,000 for the maximum estimated doses to approach the lower of the two benchmarks of concern (0.1 rad/day). It is therefore unlikely that better estimates would alter the conclusion in the EIS that inhalation and groundwater ingestion would not be important sources of ecological risk under the No Action alternative. It is possible that more refined estimates of maximum future chemical concentrations in groundwater, assuming those estimates were 10-fold higher than the existing ones, could indicate potential chemical hazards to wildlife (Volume Three, Table D.6.4.5). This discussion would apply also to the estimated radiation doses resulting from inhalation of routine releases for the remediation alternatives. The true release terms would have to be higher than the existing estimates by several orders of magnitude for the estimated doses to approach the 0.1 rad/day benchmark of concern (Volume Three, Tables D.6.4.8 trough D.4.6.9). The exceptions would be the Ex Situ Intermediate Separation/Phased Implementation and the Ex Situ No Separation alternatives. The maximum radiation doses estimated for these two alternatives would exceed the 0.1 rad/day benchmark using the existing release estimates, and the real values would have to be 10- to 100-fold lower for the maximum radiation doses to fall below the level of concern. However, the minimum radiation doses for these two alternatives were approximately 100,000-fold lower than the maximum, supporting the claim that the existing dose values would be upper bound estimates.

K.8.2 ORGANISM VARIABLES

A number of species-specific variables contributed to the uncertainty in the ecological risk estimates: food, water, and soil ingestion rates; inhalation rates; body weights; home ranges; and the effective radius for absorption of energy from radioactive decay. Risk estimates for any given pathway are directly proportional to the associated contaminant intake rate. For example, a 10-fold difference in a food ingestion rate would produce a 10-fold difference in the estimated radiation dose or chemical HI. Therefore, the risk estimates would be expected to be sensitive to errors in the intake rates. However, as discussed in Section K.8.1, most of the risk estimates would need to be wrong by several orders of magnitude for the high values to fall below levels of concern or for the low values to exceed them. Errors of this size were considered unlikely for food ingestion rates, which were based on direct measures of various types (see sources for Volume Three, Table D.6.2.1). The exception would be the food ingestion rate for the loggerhead shrike, which was estimated from body weight using an empirical equation (Volume Three, Table D.6.2.1). Water and soil ingestion rates and inhalation rates were all estimated from body weight (water ingestion and inhalation) or dry matter intake (soil ingestion). Potential errors in these variables were likely greater than those for food ingestion, and the resulting risk estimates for the water and soil ingestion and the inhalation pathways could have a greater level of uncertainty than those for food ingestion. However, the food ingestion pathway has an additional source of uncertainty, biological transfer factors in the food chain (discussed in the following paragraphs), which the other pathways do not share.

Risk estimates for any given pathway would typically be inversely proportional to body weight, since body weight appears in the denominator of the equations for estimating intake of radionuclides or chemicals (Volume Three, Appendix D). However, as noted above, water ingestion rates and inhalation rates were estimated from empirical equations that are a function of body weight. This causes weight to appear in both the numerator and denominator of the intake equations, reducing its overall effect on the risk estimate. For example, a simple equation for the intake of a chemical by water ingestion is:

1)

Where:

I_i = Intake rate of the i_{th} contaminant, mg kg^{-1} day^{-1}

C_i = Contaminant concentration in water, mg L^{-1}

IR = Ingestion rate of water, L day^{-1}
BW = Body weight, kg
FI = Fraction ingested from contaminated source, unitless

Here, the intake rate of a contaminant in water would be inversely proportional to the body weight, if the water ingestion rate remained constant. However, larger animals generally drink more water than smaller animals (on a per organism basis), so that as the denominator, body weight, increases, IR in the numerator also increases. In the TWRS EIS, this was explicitly the case, because IR was estimated from body weight using empirical equations. For example, the equation used to estimate water ingestion by the coyote and mule deer is:

2)

Where:

IR = Ingestion rate of water, L day^{-1}
BW = Body weight, kg

The equation used to estimate inhalation by the mouse, coyote, and mule deer is:

3)

Where:

IR = Inhalation rate, m^3 day^{-1}
BW = Body weight, kg

The overall effect of using these equations is to reduce the potential effect of body weight variability on the water ingestion and inhalation risk estimates and on the uncertainty in the estimates. In addition, in parallel with the previous discussions of source terms and intake rates, the body weight values would need to be wrong by orders of magnitude for the high risk values to fall below levels of concern or for the low values to exceed them. Errors of this size were considered unlikely, because the body weights were based on reported measured values of real organisms, and the body weights of adult mammals and birds do not vary by orders of magnitude within species.

Risk estimates in this ERA were also inversely proportional to the estimated home range, except that home ranges equal to or less than 100 hectares (ha) (250 acres [ac]), the unit cell size used for the risk assessment (see Volume Three, Appendix D), all have the same effect on the risk estimate. That is, FI, the fraction of exposure to a contaminated source (see Equation 1 above), was set equal to the ratio of the cell size and the home range. For example, the coyote home range of 300 ha (750 ac) (Volume Three, Table D.6.2.1) results in an FI of (100/302) equals 0.33. Above a home range of 100 ha (250 ac), exposure would be directly proportional to home range size. Below this, all species have the limiting FI of 1.0. For example, the mouse and loggerhead shrike have home ranges of 0.09 and 10 ha (0.22 and 25 ac), respectively (Volume Three, Appendix D), but both have an FI of 1.0. The consequence is that potential variability or errors in the estimated home ranges would have different effects on different species risks. A 1,000-fold error in the mouse home range (i.e., the real value is 90 ha [220 ac]) would not affect the mouse risk estimates, because the FI would still equal 1.0. However, any error or variability in the home ranges for the coyote, mule deer, or hawk, with estimated home ranges of 300, 1,200, and 222 ha, (750, 3,000 and 540 ac) respectively, would have a proportional effect on the risk estimates. Errors of 10-fold in estimates of home range would not be unlikely, given that home range is defined as an area in which an animal sleeps and/or breeds and might not be the same as the area over which the animal forages for food. However, if the estimated home ranges were too low, more accurate (higher) values would decrease the risk, assuming that the resulting FI fell below the limiting value of 1.0.

If the home ranges used were too high, more accurate values would increase the estimated risk only for the coyote, mule deer, or hawk (which have home ranges greater than 100 ha [250 ac]). The worst case increase would be about 10-fold for the deer, with a home range of 1,200 ha (3,000 ac). Decreasing this value to 100 ha (250 ac) would increase the deer FI to 1.0 and increase estimated risks by a factor of 12 (1,200/100). This would affect conclusions about risk to deer only marginally. For example, the HI for direct contact with the waste in Cell 1WSS is 0.7, which is close to but not above the 1.0 benchmark of concern. The HI 0.7 multiplied by the estimated rise 12 is 8.4, which is above the benchmark. However, direct contact with the waste was already characterized as very hazardous to deer, and this conclusion would be unchanged. Therefore, although home ranges are not known with high confidence, uncertainty or variation in them would be unlikely to affect the conclusions of the ERA.

The effective energy absorbed from radionuclide decay has a direct proportional effect on the estimated radiation dose. This energy in turn depends on the effective radius assumed for the organism. The smaller the radius, the less energy is absorbed, although this varies across radionuclides due to their different physicochemical characteristics and the relative importance of alpha, beta, and gamma decay. The effective radii assumed for the organisms used in this ERA ranged from 1.4 cm (0.55 in.) (plants) to 30 cm (12 in.) (coyote and deer). An examination of Table D.6.3.7 shows that effective absorbed energies vary by approximately 10-fold across this range, with a number of isotopes showing no difference. Therefore, the effect of the assumed radius on the radiation estimates would be at most 10-fold if the entire dose were due to isotopes with this range of variation in effective absorbed energy. Such differences would not affect the primary conclusions of the ERA.

K.8.3 BIOLOGICAL TRANSFER FACTORS, HALF-LIVES, AND RETENTION FACTORS

The ecological risk estimates for food ingestion in the EIS were directly proportional to the soil-to-plant transfer factors (which determine how much of a contaminant moves into the food chain), the biological half-lives or turnover times of contaminants within organisms, and the fraction of the contaminant retained in the organism at each step of the food chain. Soil-to-plant transfer factors are likely to vary depending on local soil conditions and different plant species. This ERA used published default values that may or may not be applicable to the specific types and locations of plants consumed by the pocket mouse or mule deer. Therefore, these factors therefore probably contribute substantially to the uncertainty in the food ingestion risk estimates. However, as discussed for the source terms, the error or variability would need to be several orders of magnitude before it would affect the conclusions of the ERA. A similar concern exists for biological half-lives and retention factors for chemicals and radionuclides, although again, these would have to be wrong by several orders of magnitude before they by themselves would affect the conclusions of the ERA. The biological half-lives for radionuclides include the radiological half-lives in their calculation. These latter values are known with very high confidence and would not contribute significantly to the uncertainty in the risk estimates.

K.8.4 NO OBSERVED ADVERSE EFFECT LEVELS

The conclusions about potential effects of radiation on ecological receptors relied on single benchmarks of 0.1 rad/day for terrestrial organisms and 1.0 rad/day for aquatic organisms (Volume Three, Appendix D). These benchmarks are independent of specific radionuclides, reflect intense study, and have been widely reviewed. It is therefore unlikely that they contribute importantly to uncertainty in the conclusions of the ERA. However, the estimates of risks due to hazardous chemical exposure are based on the ratio of the estimated intake to the No Observed Adverse Effect Level (NOAEL); see (Volume Three, Appendix D). These values were derived largely from laboratory studies of species other than those of interest in this EIS. There are potential uncertainties in extrapolating from the species used in the laboratory studies to those in the EIS, from the dose ranges used in the studies to those estimated in the field, and from the general conditions in the laboratory to those in the field. All these factors may contribute significantly to the uncertainty in the HI estimates. The HI is inversely proportional to the NOAEL. An examination of Tables D.6.4.4 and D.6.4.5 suggests that errors of 10-to 100-fold in the NOAEL could reduce the high HI values in Table D.6.4.4, for direct contact with the stored waste, to low values below the 1.0 benchmark, if the real NOAELs were higher than those used in the ERA. Similar errors in the opposite direction could increase the low HI values in Table D.6.4.5, for future consumption of groundwater reaching the Columbia River, to values above the 1.0 benchmark. It is therefore possible that uncertainty in the NOAELs for hazardous chemicals could affect the ERA conclusions about chemical hazards associated with direct contact with stored waste or future consumption of groundwater at the maximum concentrations reaching the Columbia River. This would not affect conclusions about the presence or absence of radiological hazards or general conclusions about the need to prevent contact with the tank wastes by ecological receptors.

K.8.5 ECOLOGICAL RISK ASSESSMENT UNCERTAINTY CONCLUSIONS

Overall, the parameters of the equations used to estimate ecological risks would need to vary or be in error by several orders of magnitude to affect the conclusions of the ERA by themselves. Simultaneous variability in multiple parameters in the same direction could do so. For example, increasing IR and FI in Equation 1 above by 10-fold each would increase the estimated contaminant intake by a factor of 100. Such simultaneous variability is possible and would contribute to the overall uncertainty in the risk estimates. Nonetheless, because the ecological risk estimates in this EIS are so different for the various scenarios considered; very high for direct contact with stored wastes and very low for routine releases associated with either the No Action or various remedial alternatives, more detailed analysis would not be considered likely to alter those distinctions. Conversely, more detailed analysis would be unlikely to permit clear distinctions among the remedial alternatives based on potential radiological risks of routine releases, because these latter values are both low and similar to each other. The primary distinction in ecological risks thus remains between the No Action (assuming direct contact with the stored wastes at some future point) and remediation alternatives collectively.

K.9.0 RESULTS

Uncertainty in the conclusions of the TWRS EIS is a consequence of uncertainty in two major areas: the descriptions of the alternatives, with their associated assumptions about tank waste inventories, composition, and remediation technologies; and the consequences analyses, which included assumptions about waste source and release terms, future land uses, environmental transport parameters, and relationships between exposure and risk. The purpose of Appendix K is to discuss the major sources of uncertainty in each of these areas. In addition, a less conservative human health risk analysis is presented to illustrate the implications of making fewer conservative assumptions than were made for the bounding case analyses in the EIS.

Uncertainty in risk analysis is a consequence of two factors: lack of data and natural variability. Lack of data is reflected in our limited knowledge either about the value of constants (e.g., distribution coefficients), or about the statistical parameters (e.g., distribution shape, mean, variance) of things that are inherently variable (e.g., inhalation rates or body weights). Uncertainty due to lack of data can be reduced in principle by more accurate measurements. Uncertainty due to natural variability cannot be reduced by more data, but can be better estimated by acquiring data to characterize statistical distributions of measured variables and by using computer programs to simulate the effect of such variability in the components of equations on calculated values, for example, risk estimates. These combined efforts can reduce systematic uncertainty in the EIS analyses and provide a more thorough understanding of the effects of the remaining uncertainty on the conclusions in the EIS.

K.9.1 UNCERTAINTIES IN THE ALTERNATIVES

There were many uncertainties associated with the alternatives for remediating the tank waste. These uncertainties involved the types of waste contained in the tanks, the effectiveness of the proposed retrieval techniques, waste separations, waste immobilization, and the costs of implementing the alternatives. These uncertainties existed because some of the technologies that may be implemented would be first-of-a-kind technologies, would not have previously been applied to the tank waste, or would not have been applied on a scale as large as would be required for the tank waste, and because only conceptual designs would be available for the alternatives.

K.9.1.1 Major Assumptions

The impact analyses in the EIS required assumptions be made regarding the technologies used for each of the alternatives. These assumptions were based on either the best information available, applications of a similar technology, or engineering judgement. By definition, when an assumption was made, there was some uncertainty associated that was expressed as a reasonable expected range for the assumed value. This section identifies the major assumptions used for the alternatives, describes uncertainties associated with the cost estimates, and presents the results of an uncertainty analysis for the Ex Situ Intermediate Separations alternative.

K.9.1.2 Continued Management and In Situ Alternatives

The following assumptions were made for the Long-Term Management and in situ alternatives. It was assumed that there would be no leaks from the SSTs or DSTs during the administrative control period for the No Action, Long-Term Management, and In Situ Fill and Cap alternatives. The SSTs and DSTs were assumed to maintain their structural integrity throughout the administrative control period for the No Action and Long-Term Management alternatives. The In Situ Vitrification, In Situ Fill and Cap, and the in situ portion of the Ex Situ/In Situ Combination 1 and 2 alternatives were assumed to require additional characterization data to evaluate the acceptability of in-place disposal and to address Resource Conservation and Recovery Act (RCRA) land disposal requirements. The in situ vitrification system was assumed to be capable of vitrifying each tank to the required depth, with no impact of variation in waste composition and inventory on the ability to produce an acceptable waste form. The concentrated liquid waste contained in the DSTs was assumed to be acceptable for gravel filling under the In Situ Fill and Cap alternative.

K.9.1.3 Ex Situ Alternatives

The impact analysis for ex situ alternatives required assumptions about waste retrieval efficiencies, waste loading and blending factors, separations efficiencies, canister sizes and types, and releases to the soil during retrieval. The efficiency of waste retrieval was assumed to be 99 percent. The volume of HLW produced was calculated using the waste inventory, conservative assumptions for waste loading and blending factors, and separations efficiencies. Assumptions about volumes released to the soil during retrieval were made, which directly affected the predictions of the risk consequences resulting from such releases.

K.9.1.4 Schedule

Schedules for construction, operation, and closure were developed for each of the alternatives within the constraints of the Tri-Party Agreement. Schedule constraints would affect the size of the treatment facilities required to process the waste. Following design and construction of a waste treatment facility, the major schedule uncertainty would be the operating duration. Each of the ex situ alternatives was developed using 60 percent overall operating efficiency except for Phase 2 of Phased Implementation, which used 70 percent overall operating efficiency. Operating at higher efficiencies would reduce the operating duration and lower operating efficiencies would increase the duration.

For the alternatives with multiple components, such as retrieval, pretreatment, HLW treatment, and LAW treatment, the overall operating schedule would depend on the efficiency of each component. Uncertainties in the operating schedule would be expected to result in longer operating durations. The operating duration for the ex situ alternatives would be sensitive to the rate at which waste could be retrieved from the SSTs. A low SST sludge retrieval rate could increase the operating duration by 50 percent.

K.9.1.5 Staffing

Staffing estimates were developed for each alternative in support of risk, accident, and socioeconomic impact analysis. These estimates were developed using conservative assumptions for both construction and operating staffing levels. The major uncertainty was associated with the operating schedule. Staffing requirements would be affected by operating efficiencies because efficiency changes would increase or decrease the operating duration and the overall staffing requirements.

K.9.1.6 Resources

The resources required to construct and operate waste treatment facilities were estimated for each alternative using a consistent methodology and common assumptions. The ex situ alternatives and the In Situ Vitrification alternative would have the largest uncertainty for estimated resources. The major uncertainties associated with the estimated resource requirements for the ex situ alternatives included the size and type of facilities required and the volume of LAW and HLW produced.

K.9.1.7 Cost

Cost uncertainties for the various tank waste treatment alternatives were evaluated using a range estimating model. The Ex Situ No Separations (Vitrification) alternative had the largest estimated cost range due to the disposal cost for the large number of HLW packages that would be produced. The In Situ Vitrification alternative had the highest cost range on a percentage basis due to the uncertainties associated with implementing this technology for remediation of the tank waste.

K.9.2 UNCERTAINTIES IN SOURCE AND RELEASE TERMS

Source terms refer to the inventory, which is the total quantity of the hazardous material within the tanks, and to the release term, which is the amount released to environmental media such as air, groundwater, surface water, and soil under normal or accident conditions. Uncertainties associated with source terms included the characteristics and composition of the waste in the tanks and the specific performance capabilities of waste retrieval and processing technologies. Information needed to more thoroughly determine the composition and characteristics of the tank waste currently is being obtained through waste characterization studies. DOE has identified 46 key radionuclides for tracking in development of a "best basis inventory" for Hanford Site tank wastes. These include the radionuclides that dominate the risk estimates in this EIS: C-14, I-129, Np-237, Pa-231, Se-79, Tc-99, and U isotopes. This information will be incorporated into any NEPA analysis of tank farm closure alternatives.

K.9.3 UNCERTAINTIES IN TRANSPORT

Uncertainties in the human health and ecological exposure assessments depend in part on the uncertainties of estimated transport of contaminants from sources through air, soil, groundwater, and surface water to potential receptors. The principal sources of uncertainty of soil and groundwater transport include the physical and chemical mechanisms of contaminant transport through the vadose zone to the groundwater, the rates of infiltration into natural soil and through a protective barrier cap, distribution coefficients (K_d) of contaminants, assumptions about future groundwater flow direction due to assumed decay of groundwater mounds onsite and to climate change, assumptions about future vadose zone thickness due to climate change, assumptions about vadose zone transport in one-dimensional flow and transport simulations, and estimates of releases during retrieval.

The primary sources of uncertainty in estimating surface water transport were associated with the rate of dilution of contaminants in groundwater entering the Columbia River. These sources were the groundwater flow rate and river flow rate, including seasonal and diurnal fluctuations ranging from 2,300 m^3/s (81,000 ft^3/s) to 7,100 m^3/s (250,000 ft^3/s); plus turbulence of river flow, which depends on velocity; irregularities in the stream channel, including bends; and width of the river. All of these factors ultimately would depend on the total flow in the river at the point(s) where contaminated groundwater is discharged.

Estimation of transport through air depends on air dispersion modeling. Various assumptions and other factors can introduce uncertainty to these estimates. These uncertainties can be broadly separated into uncertainty inherent in the models, uncertainty in the data used as model inputs, and uncertainty in interpretation of model outputs. Input assumptions included pollutant release characteristics (form, particle size distribution, emission rate, temperature, flow rate), meteorological conditions (ambient temperature, mixing height, stability, wind speed and direction, atmospheric temperature, wind speed profile), and pollutant transport behavior (dispersion, plume rise, interaction with terrain). Model output interpretation required converting 1-hour average values to 3-, 8-, and 24-hour average values using conversion factors. These factors involved an implied assumption regarding the persistence of the meteorological condition producing the highest 1-hour impact. For example, conservative meteorological conditions that produced the highest 1-hour concentration could be expected to persist for most of a 3-hour period, and to a lesser degree, over an 8- or 24-hour period. The midpoint conversion factor values of 0.9. 0.7, and 0.4, respectively, were considered appropriate for this study.

K.9.4 UNCERTAINTIES IN HUMAN EXPOSURE ASSESSMENT

Uncertainties in the human health exposure assessment were divided into two parts. The first part was associated with the exposure parameters used in the post remediation land use scenarios. The second part was associated with the accidental release scenarios. In both cases, Monte Carlo simulations were used to evaluate the uncertainty in the exposure assessment and to establish the parameters that contributed the most to the uncertainty in the exposure assessment (i.e., sensitivity analysis).

In the Monte Carlo approach, PDFs were used to represent the range of values of a given parameter. The effects of simultaneous variations over these ranges on the exposure assessment then were examined using a computer software package (Crystal Ball). These computations were repeated a large number of times to produce complete PDF of the output functions. Statistical summaries of the results then were plotted to help interpret the data.

K.9.4.1 Post-Remediation Land-Use Scenarios

The percentiles of the Monte Carlo-based PDFs were computed and compared to the fixed point estimates of the same function. Two important conclusions can be drawn from these results. First, as expected, the fixed point estimates in the exposure assessment generally lie at the high end of the PDF or approximately the 95th percentile. This is expected, because the fixed point estimate is intended to be an upper bound estimate. Second, the mean of the Monte Carlo-based PDF generally was approximately one order of magnitude lower than the fixed point estimate. This result suggests that the exposure estimates in the EIS were higher-than-expected values or best estimates by approximately an order of magnitude.

K.9.4.2 Accidental Release Scenarios

A Monte Carlo uncertainty and sensitivity analysis also was conducted on the parameters used to compute LCFs or the probability of contracting cancer from accidental releases associated with the remedial actions. The sensitivity analysis indicated that the parameters that contributed the most to the uncertainty in the LCF for the accidental release scenarios, as measured by rank correlation, were the ULD, atmospheric dispersion coefficient (Chi/Q), release volume, IR, and LCF conversion factor.

Comparing the mean and percentile estimates of the LCF distributions for the four accidental release scenarios with the fixed point estimates derived using the upper-bound values indicated that the LCFs based on the upper-bound values were in all cases greater than the 100th percentile of the LCF PDF. The means of the LCF PDFs were approximately one order of magnitude lower than the upper-bound fixed point estimates. These results suggest that the LCF estimates in the EIS are upper bound values. The true probability of contracting cancer or fatalities resulting from cancer actually could be much less than the predicted value.

K.9.5 UNCERTAINTIES IN HUMAN HEALTH RISK

The uncertainties associated with the TWRS EIS risk estimates included parameters used in the equations relating exposure to risk and the historical data on worker risks and accidents used in the evaluations of potential accident impacts. To estimate risk, information must be available on dose-response relationships, which would define the biological response from exposure to a contaminant. Although human epidemiological data were used for developing radiological and nonradiological chemical dose-response models, this information also was developed in laboratory tests using animals exposed to relatively high doses. Therefore, uncertainty is inherent in dose-response relationships, including extrapolating from effects in animals at high doses to potential effects in humans who most often are exposed at much lower doses.

Uncertainty associated with the derivation of toxicity values also affects the level of confidence in human health risk estimates. Sources of uncertainty associated with published toxicity values include the following:

- Use of dose-response information from effects observed at high doses to predict effects at low levels expected in the environment;
- Use of data from short-term exposure studies to extrapolate to long-term exposure or vice versa;
- Use of data from animal studies to predict human effects; and
- Use of data from homogeneous animal populations or healthy human populations to predict effects on the general population.

The summation of cancer risk across pathways or for multiple pathways makes the total cancer risk more conservative. This is because each slope factor for each chemical carcinogen is an upper 95th percentile estimate, and such probability distributions are not strictly additive. The risk values calculated for the post-remediation scenario in the TWRS EIS were a conservative bounding estimate. The uncertainty in the risk values for certain receptors increases as the time to the future increases. Less uncertainty was associated with the risk values at 300 years than the risk estimates at 500, 2,500, 5,000, and 10,000 years.

By far the greatest uncertainty in the routine remediation risk was associated with the source data, which were based on the estimated inventory and source terms (i.e., the amount of chemicals and radionuclides released to the environment). Other contributors to the routine risk uncertainty were airborne transport of the released chemicals and radionuclides; accumulation of contaminants in food products; production and distribution of food products; lifestyle and diet of specific individuals; food consumption rates; and dose conversion factors.

The risk estimates for the post-remediation and intruder scenarios were associated with more uncertainty than facility routine operation risk because they involved uncertainties associated with the future land use and intrusion into residual waste, in addition to modeling. Finally, the MEI risk estimates generally involved a greater level of uncertainty than population risk estimates. The greatest uncertainty in calculating the post-remediation intruder risk was associated with the source data. Source terms were based on the estimated inventory and an average tank within the eight aggregated tank farms of the 200 Areas (Volume Two, Appendix A). Additional information regarding the source term would decrease the uncertainty in the risk estimate. The relative uncertainties associated with the dose conversion factors were not as important as the source data, source terms, and exposure pathway parameters.

K.9.5.1 Uncertainties in Ecological Risk

The ERA for this EIS used a screening level methodology to estimate potential radiological and chemical hazards to a suite of representative terrestrial receptors: the Great Basin pocket mouse, coyote, mule deer, red-tailed hawk, and loggerhead shrike. Pathways considered for the No Action alternative were food and water ingestion (all receptors except the mouse, which was assumed to obtain all water from metabolic sources), incidental soil ingestion (mouse and mule deer, coincident with consumption of vegetation), inhalation of routine releases (all), and direct external exposure (mouse, while in a burrow). Potential hazards to aquatic organisms were evaluated using the CRITRII program developed at the Pacific Northwest National Laboratory.

Overall, the parameters of the equations used to estimate ecological risks would need to vary or be in error by several orders of magnitude to affect the conclusions of the ERA by themselves. Simultaneous variability in multiple parameters in the same direction could do so. For example, increasing both water ingestion rates and the fraction of water obtained from a contaminated source by 10-fold would increase receptors estimated contaminant intake by a factor of 100. Such simultaneous variability is possible and would contribute to the overall uncertainty in the risk estimates. Nonetheless, because the ecological risk estimates in this EIS were so different for the various scenarios considered (very high for direct contact with stored wastes and very low for routine releases associated with either the No Action or various remedial alternatives) more detailed analysis was not considered likely to alter those distinctions. Conversely, more detailed analysis was unlikely to permit clear distinctions among the remedial alternatives based on potential radiological risks of routine releases, because these latter values were both low and similar to each other. The primary distinction in ecological risks thus remains between the No Action (assuming direct contact with the stored wastes at some future point) and remediation alternatives collectively.

K.9.6 CONCLUSIONS

The scope of the tank waste disposal action and alternatives analyzed in the TWRS EIS was such that a number of components of actions and analyses contributed varying degrees of uncertainty to the assessment of impacts as discussed above. Some of the components were well characterized and the uncertainties were well known and documented. Other components were better characterized as estimates and the uncertainties were not known or were also estimated. However, the major sources of uncertainty were associated with a few major components of the proposed action and alternatives. Following is a brief discussion of those major components of uncertainty and DOE or other actions which would be expected, in time, to reduce the level or range of uncertainty for that component.

K.9.6.1 Engineering

Uncertainties related to engineering included facility, process, and equipment design, and performance. The flowsheets and facility designs for the TWRS alternatives were preconceptual, based on design information and performance criteria that are in the early planning stages and involve considerable engineering judgement. Engineering design uncertainties will be reduced or better defined as investigations are completed, disposal decisions are made, and engineering design proceeds to preliminary and ultimately definitive design. These efforts would include pilot-scale testing and process demonstration on the tank waste before full scale implementation.

K.9.6.2 Waste Inventory

Uncertainties regarding waste inventory relate to the waste type, form, and quantity of tank waste constituents. These uncertainties contributed in turn to the uncertainty of source terms, release rates and transport estimates (Figure K.1.0.1). The waste inventory data used in developing the alternatives and their associated impacts were derived from model predictions and sample analyses performed to date. DOE has an ongoing waste characterization program in place to better define the quantity, content, form, and characteristics of the tank waste that will ultimately reduce the inventory-related uncertainties. DOE has identified key radionuclides for tracking in developing a "best basis inventory" for Hanford Site tank waste. These include the radionuclides that dominate the risk estimates in this EIS: C-14, I-129, Np-237, Pa-231, Se-79, Tc-99, and U isotopes. This information will be incorporated into any NEPA analysis of tank closure alternatives. As part of this program, DOE is currently developing the HTI program that will provide information on the characteristics of the tank residuals and the capability of retrieval systems to deal with difficult-to-remove SST wastes. This program, which will reduce the uncertainties associated with residual waste, includes demonstrations of capabilities to quantify residual waste volume and technologies for sampling and characterizing the residual waste.

K.9.6.3 Waste Transport

Uncertainties regarding waste transport include source terms (type, quantity, form, composition, concentration, solubility), and release rates for tank residuals and LAW, vadose zone characteristics, groundwater flow characteristics, transport mechanisms, and rates. Recent observations of relatively immobile contaminants at depths of up to 38 m (125 ft) below the tanks are not fully explained with interstitial flow and may indicate there are other transport mechanisms in effect. These observations are currently the focus of a DOE program. The initial phase of the program is to determine if the observations are representative of extensive vadose zone contamination beneath the tanks or if they are related to other phenomena such as borehole cross contamination. DOE is also currently developing criteria and technologies to identify leaks and limit releases during retrieval.

K.9.6.4 Exposure Scenarios

The TWRS EIS has assessed an extensive and well defined suite of potential human exposure scenarios including an array of potential remediation and post remediation receptors. The scenarios included a variety of Hanford land uses (farming, industry, recreation, Native American subsistence), a variety of receptors (resident, worker, farmer, recreational user, intruder) and a variety of pathways. Uncertainties related to exposure scenarios include the degree to which Hanford land or groundwater would be accessible or restricted, the location, timing, and duration of exposures to contaminants, and the density of user populations. DOE has an ongoing program to determine future land uses for the Hanford Site including preparation of a Comprehensive Land Use Plan. These efforts, in combination with those described in Sections K.9.1 through K.9.3, will both reduce the total uncertainty in the TWRS risk analyses and better characterize that which remains.

ATTACHMENT 1

Explanation of Input Distributions Used in the Monte Carlo Methodology

This attachment explains the information sources and rationale used in deriving the input distributions used in the Monte Carlo uncertainty and sensitivity exposure analysis. This attachment is ordered by exposure scenario (e.g., industrial, residential) with input distribution explanations given for the exposure route which resulted in the greatest risk for each particular exposure scenario.

Industrial Exposure Scenario

The industrial exposure scenario is based on worker exposure over a 20-year duration. The scenario involves mainly indoor activities, although outdoor activities (e.g., soil contact) are also included. The air inhalation rate is 20 m^3 per day for a worker and external exposure occurs 8 hours per day. Inhalation of contaminants occurs 250 days per year and external exposure occurs for 146 days per year.

EF (exposure frequency)

Units: days per year
Distribution used: triangular (likeliest 245, maximum 307, minimum 156)
Source: EPA 1989

This input represents the number of days per year that a typical worker would spend in the workplace. The likeliest value for EF was established using the rationale that the worker works two weekends per year and takes two weeks' vacation and two weeks' sick leave. The minimum value for EF was established by assuming that the worker is part-time and only at the site approximately 60 percent of the time. The maximum value for EF was based on a person taking two weeks' vacation, two weeks' sick leave, and working all but 15 weekends per year.

ED (exposure duration)

Units: years
Distribution: lognormal (mean 7.3, standard deviation 8.7)
Source: Department of Labor 1992

This input represents the number of years that the individual being modeled will spend at a particular job location within the contaminated area. After considering the information in the EPAs Exposure Factors Handbook (EPA 1989) and after considering various factors that could impact ED, it was determined that the input would be characterized using the data from a study conducted by the Department of Labor completed in 1992. The distribution used for ED is a lognormal distribution based on a mean standard deviation presented by the Department of Labor report. The maximum value is 30 years, which is the upper bound time specified by the report for a worker at any one given job, and which is also the value specified by the EPA.

IR (inhalation rate)

Units: cubic meters per day
Distribution: triangular (likeliest 18.9, maximum 32.0, minimum 6.0)
Source: EPA 1985

This input represents the amount of air that is breathed in during a typical day at work by an adult under an industrial exposure scenario. Layton (Layton 1993) has shown that inhalation rates vary with body weight and the type of activity (i.e., light, medium, or heavy). For this evaluation, a triangular distribution was used based on adults working at light activity levels.

Residential Exposure Scenario

The residential scenario is based on exposures over 30 years duration to an individual residing onsite. The individual is assumed to be exposed to contaminated soil, air, surface water, and groundwater, and homegrown fruits and vegetables 365 days per year. The exposed individual was assumed to ingest 2 L (0.5 gal) of contaminated water per day, 365 days per year for 30 years.

EF (exposure frequency)

Units: days per year
Distribution used: triangular (likeliest 345, maximum 365, minimum 180)

Source: Smith 1994

This input represents the number of days per year that the typical behavior being used to characterize risk to the target population takes place. Providing an example of a nontypical day that would be excluded from consideration when generating an EF input may be helpful in understanding the purpose of the input. Days taken during the year as vacation, where the person is away from work, would not be considered typical since exposure parameters are likely to differ from those associated with a typical day in that persons life.

The likeliest value for EF was established using the rationale that two weeks spent away from home was a plausible likeliest value for EF. The minimum value for EF assumes that a person spends 50 percent of his or her time at home and the rest away from home. The maximum value for EF assumes that the person spends all of his or her time at home.

ED (exposure duration)

Units: years
Distribution: lognormal (mean 11.4, standard deviation 13.7)
Source: Department of Labor 1992

This input represents the number of years that the individual being modeled will reside at a residence located within the contaminated area. After considering the information in the EPAs Exposure Factors Handbook (EPA 1989) and after considering various factors that could impact ED, it was determined that the input would be characterized using the data from a study conducted by the Department of Labor completed in 1992. The distribution used for ED is a lognormal distribution based on the mean and standard deviation presented by this report. The maximum value is the upper bound time specified by the report for a worker at any one given job.

IR (drinking water ingestion rate)

Units: liters per day
Distribution: lognormal (mean 1.12, standard deviation 1.63)
Source: Rosenberry-Burmaster 1992

Direct ingestion of radionuclides in tap water is an important exposure pathway that often dictates groundwater remediation at contaminated sites. The IR input represents the amount of drinking water ingested during a typical day by an adult under a residential exposure scenario.

Native American Scenario

The Native American scenarios are intended to include a wide range of activities from reserved rights related to traditional lifestyles and preservation of natural and cultural resources to those specifically delineated in the Treaties. Specific activities include hunting, gathering, collecting, fishing and processing of the catch along the shoreline, and pasturing of livestock, as well as ceremonial, educational, seasonal, social, and trade activities.

EF (exposure frequency)

Units: days per year
Distribution used: triangular (likeliest 345, maximum 365, minimum 180)
Source: Smith 1994

This input is the number of days per year that the typical behavior being used to characterize risk to the target population takes place. An example of a nontypical day that would be excluded from consideration when generating an EF input may be helpful in understanding the purpose of the EF input. Days taken during the year as vacation, where the person is away from work, would not be considered typical since exposure parameters are likely to differ from those associated with a typical day in that persons life.

The likeliest value for EF was established using the rationale that two weeks spent away from home seemed a plausible likeliest value for EF. The minimum value was based on a scenario in which a person spends 50 percent of his or her time at home and the rest away from home. The maximum value was based on a person spending 100 percent of their time at home.

ED (exposure duration)

Units: years
Distribution: lognormal (mean 11.4, standard deviation 13.7)
Source: Israeli-Nelson 1992

This input is the number of years that the individual being modeled will reside at a residence located within the contaminated area. After considering the information in the EPAs Exposure Factors Handbook (EPA 1989) and various factors that could impact ED, it was determined that the input would be characterized using the data from a study conducted by the Department of Labor in 1992. The lognormal distribution used for ED is based on that report. The maximum value is 70 years, which is the upper bound time specified in the Native American scenario.

IR (fish ingestion rate)

Units: grams per day
Distribution used: triangular (likeliest 140, maximum 1,080, minimum 30.0)
Source: DOE 1996 and EPA 1989

Consumption rates for recreationally caught fish from large bodies of water have a 50th percentile average of 30 g/day and a 90th percentile average of 140 g/day (EPA 1989). Therefore, for purposes of this scenario, the fish ingestion PDF was approximated by a triangular distribution.

VF (volatilization factor)

Units: liters per cubic meter
Distribution: triangular (likeliest 0.1, maximum 0.3, minimum 0)
Source: Andelman 1990

For groundwater, an upper bound volatilization factor (VF) based on uses of household water (e.g., showering, laundering, dish washing) was used. A VF of 0.1 L/m^3 was used for household activities. The transfer of contaminants from water to a Native American in a sweat lodge was also estimated using a VF similar to that proposed by EPA (Andelman 1990). The steam in the sweat lodge is generated by pouring water onto heated rocks. A VF of 0.3 L/m^3 is used for all nonvolatile contaminants, a factor of 2.5 is used for all VOCs, and a factor of 0.5 is used for radon. Therefore, for the Native American scenario, the VF probability density function was modeled as a triangular PDF with a most likely value of 0.1 L/m^3, maximum value of 0.3 L/m^3, and minimum value of zero.

Total Health Impacts for Hanford Site Users

The total adverse health impacts to a hypothetical future resident of the Hanford Site is expressed as the total cancer fatalities over a 10,000-year period. The cancer fatalities are calculated by first computing the total cancer risk for a given population and then dividing by the dose to risk conversion factor for cancer incidence and cancer fatalities (ICRP 1991). The parameters driving the uncertainty are the population density and the length of time for a life span or generation.

P (population density)

Units: persons per square kilometer
Distribution used: triangular (likeliest 3, maximum 5, minimum 1)
Source: professional judgment and WSDFM (1994)

The population density describes the number of people in a given area that will live at some hypothetical time in the future at the Hanford site. The current estimates of the farming population density surrounding the site give a value of approximate 5 persons/km^2. The triangular distribution for population density was chosen in order to estimate the uncertainty in the cancer fatalities at a population density of as low as 1 person/km^2.

D (Duration of each generation)

Units: years
Distribution: normal distribution (mean 75 years, standard deviation 7.5 years)
Source: EPA 1989

This input is used to represent the life expectancy for the each generation. Although 70 years has been widely used in the past, current data suggest that 75 years would now be a more appropriate average value.

Intruder Scenario

The post drilling scenario has three exposure pathways: exposure to airborne contamination via inhalation, external exposure to penetrating radiation, and consumption of contaminated produce. For the post drilling scenario, 0.35 m^3 of waste are distributed throughout a 15-cm-deep plow layer in a garden that is 2,500 m^2 in area. The individual is assumed to spend 4,380 hr/year residing at home (indoors), 1,700 hr/year outdoors, and 100 hr/year outdoors in gardening activities on the Site. The sensitivity analysis for the intruder scenario indicated that the intruder effective dose is most dependent in order of rank upon soil concentration, external exposure time, depth to the contamination, and the soil density.

Soil Concentration

Units: picocuries per gram
Distribution used: triangular (likeliest 9.9 E+05 maximum 1.7 E+06 minimum 4.4 E+05)
Source: professional judgment and Rittman 1994

The concentration of the contaminant in soil is a function of the diameter of the well, the thickness of the waste layer, the garden surface area, and the soil density. The thickness of the waste layer is assumed to be a constant 5 m (16 ft), although some uncertainty is associated with this parameter. The uncertainty associated with the surface area of the garden and the soil density are treated separately below. The diameter of the well excavated at the site was assumed to vary as a triangular distribution. The maximum value was assumed to be the point estimate of 30 cm (12 in.) and the most probable and minimum values were selected to be 22.5 cm (9 in.) and 15 cm (6 in.), respectively. The rationale for this assumption is that the well diameter could conceivably be three-fourths or one-half the point estimate. The corresponding triangular distribution for the soil contaminants concentration had the values stated above.

External Exposure Time

Units: hours
Distribution used: triangular (likeliest 1,800, maximum 3,260, minimum 676)
Source: professional judgment and EPA 1989

For estimating external exposure from the soil contamination, the house was assumed to reduced the dose rate to one-third the direct dose rate. Therefore, the average time exposed at the unshielded dose rate is:

$$(1{,}800 \text{ hr/year})*1 + (4{,}380 \text{ hr/year})*(1/3) = 3{,}260 \text{ hr/year}$$

For the purposes of the Monte Carlo assessment, the minimum external exposure time was based on EPAs analysis of activity patterns in United States households (EPA 1989). The most likely value was chosen to represent 100 percent shielding of the receptor by the house.

Depth to Contamination

Units: centimeters
Distribution used: triangular (likeliest 15.0, maximum 22.5, minimum 7.5)
Source: EPA 1989 and Rittman 1994

The likeliest depth to the contaminants was chosen to be 15 cm or the tilling depth (Rittman 1994). However, due to leaching and other factors, surface soil was considered to extend to 22.5 cm or to be as shallow as 7.5 cm.

Soil Density

Units: grams per cubic centimeter
Distribution used: uniform (maximum 1.50, minimum 0.50)
Source: Rittman 1994 and DOE 1996

Published soil densities for the Hanford Site range from 0.5 g/cm^3 (DOE 1996) to 1.5 g/cm^3 (Rittman 1994). Therefore, the soil density distribution was assumed to be uniform with likeliest value 1.0.

Total Health Impacts Along the Columbia River

This scenario is used to estimate the dose to a population exposed to contamination from the Columbia River. The contamination enters the Columbia River as a result of groundwater flow into the river. Different contaminants will enter the groundwater and reach the Columbia River at varying times in the future.

Total cancer fatalities are calculated using factors that relate the number of fatal cancers to the curies of each contaminant released to the river. These factors were calculated using a computer program which estimates the time integral of collective dose over a period of up to 10,000 years for time variant radionuclide release to surface waters, such as rivers (DOE 1987).

The dose estimates for the Columbia River scenario indicate that of the three principal routes of exposure (i.e., external, ingestion, and inhalation), ingestion is the principal route, followed by inhalation and external exposure. A Monte Carlo sensitivity analysis indicated that the parameters which most affect the equivalent dose are in rank order: soil to plant transfer factor, root ingestion rate, Columbia River flow rate, total population exposed, months per year of irrigation, and soil area density.

Root Ingestion Rate

Units: kilogram per year
Distribution used: triangular (likeliest 55.7, maximum 73.0, minimum 0.0)
Source: DOE 1996 and Rittman 1994

The root ingestion rate is the quantity of rooted vegetables consumed on a yearly basis by a resident along the Columbia River. For nonleafy vegetables, this value is approximately 55.7 kg/year (Rittman 1994). A more recent publication which deals directly with potential impacts to the Columbia River by contaminants from the Hanford Site states a value of 200 g/day or approximately 73 kg/year (DOE 1996).

Columbia River Flow Rate

Units: cubic feet per second
Distribution used: triangular (likeliest 8.1E+04, maximum 2.5E+05 minimum 3.6E+04)
Source: Volume One

The flow rate of the Columbia River is important in that it is used to estimate the amount of dilution that a contaminant would undergo once groundwater discharges to the river. Flows through the Reach fluctuate significantly and are controlled by operations at Priest Rapids Dam. Daily average flows range from 3.6E+04 ft^3/sec to 2.5E+05 ft^3/sec.

Months Per Year of Irrigation

Units: months per year
Distribution used: triangular (likeliest 6.0, maximum 7.0, minimum 5.0)
Source: Rittman 1994 and professional judgment

This parameter is the number of months per year that plants are irrigated with contaminated Columbia River water. A default value of six months per year has been assumed for the Hanford Site (Rittman 1994). However, in order to place some uncertainty on this value, irrigation has been assumed to occur for six months plus or minus 1 month to account for dry and wet years.

Soil Area Density

Soil area density is the product of soil density and the depth to the contamination. The same distributions used in the Monte Carlo approach for the intruder scenario for these distributions were used in the present scenario.

Soil to Plant Transfer Factor (root)

Units: curie per kilogram dry weight of vegetable to curie per kilogram of soil
Distribution: lognormal (mean 0.50, standard deviation 0.25)
Source: professional judgment

The soil to plant transfer factor accounts for the amount of contaminant that will be taken up from the soil through the roots of a plant. The most recent published value for this factor is 1.0 (Rittman 1994) for Np which is two orders of magnitude larger than the last published value (PNL 1986). However, examination of the most recent published values for this factor for other radionuclides (Rittman 1994) indicates that in general, the soil to plant transfer factor is between 0.01 and 1.0. Therefore, the distribution used for the Monte Carlo analysis was a lognormal with a mean value of 0.50 and standard deviation of 0.25. Examination of this probability distribution reveals that the selected distribution captures the range of values between 0.01 and 1.0.

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APPENDIX L

DRAFT EIS COMMENTS AND AGENCY RESPONSES

INTRODUCTION

The U.S. Department Of Energy and the Washington State Department of Ecology added Appendix L, Response to Public Comments, to the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS) to fully address and respond to public comments on the Draft EIS. In addition, DOE considered public comments, along with other factors such as programmatic need, short- and long-term impacts, technical feasibility, and cost, in arriving at DOE's preferred alternative. During the public comment period for the Draft EIS, more than 350 individuals, agencies, Tribal Nations, and organizations provided comments. This volume represents a broad spectrum of private citizens; businesses; local, State, and Federal officials; Tribal Nations; and public interest groups.

Appendix L contains the comments on the EIS received during the public comment period and DOE and Ecology responses to those comments. Frequently, identical or similar comments were provided by more than one individual, and in such cases, DOE and Ecology grouped the comments and prepared an in-depth response for each group. These responses are included as the response to the first comment. Subsequent similar comments refer the reader to the initial response. In compliance with the provisions of the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations [40 CFR 1502.14(e)], and Washington State Environmental Policy Act (SEPA) Rules (WAC 197-11) public comments on the Draft EIS were assessed and considered both individually and collectively by DOE and Ecology. Some comments resulted in modifications to the EIS. Other responses contained an explanation of the reasons that the comments did not warrant any further response or modification to the EIS. The final decision on which alternative to implement will be made following publication of the Final EIS and will be documented in a Record of Decision (ROD). The public comments on the Draft EIS will be considered when making the final decision. The ROD will be published no sooner than 30 days after the publication of a Notice of Availability for the Final EIS in the Federal Register.

HOW DOE AND ECOLOGY CONSIDERED PUBLIC COMMENTS IN THE NEPA PROCESS

As required in the CEQ regulations, the Final EIS identifies DOE's and Ecology's preferred alternatives. The preferred alternatives were identified based on consideration of environmental impacts, regulatory compliance, DOE and Waste Management programmatic missions, public comments, and DOE policy. Public input considered in DOE's and Ecology's identification of preferred alternatives included concerns, preferences, and opinions regarding the activities addressed in the EIS, as well as expectations of DOE in making the decisions on environmental restoration and waste management programs at the Hanford Site.

CHANGES TO THE EIS RESULTING FROM PUBLIC COMMENTS

A major purpose of NEPA and SEPA is to promote efforts that will prevent or reduce damage to the environment by ensuring informed decision making on major Federal actions that significantly affect the quality of the human environment. Consideration of public comments on the Draft EIS helps ensure that the EIS is an adequate decision making tool; accordingly, this EIS has been enhanced, as appropriate, in response to public comments. Based on review of public comments, along with with consultations held with commenting agencies, State and Tribal governments, primary EIS enhancements include the following.

- Discussion and analysis associated with the disposal of high-level waste at the potential national geologic repository were reviewed, clarified by separating the discussion and analysis from other components of the alternatives, and current data and formulas for calculating costs were added to Volumes One and Two, as appropriate.

- The option of longer interim onsite storage of high-level immobilized waste pending availability of an offsite geologic repository was included in the Final EIS.
- In Volume One, Section 5.11 and Volume Three, DOE revised the risk analysis to include a Native American subsistence user scenario. This analysis compared impacts of each alternative to a future population of individuals who would reside on the Hanford Site and subsist in a traditional lifestyle. This scenario was developed in consultation with affected Tribal Nations.
- Additional consultation with the affected Tribal Nations is reflected in the environmental justice analysis and throughout the EIS, as appropriate.

As committed to in the Draft EIS, a discussion of emerging data regarding vadose zone contamination beneath the tanks resulting from past leaks has been added to the Final EIS in Volume One, Sections 4.2 and 5.2, Appendix F, and Appendix K. The data were unavailable for inclusion in the EIS at the time the Draft EIS was published. Much of the data presented in the Final EIS are based on preliminary analysis of the vadose zone contamination, and thus the EIS presents several scenarios that are currently under review by DOE regarding the cause, nature, and extent of the contamination.

The Draft EIS contained an analysis of uncertainties for each relevant component of the environment (e.g., risk, waste inventory, groundwater migration) in the applicable section of the EIS. For the Final EIS, the evaluation and discussion of uncertainties was expanded and presented together in Volume Six, Appendix K.

Other enhancements to the EIS included modifying Phase 2 of the Phased Implementation alternative to include construction and operation of two waste treatment facilities. Accident discussions and analysis were reviewed, and emerging data were added to Volume One, Section 5.12 and Appendix E. The EIS was also revised to reflect 1995 Site environmental monitoring and reporting. Finally, DOE expanded the EIS analysis of a variation to the Ex Situ/In Situ Combination alternative (known as Ex Situ/In Situ Combination 1 alternative in the Final EIS) presented in the Draft EIS. This alternative was described in the Draft EIS in the cover letter and preface to Volume One and is called the Ex Situ/In Situ Combination 2 alternative in the Final EIS. The discussion and analysis for this alternative are presented in Volume One and Appendix B. DOE added an expanded discussion and analysis of uncertainties to the Final EIS.

Editorial changes were made to the EIS to correct errors, none of which were considered substantive, and to clarify discussions.

HOW TO USE APPENDIX L TO LOCATE RESPONSES

Three indices, Tables L.1, L.2, and L.3, are provided as cross references for specific comments and corresponding section number in Appendix L. Table L.1 is organized by individual or organization providing comment, listed alphabetically; date the comment was provided, if the same individual or organization submitted multiple comments; comment document number assigned and method used to submit the comment, whether written or verbal; comment number, and corresponding Appendix L section number. Individuals providing comments by postcard will find the associated response section by locating "Postcard Correspondence" in column 1 (Individual/Organization [Date Submitted]). Individuals who provided comments by means of the public interest group survey may find the compiled results of the survey, along with references to other Appendix L sections, in Section L.3.9. Table L.2 is organized by section number in Appendix L, page number, and associated comment numbers. Table L.3 lists comment numbers along with their section number and page number.

To find a response to a specific or group of comments, please use the following procedure.

1. Turn to Table L.1 and locate the individual or organization listed in Column 1, and note the response section number(s) assigned to that comment document in Column 4.
2. Following the section number, the page number is listed in Column 5 for the page on which comment and response are listed in numerical order.
3. Turn to the appropriate page(s) to find a response to the comment.

Use the same process to find comments provided by other individuals and organizations. Throughout the appendix, when responses to a particular comment are related to responses to other similar comments, the comment number of the similar comment or comments is provided. To locate the similar comments and associated responses, refer to Table L.3, which lists the comments numerically and the corresponding page number. In an effort to be as complete as possible and address all issues and concerns, each written comment or transcript of an oral comment was reviewed for specific concerns or recommendations. Each concern or recommendation was given a specific comment number and assigned to a specific number in Volume Six, Appendix L most closely corresponding to the nature of the comment. If your comment document contains more than one comment, repeat steps 2 and 3 for each comment because each response could fall under a different response section.

HOW TO FIND REFERENCE DOCUMENTS

Technical references and other supporting documentation cited in Appendix L are available in the DOE Reading Rooms and Information Repositories listed at the end of the Summary and in Volume One, Section 8.0.

APPENDIX L
DRAFT EIS COMMENTS AND AGENCY RESPONSES

ACRONYMS AND ABBREVIATIONS

Section L.1.0 is unavilable electronically.

L.2.0 PURPOSE AND NEED FOR ACTION

Comment Number 0005.36

Swanson, John L.

Comment The term "low-activity waste" is used incorrectly on page 2-1: at least the usage there does not agree with the distinction drawn on pages 1-3 and 6-18 that LAW is tank waste remaining after the removal of the practicable amount of HLW. By this distinction, how can there be any LAW in the tanks now? As I understand it, all of the tank wastes except for the NCRW and PFP tanks are HLW by definition; they will be pretreated to divide them into HLW and LAW fractions, but LAW does not exist until after pretreatment has happened. If this understanding is not correct, you had better revise your definition of LAW so that it is consistent with whatever it is that you mean. (I would be happy to try to assist in such a revision if it were explained to me what is really meant).

Response The use of the term LAW on page 2-1 is consistent with the definition of LAW provided in Volume One, Section 1.0. LAW is the waste remaining after the removal of as much of the radioactivity as is practicable from HLW. As indicated in Volume One, Section 1.1, during the 1950's and 1960's uranium, cesium, and strontium were separated from the waste in some of the SSTs. Based on this earlier waste separations, some of the SSTs may be able to be classified as containing LAW. However, due to incomplete tank-by-tank waste characterization, it is not possible at this time to conclude how many or which tanks could potentially be considered for classification as LAW tanks.

As discussed in Volume One, Section 6.2, the correct classification of the waste from each tank will be required to determine which regulations are applicable to the disposition of the waste in each tank. Thus, it is possible that when tank waste characterization is complete, some of the tanks may be classified as LAW tanks. The waste from these tanks then could be processed accordingly. For example, under the preferred alternative, Phased Implementation, the waste from tanks determined to contain only LAW could be directly treated at the low-activity vitrification facility without requiring pretreatment. Please refer to the responses to Comment numbers 0005.25, 0041.01, and 0072.41.

Comment Number 0019.02

WDFW

Comment WDFW has reviewed, the purpose and need for action, and requests additional language be incorporated for clarification. Specifically, the need for action should state 67 SSTs are known or are assumed to have leaked 2.3 million to 3.4 million liters of hazardous waste to the groundwater, thus the need to remediate the source (tank waste) to prevent further contamination of groundwater. As long as an uncontained liquid waste source exists, it will continue to contribute to groundwater contamination and ultimately end up in the Columbia River.

Response The transfer of the liquid waste from the SSTs, many of which have leaked or could leak in the future, into the DSTs greatly reduces the potential for additional leaks into the soil column. A separate NEPA analysis was performed for this action, referred to as saltwell pumping. The purpose and need does identify the need to manage and dispose of tank waste to reduce existing and potential future risks to the public, Site workers, and environment. The analyses provided in the EIS include a No Action alternative and the impacts analyzed for the alternative include potential future migration of waste to groundwater. Because DOE and Ecology believe the purpose and need for action is accurately presented in the Draft EIS, no modification to the document is warranted.

Comment Number 0043.01

Hanford Communities

Comment Radioactive tank waste is one of the most serious environmental risks on the Hanford site. The tanks continue to pose imminent safety risks to workers and the environment. These risks include the potential for catastrophic release through hydrogen gas flammability and groundwater contamination from leaking tanks. Our communities are frustrated with the lack of progress in getting the wastes out of the tanks and safely stored.

Response DOE and Ecology share the desire to move forward with remediation of the tanks at the earliest possible date and are implementing plans to accelerate remediation. In the mean time, DOE is performing numerous activities to place the tank farms in a controlled and stable condition and upgrade the regulatory compliance status of the tank farm system. (See Volume One, Section 3.4 and Appendix B for discussions of current and planned programs to manage the tank waste.)

L.3.0 DESCRIPTION AND COMPARISON OF ALTERNATIVES

L.3.1 INTRODUCTION

L.3.2 SITE AND WASTE DESCRIPTION

L.3.2.1 Tank Waste

Comment Number 0005.10

Swanson, John L.

Comment On another matter related to tank-by-tank inventory, on page A-2 it is said that "...tank farms were grouped together based on tank contents (inventory)..." Again, what data were used to perform such groupings? The inventory data presented in the EIS, and represented to be used therein, do not allow such groupings to be made. We thus have no way of knowing (or estimating) how valid these groupings are. I detect no special bias here, as I do in the consideration of the combined ex situ/in situ alternatives cases, but the story presented in the EIS should be complete and consistent.

Response DOE and Ecology acknowledge the concern expressed in the comment. The text has been modified to show that the tanks were grouped according to configuration, not according to content. This text modification appears in Volume Two, Appendix A, Section A.2.1.1.

Comment Number 0005.22

Swanson, John L.

Comment On page A-3, it appears to be stated as a fact that the K Basins sludges will be added to the tanks. This is news to me, and I do not believe that it is reflected in other portions of the EIS.

Response One proposed option for disposition of K Basin sludge identified by the 1996 K Basins EIS ROD is to remove and transfer the sludge to the DSTs. If implemented, the final disposition of this waste would be in accordance with the alternative implemented for tank waste management and disposal under the TWRS EIS. The Draft EIS included, in Appendix A, the K Basin sludge inventory as a potential source of new waste to be added to DSTs. K Basin sludges are discussed in Volume One, Section 3.4.1 and Volume Two, Appendix A, Section A.2.4.

Comment Number 0005.37

Swanson, John L.

Comment On page 3-11 it is said that "--new leaks are developing in these tanks at a rate of more than one a year." Are data available to support this statement, or is it an assumption that is stated as fact?

Response At the time the Safe Interim Storage (SIS) EIS was published, 67 SSTs were assumed to have leaked over the past 50 years. This number was used to support the statement that leaks would develop at a rate of more than one a year in the future. The saltwell pumping program, which involves removing liquids from the tanks, is expected to slow the rate of corrosion and substantially reduce future leaks (see Volume One, Section 3.4). Data are not available to accurately predict the number of new leaking tanks that will develop. The data identified above provide the best estimate available at the current time. Based on the saltwell pumping program to stabilize the SSTs and for the purposes of analysis in the TWRS EIS, no new leaks are assumed to occur during the 100-year administrative control period. The text of the EIS in Volume One, Section 3.2 has been modified to state that, "... new leaks are developing at a rate of one new tank known or assumed to have leaked per year."

Please refer to the response to Comment numbers 0072.70 (leak detection methods), and 0072.85 (predicted and anticipated future leaks).

Comment Number 0012.14

ODOE

Comment Tank Waste Characterization

The tank wastes are complex and poorly understood. The complex operating history of Hanford tanks has created a situation where the contents and character of the waste in every tank varies significantly from every other tank.

USDOE is working to characterize tank wastes. This should allow USDOE to narrow the uncertainties and mitigate severe hazards such as flammable gas generation. But, the data will not be detailed or accurate enough to ensure the risk assessments can accurately predict the fate of these wastes if they are left in the tanks.

Response The tank wastes are not well characterized on an individual tank basis, but an estimate of overall tank contents can be made. As noted in the EIS in Volume One, Section 3.2 and Volume Two, Appendix A, DOE has implemented a program to characterize tank waste on a tank-by-tank basis, which will be instrumental for resolving tank safety issues and final design activities for waste treatment. This program will aid in narrowing uncertainties regarding the waste in the tanks. However, DOE and Ecology believe that the existing historical data, laboratory data, and characterization reports provide an approximate estimate of tank contents from which the analysis of the tanks alternative can be completed to support the analysis and comparison of potential environmental and human health impact under National Environmental Protection Act (NEPA). The EIS acknowledges the uncertainties involved with the level of knowledge of the tank waste inventory and uses a conservative approach to assessing impacts based on the available data. This approach, known as bounding, provides an inventory of tank wastes that supports a risk assessment that DOE and Ecology believe fairly and objectively informs the decision makers and the public of the potential impacts associated with each alternative and support a comparative analysis of the alternatives. Tank-by-tank characterization will be needed to implement detailed design and operation of the TWRS action. If characterization data become available that are not bounded by the EIS analysis, DOE would complete an appropriate NEPA analysis to support analysis of environmental impacts and, if appropriate, alternatives that address the new data. See Volume Two, Appendix A for a discussion of tank inventory and Volume Five, Appendix K for a discussion of uncertainties.

Comment Number 0072.07

CTUIR

Comment In particular, two aspects are deficient within the TWRS-EIS. First, thorough characterization of the nature and composition of Hanford's chemically and physically complex tank wastes is in its infancy. It is clear that not enough information exists about these wastes within this EIS to adequately support retrieval and treatment needs, let alone facility design(s). If overall planning goals are not well understood in advance, the CTUIR SSRP asks, how will it be possible to design retrieval, treatment, and disposition systems that will meet protective waste management endstate and Tri-Party Agreement goals? This EIS should fit hand in hand with the Hanford sites overall guiding, framework document.

Response Though the characterization program for the tank waste is not complete, the EIS functions primarily as an environmental planning document, not as an engineering design document, and as such, will not include the complete details of programs like tank inventory and characterization or retrieval. As required by the Tri-Party Agreement, the tank waste characterization program will be completed September 1999. Assuming the tank waste characterization sample collection, analysis, and data interpretation must be finalized well in advance of the program, in addition to the reservoir of existing information, sufficient data would be available to support the detailed design of the transfer and retrieval systems, as well as of the treatment facilities. Where appropriate, the EIS incorporates such information by referencing the publicly available information on relevant topics. The locations of DOE Reading Rooms and information repositories containing publicly available information are given in the Summary, Section S.8. For example, the EIS contains references WHC 1995b, WHC 1995o, WHC 1994f, and WHC 1994g pertaining to tank contents and WHC 1994h pertaining to the characterization program. Tank retrieval and blending strategy is the subject of reference WHC 1995p. DOE and Ecology agree that it is necessary to ensure that tank waste remediation decisions are based on this EIS and are consistent with overall goals or designed endstates for the Hanford Site. To this end, the EIS describes the relationships among the alternatives and broader goals and policies, both nationwide and for the Hanford Site. For example, the relationship between the alternatives and tank closure is discussed in Volume One, Sections 3.3, 5.1-5.10, and 6.0. Further, Volume One, Section 6.0 describes the policy and regulatory background, including the Tri-Party Agreement, in relationship to the proposed action. Please refer to the response to Comment number 0012.14.

Comment Number 0072.14

CTUIR

Comment Considering the controversy surrounding the characterization of tank waste, the documentation of the contents of individual tanks and development of the "supertank" inventory should be better.

The entire tank waste characterization strategy needs to be examined and improved.

Response More complete knowledge of the tank contents would be preferable. At present, there is a program of tank characterization which, when completed, will provide information on the contents of each tank. Because that program of characterization is not completed, estimates of tank components were used in the EIS. The documentation of the inventory estimates that were used in the EIS is discussed in Volume Two, Section A.3.0 and in Volume Four,

Appendix E (Section E.1.1.3.1). The use of the super tank inventory is specifically discussed in Appendix A (Section A.3.3). The super tank inventory is intended to present the most conservative impacts from an accident so that the effects of accidents will not be underestimated. The super tank concentration of a chemical or radionuclide is the highest reported value that has been measured or calculated for that substance. This means that for assessing the impacts of an accident, a uniform inventory will be used for every accident scenario. For assessment of impacts, the use of this inventory data provides an equitable comparison of impacts. For the Final EIS, Appendix K (Volume Five) has been added to provide expanded information regarding uncertainties including inventory and accident. Please refer to the response to Comment numbers 0012.14 and 0072.07.

Comment Number 0072.67

CTUIR

Comment P 3-2: Sect. 3.2.1.2: Tank farm description: It is indicated here that 67 SSTs have leaked 2.3 million -3.4 million liters of liquids, it would be useful if there were a description on how this was calculated.

Response The estimate for the volume of waste that has leaked from the 67 known or assumed leaking SSTs was taken from the cited reference (Hanlon 1995). The referenced document, titled Tank Farm Surveillance and Waste Status Summary Report is one of a series of periodic reports that contains tank volume data as well as estimates and data for leak volumes from each of the known or assumed leaking SSTs. The methods used to estimate the volume of waste to have leaked varied by tank. The estimating method and the other parameters that impacted the assessment are contained in the footnotes to Table H-1 in the Waste Tank Summary Report for the month ending February 29, 1996 (Hanlon 1996).

Comment Number 0072.68

CTUIR

Comment P 3-4: PP 1: A vadose zone baseline characterization program could not possibly have determined the structure of the region underneath the tank farms given the amount of liquids presumed to have leaked and the large number of unknowns associated with the vadose zone points to an enormous amount of error in the ground water assumptions changing the future predictions on the rate of contaminate transport through the vadose zone will necessarily change the risk.

Response There are uncertainties and unknowns associated with the vadose zone modeling of rate and transport of contaminants from the tanks. Many of the uncertainties were addressed in Volume Four, Sections F.4.3.5 and F.3.4. The impact assessment modeling in Appendix F only addresses impacts from releases associated with TWRS remediation, not past leaks. Additional modeling was performed with evaluations provided in Volume Five, Appendix K that address potential transport mechanisms that may have been active during past leaks. Together, these evaluations and assessments provide the basis for developing appropriate mitigating measures. The response to Comment number 0012.15 contains an extensive discussion of vadose zone contamination issues, particularly uncertainty and subsurface geology.

Comment Number 0072.69

CTUIR

Comment P 3-7: PP 3: S 5: what is the precipitation process for the metal-salt compounds indicated here.

Response The sentence cited in the comment refers to the sludges in the tanks. Sludge is contained in a layer of water-insoluble chemicals that precipitated and settled to the bottom of the tank when the waste liquid from the processing plants was made basic by the addition of sodium hydroxide. Because of their reaction with sodium hydroxide, the sludge compounds are composed of primarily of metal hydroxides. Because the sludge composition may vary and other compounds may precipitate, the precipitate also is termed hydrous metal oxides.

Comment Number 0072.70

CTUIR

Comment P 3-11: PP 3: Bullet 1: How was the rate of leakage determined? Please explain how the control wells or the leak sensors are strategically placed.

Response The statement cited in this comment, taken from the SIS EIS, is as follows: "Removing saltwell liquid from older SSTs to reduce the likelihood of liquid waste escaping from corroded tanks into the environment. Many of these tanks have leaked, and new leaks are developing in these tanks at a rate of more than one per year" (DOE 1995i). This statement was intended to reflect the age, condition, and historical perspective of the SSTs. This statement also reflected the thinking at the time that since 67 SSTs were assumed or confirmed to leak, the leakage rate would continue at more than one per year in the future.

Several methods are used to find leaks. Starting in the early 1960's, vertical monitoring wells, called drywells, were drilled around the SSTs. These wells are called drywells because they do not reach the water table. Approximately 760 drywells, located around the SSTs, are used to measure increases in radiation in the ground caused by tank leakage. Multiple drywells are located around the perimeter of the tanks in order to monitor around the tanks. A second way to detect leaks is to use a lateral drywell. This is a drywell drilled horizontally underneath a tank where the radiation in the soil can be measured by a detection probe. A third way to detect leaks is to lower radiation probes into liquid observation wells inside the tank and measure the radiation as a way to identify the level of liquid. By comparing the current liquid level with the last recorded level, a large leak can be detected. Detecting leaks in SSTs is an imprecise activity. As all tanks continue to age, the number of leaking tanks will likely increase. Please refer to the response to Comment number 0005.37.

Comment Number 0072.71

CTUIR

Comment P 3-11: PP 5: Bullet 3: In the event of loss of institutional control, and the loss of the mixer pump in 101-SY, could the microcrystalline mat reform much stronger and thicker, resulting in greater entrapment of hydrogen and other flammable gases?

Response The loss of institutional control, as an assumed event, would result in the termination of continuing operations at the tank farms. The loss of institutional control would mean that the day-to-day activities concerned with management of the tank wastes would no longer continue. This would mean that the mitigative measures currently being applied to the tank wastes would no longer be performed including the use of the mixer pump in tank 101-SY. The tank would revert to its condition before the mixer pump was installed. Whether the sludge layer would reform much stronger and thicker is unknown; however, this possibility cannot be ruled out. A discussion of potential remediation and post-remediation accidents is contained in Volume One, Section 5.12 and Volume Three, Appendix E. Please also refer to the response to Comment numbers 0040.02 and 0040.03 for more information related to administrative controls and the response to Comment number 0072.80 for discussions of the reason and basis for assuming a 100-year administrative control period.

Hydrogen and other flammable gas deflagration accidents were analyzed in the EIS. For post-remediation accidents, an analysis of the flammable gas deflagration accident, among others, determined that a seismic event would result in bounding case accident conditions and therefore the post-remediation accident presented in Volume One, Section 5.12 is the seismic event.

Comment Number 0072.72

CTUIR

Comment P 3-13: PP 1: This is the first notation on complexing of tank waste, please include a discussion on exactly what is meant by complexing waste.

Response The subject discussion regarding the SIS EIS ROD is provided in the EIS to inform the reader of planned activities to address urgent safety or regulatory compliance issues. The discussion of complexed and noncomplexed waste with respect to tank 102-SY was presented in the SIS EIS (DOE 1995i). A definition of complexed and noncomplexed waste is also provided in the glossary of the TWRS EIS. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please also see the response to Comment number 0072.170 for more information about complexed waste.

Comment Number 0072.73

CTUIR

Comment P 3-13: PP 2: S 3: What part if any has the DOE done to insure that the affected tribes are involved and kept up to date with the transfer of responsibility, accountability, and liability?

Response The phased approach to implementation of the alternatives is discussed in Volume One, Section 3.3. Contracting strategy is not an issue addressed in the EIS. However, DOE recognizes the importance of maintaining an interactive relationship with the affected Tribes. Informal discussions as well as meaningful consultation and cooperation result in better understanding of important cleanup issues.

In the developing months of the privatization effort (Spring/Summer 1995), invitations were issued to the affected Tribes to present the initially envisioned concept. Letters and follow-up communiqués were issued to J.R. Wilkinson, Hanford Program, Confederated Tribes of the Umatilla Indian Reservation (CTUIR); Donna Powaukee, Environmental Restoration and Waste Management (ERWM) Manager, Nez Perce Tribe; and Russell Jim, Confederated Tribes and Bands of the Yakima Indian Nation. Of the invitations, only the Nez Perce requested and participated in a discussion of the project with a DOE representative and staff. Follow up correspondence addressing questions and concerns was issued August 1995.

Following issuance of the TWRS Request for Proposals (RFP) (February 1996), a request was made for a copy by Joseph H. Richards, Environmental Compliance Auditor, CTUIR on February 23. The following day, the document was forwarded to him.

Progress reports and status updates are routinely provided to the Hanford Advisory Board, which has Tribal representation. This is not to suggest that interactions with the Board substitutes, or may be conducted in lieu of, both formal and informal interactions with the Tribes. DOE encourages such interactions and welcomes opportunities to discuss important cleanup activities with the Tribes. An in-depth discussion of the Tribal consultation process for the TWRS EIS is presented in the response to Comment number 0072.252.

Comment Number 0072.74

CTUIR

Comment P 3-13: PP 2: S 7: The CTUIR agrees that the plan for privatization is subject to the final record of decision of the TWRS EIS.

Response The TWRS EIS ROD will document the decision for how to remediate the tank waste. DOE intent in preparing the schedules for the TWRS EIS and the award of Phase 1a contracts was to have the EIS ROD completed prior to the contract award. To ensure that the award of contract could proceed in the event of a schedule disruption to the EIS ROD, DOE clarified in the final RFP that action under the contract would be contingent on the outcome of the TWRS EIS ROD, a decision which would be considering other alternatives and, if chosen, might necessitate renegotiating or voiding the contract award.

DOE NEPA Implementing Procedures (10 CFR 1021) require DOE to "complete its NEPA review for each DOE proposal before making a decision on the proposal (e.g., normally in advance of, and for use in reaching, a decision to proceed with detailed design)" (10 CFR 1021.210 [b]). The November 1995 draft RFP indicates that Phase 1a is intended as a "development period to establish the technical, operations, regulatory, and financial elements required in privatized facilities." It is only in Phase 1b that the selected contractors will provide detailed, complete design, and be authorized to proceed with construction and operations. These circumstances and requirements comply with NEPA procedures that provide for submittal of environmental data and analysis by offerors and incorporation of an environmental synopsis of that data and analysis in any NEPA document prepared (10 CFR 1021.216 [h]), as long as the actions taken prior to beginning detailed design do not "have an adverse environmental impact" or "limit the choice of reasonable alternatives." Based on the planned Phase 1 approach of splitting the action into two subphases, DOE would be able to proceed with Phase 1a (conceptual design) prior to completion of the TWRS EIS ROD and be within the intent of NEPA. However, the TWRS EIS ROD would be required prior to the anticipated April 1998 award of Phase 1b contracts.

Comment Number 0072.80

CTUIR

Comment P 3-21/22: while it is acknowledged that NEPA requires that an EIS includes a no-action alternative, it should also be acknowledged that leaving leaking tanks violates several laws, regulations, and statutes. Also, no-action would not necessarily be a "continue the current waste 'management' program." It would more likely be a walk-away situation where institutional controls fail.

Response The No Action alternative would result in failure to comply with Federal and State laws and regulations. This information is presented in Volume One, Section 6.2 and in the Summary, Section S.7. EIS Sections S.7, 3.4, and 6.2 describe the Federal and State compliance issues applicable to the No Action alternative. DOE guidance on NEPA requires that EIS alternatives be addressed regardless of "conflict with lawfully established requirements" (DOE 1993d). DOE is required to identify the laws and regulations that apply to each alternative and indicate whether the alternative, if selected, would comply with applicable laws and regulations (40 CFR 1502.2d). Please refer to the response to Comment numbers 0093.02 and 0072.52.

Guidance on the implementation of NEPA Council on Environmental Quality (CEQ) Memorandum to Agencies: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations states the following.

Section 1502.14(d) requires the alternatives analysis in the EIS to "include the alternative of no action." There are two distinct interpretations of "no action" that must be considered, depending on the nature of the proposal being evaluated. The first situation might involve an action such as updating a land management plan where ongoing programs initiated under existing legislation and regulations will continue, even as new plans are developed. In these cases "no action" is "no change" from current management direction or level of management intensity. To construct an alternative that is based on no management at all would be useless academic exercise. Therefore, the "no action" alternative may be thought of in terms of continuing with the present course of action until that action is changed.

In the case of the TWRS program, there is an ongoing program to safely manage the tank waste that would continue under any reasonable scenario for the 100-year administrative control period. For this EIS, no action is assumed to be no effort other than the safe management practices currently conducted. The "walk-away" alternative was not evaluated, because it would present an imminent danger to human health and the environment and would be a useless academic exercise.

Comment Number 0072.81

CTUIR

Comment P 3-24: last paragraph: exactly what does "enough waste would be remediated"? Does this mean that the characterization of the tanks, tank farms, intra-tank, tank mixtures, solubility mixtures would be done on a pilot scale in ten years on an order of magnitude to justify 1.6 billion dollars of set-aside moneys. Is this amount of money justified in terms of removal of tank waste, lowering of risk, characterization, and achieving Tri-Party Agreement milestones.

Response The referenced language means that a sufficient quantity of waste would be remediated during Phase 1 to prove that remediation would be effective for the entire remediation program. The sentence was modified in Volume One, Section 3.3 as follows for clarification. "A sufficient quantity of a variety of tank waste types would be processed to demonstrate the effectiveness of the process and to provide the necessary data to design a full-scale facility." Please refer to the response to Comment number 0005.38.

Comment Number 0072.168

CTUIR

Comment P A-1: Sect. A.2.1: It is appropriate to list the estimated radionuclide and non-radionuclide inventory for each tank or tank farm for comparison.

Response Please refer to the response to Comment numbers 0012.14 and 0072.07. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.169

CTUIR

Comment P B-8: What is actually in the miscellaneous underground storage tanks? The characteristics of an expected waste indicates a need for a comprehensive characterization, even if the total combined inventory of MUSTs volumes is less than one half of one percent of the total tank inventory.

Response Please refer to the response to Comment numbers 0012.14 and 0072.07 for issues related to tank waste characterization. Please also refer to Comment number 0072.99 for MUST content information. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.170

CTUIR

Comment P B-10: What are the characteristics of concentrated complexant waste?

Response Concentrated complexant waste is the concentrated aqueous raffinate from strontium-90 liquid-liquid extraction operations performed in the 1960's and 1970's. This waste is a component of the wastes in the AN and SY tank farms, although some is in the DSTs because of saltwell pumping. It is characterized by a high organic content including the complexants ethylenediaminetetraacetic acid (EDTA), citric acid, and hydroxyethylenediaminetriacetic acid (HEDTA).

Comment Number 0072.171

CTUIR

Comment P B-12: PP3: Please explain what is meant by 'have or may have' greater than 50,000 gal of drainable liquid.

Response The section describes the installation of liquid observation wells in the tanks. The criteria for installation is the presence, or suggested presence, of at least 50,000 gallons of drainable liquid. The criteria retains the provisional phrase 'have or may have' because the exact quantity of liquid remaining in the saltcake will not be known until the liquid has been removed and its volume is measured.

Comment Number 0072.172

CTUIR

Comment P B-12: PP4: How many and how often are radiation measurements taken in the drywells?

Response Radiation measurements taken in the drywells are included in the discussion of ongoing tank monitoring and maintenance activities and are one of the methods used to monitor for tank leaks in Volume One, Section 3.2 and Volume Two, Appendix B. Two drywells at two SSTs (tanks 241-C-105 and 241-C-106) are currently monitored monthly by gamma radiation sensors. The remaining tanks are monitored by the TWRS program periodically based on the need to detect potential new leaks and/or to document the extent and nature of past leaks.

Comment Number 0072.173

CTUIR

Comment P B-16: PP5: Please re-do this paragraph. It is confusing and could be better written. For example, the description of the majority of radioactive elements in the sludges needs to be expanded and an indication needs to be made whether the sludges are at the bottom of the tanks or elsewhere.

Response The referenced paragraph provides a generic description or overview of the waste in numerous tanks rather than in individual tanks. The three types of waste (i.e., liquid, sludges, and saltcake) are present in the individual tanks in varying combinations and proportions. For example, sludges may be located at the bottom of the tank, caked along the side of the tank, or both. Although there is a considerable amount of tank waste inventory available from process records and past sampling activities, this information is not considered adequate to characterize the waste in individual tanks. However, DOE is actively involved in an ongoing waste characterization program that is using waste sampling and analysis, in situ measurements, monitoring, surveillance, and waste behavior modeling to provide more detailed and accurate characterization data for the content of individual tanks. Current agreements among DOE, Ecology, and EPA require that all characterization reports be issued by September 1999. Volume Two, Sections A.2 and A.3 present additional information on the tank inventory data including the estimated radionuclide inventory for SSTs and DSTs, ongoing tank characterization programs, and tank inventory data accuracy and its effect on the EIS. Please refer to the response to Comment numbers 0012.14 and 0072.07. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.174

CTUIR

Comment P B-18: PP3: The statement, "upgrade the regulatory compliance status" implies that the DOE may not be in compliance even after they complete the SIS EIS activities.

Response In the context of the TWRS EIS alternatives, the referenced statement regarding the SIS EIS refers only to the compliance status of the cross-site transfer portion of TWRS. Installing the cross-site transfer pipeline would comply with applicable regulations whereas the existing cross-site transfer pipeline does not. It is DOE policy to conduct its operations in an environmentally safe and sound manner in compliance with applicable environmental statutes, regulations, standards, and the Tri-Party Agreement. Routine operations at the tank farms include monitoring and maintaining the regulatory status, and operations and maintenance of facilities and equipment. However, upgrading the regulatory compliance status as part of the process of placing the tank farms in a controlled, stable condition involves multiple and continuing activities, particularly as facilities age. The EIS addresses upgrades specific to the waste transfer system (Volume Two, Section B.3). The cross-site transfer system and upgrades under the TWRS EIS are actions identified in the Tri-Party Agreement Resource Conservation and Recovery Act (RCRA) compliance provisions. Volume One, Sections 1.1 and 3.2 provide additional information regarding how the SIS EIS and TWRS are interrelated. Volume One, Section 6.0 describes the statutory and regulatory requirements potentially applicable to TWRS.

Comment Number 0072.175

CTUIR

Comment P B-20: PP1: If the goal of privatization has a component that transfers a share of accountability and liability to industry, have the affected Tribes been properly notified and consulted regarding this? If so, when and with whom were the notifications and consultations addressed to?

Response Please refer to the response to Comment number 0072.73.

Comment Number 0072.176

CTUIR

Comment P B-20: PP2: Once again the statement "upgrade the regulatory compliance status" indicates that even after the current planned upgrades the tank farms may not be in compliance. The planned upgrades listed including instrumentation, ventilation, and electricity is supposed to place the tank farms in a controlled stable condition. Please bring forth a discussion on how these three upgrades will accomplish this.

Response DOE and Ecology acknowledge that even after the current planned upgrades, the tank farms may not be in full compliance. However the upgrades are required by the Tri-Party Agreement which is the RCRA enforcement agreement among DOE, Ecology, and EPA. The upgrades when completed along with other projects such as the saltwell pumping program will result in the attainment of controlled onsite conditions for the SSTs. Upgrades to the instrumentation, ventilation, and electrical systems are not included in the scope of this EIS; however, these activities are the subject of other NEPA documents. Please refer to the response to Comment number 0072.174. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0077.01

ODOE

Comment More than a million gallons of high-level wastes have already leaked from these tanks, threatening the aquifer and the groundwater. Plutonium and americium from one tank leak at Hanford have migrated over 100 feet through the soil and may have reached the groundwater. A third of the tanks have been placed on a "watch" list because of the danger of explosions.

Response DOE and Ecology concur the magnitude and complexity of the tank waste issues that constitute the purposes and need for the TWRS action. DOE must implement decisions to manage and dispose of tank waste to reduce existing and potential future risk to the public, Site workers, and the environment. The EIS includes an analysis of alternatives to manage and dispose of tank waste. The analysis of impacts includes potential impacts to groundwater in Volume One, Section 5.2 and Volume Four, Appendix F; remediation and post remediation health impacts in Volume One, Section 5.11 and Volume Three, Appendix D; and remediation and post-remediation accidents, including the risk of explosions, in Volume One, Section 5.11 and Volume Four, Appendix E. The cumulative impacts of past leaks and TWRS actions are presented in Volume One, Section 5.13. Please refer to the response to Comment numbers 0072.61 (estimates of tank volume thought not to have leaked), 0072.63 (leak volume thought to be cooling water) and 0072.67 (leak volume estimating methods) for more information about tank leaks. Current methods used to detect leaks are discussed in the response to Comment number 0072.70.

Comment Number 0089.10

Nez Perce Tribe ERWM

Comment Page A-13, Table A.2.1.2

The Table delineates the soluble and insoluble portions of chemical species. This information is useful, but it would be helpful to see a listing of the chemical compounds rather than just anions and cations listed separately. A better understanding of tank chemical processes is possible with a listing of chemical compounds.

Response DOE and Ecology concur that more complete knowledge of the tank contents, including the exact nature of the chemical compounds would be advantageous. At present, there is a program of tank characterization which, when completed, will provide greater depth of knowledge as to the contents of each tank. Because that program of characterization is not yet completed, estimates of tank components were used in the EIS. Information on the chemical compounds within the tanks is limited. The inventory estimate provided for use in the EIS (WHC 1995d) gives the chemical species in their ionic form. For purposes of assessing impacts from the release of the tank contents, the use of the ionic forms was sufficient. Please refer to the response to Comment numbers 0012.14 and 0072.07. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

L.3.2.2 Cesium and Strontium Capsules

No comments were submitted for this topic.

L.3.3 DEVELOPMENT OF ALTERNATIVES

L.3.3.1 Tank Waste

Comment Number 0005.17

Swanson, John L.

Comment The fact that tank closure is not included in the analysis seems to me to be a serious deficiency. The statement on S-15 that "Closure is not within the scope of this EIS because there is insufficient information available concerning the amount of contamination to be remediated." seems to me to be a cop-out. You go on to base the analysis that you do on an assumed 1 percent left in the tanks; data given on page S-7 indicate that 0.5 percent of the waste activity has been released or leaked to the ground. Isn't an estimate of 1.5 percent of the contamination to be remediated during closure sufficient information on which to base an analysis? (It is certainly as close an estimate as many of those used in the analyses that were done in this draft).

Response Closure is not within the scope of this EIS because information, such as the nature and extent of vadose zone and groundwater contamination to identify and analyze reasonable closure alternatives is insufficient to support an evaluation of closure alternatives. The Notice of Intent to prepare the TWRS EIS stated, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future" (59 FR 4052). However, some of the decisions to be made concerning how to dispose of tank waste may impact future decisions on closure, so the EIS provides information on how tank waste remediation and closure are interrelated. A single and consistent method of closure was assumed for all alternatives to allow for a meaningful comparison of the alternatives. The closure method used for purposes of analysis was closure as a landfill, which includes filling the tanks and placing an earthen surface barrier over the tanks after remediation is complete. For a discussion of how closure was addressed within the EIS, see Volume One, Section 3.3.

Specific and detailed information on the distribution of contaminants from tank leaks and past practice activities is not available in sufficient detail to provide a meaningful comparison of impacts. When sufficient information is available to evaluate the closure options, DOE will submit a final closure plan to Ecology for review and approval, and an appropriate NEPA analysis will be completed. An extensive discussion of closure and issues related to closure is presented in Comment number 0072.08.

Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0005.18

Swanson, John L.

Comment The assumptions of a) 1 percent of the contaminants (including the water soluble ones) left in the tanks and b) no attempt to immobilize this residual, lead to a lack of discrimination risk is dominated (by a factor of 100) by the risk of the non-immobilized 1 percent assumed to be left in the tanks. This is a classic case of "assumption driving the conclusion." For the purposes of this EIS, wouldn't it be better to assume a closure approach that would allow differences in the considered alternatives to apparent? It would be strange to me if the same "public" that drove out grout as a LLW form because of perceived contaminant release problems would be willing to accept a situation where the overall release is 100 times greater than that from their preferred waste form because something was not done to immobilize the waste left in the tanks (or to rinse out more than 99 percent of the water-soluble contaminants).

Response As stated in Volume One, Section 3.4, the calculations in the EIS are based on the assumption that the waste residual would be composed of the average tank contents, which is a very conservative assumption because the liquids used to retrieve the waste would remove a high percentage of water-soluble contaminants. The water-soluble contaminants are those that contribute to long-term risks because they can be transported over the long term into the groundwater. In response to the issue raised in this comment and others, calculations have been performed and presented in the Final EIS based on a less conservative content of the residuals where most of the water-soluble contaminants are removed. This provides both a bounding and nominal calculation of risks and provides the public and decision makers with greater information concerning long-term risks. This new information is contained in Section 3.4, 5.2 and Appendix F of the Final EIS. For more information regarding closure assumptions and how closure was addressed in the EIS, please refer to the response to Comment numbers 0005.17 and 0072.08 and Volume One, Section 3.3.

Comment Number 0005.26

Swanson, John L.

Comment Page A-7 contains a statement that conservative values of distribution coefficients"--would ensure that travel times of contaminants were at the upper bound--." Shouldn't that be LOWER bound?

Response The distribution coefficient is defined in such a manner that the constituents with the lowest distribution coefficients are those that travel with a greater velocity. The higher the distribution coefficient, the greater the resistance to movement. Therefore, the text is correct as written.

Comment Number 0005.38

Swanson, John L.

Comment At the bottom of page 3-24 and top of page 3-25, it is said that the Phased Implementation approach Phase 1 would remediate enough waste to prove that the many waste types in the tanks could be remediated effectively. This sounds good, but for it to be true you must have a different Phase 1 in mind that the Privatization Phase 1, which will prove essentially nothing about the pretreatment of SST sludges. (On page 3-92 I find "The waste processed during Phase 1 COULD (emphasis added) also include selected SST waste." This is a much different slant than the statement on page 3-24,-25).

Response The referenced text in Volume One, Section 3.3 has been revised to be less encompassing. It is DOE's intent to process enough different feedstocks (e.g., waste types and compositions) during Phase 1 to demonstrate the treatment processes before implementing Phase 2. Different feedstocks processed during Phase 1 would be expected to demonstrate maximum facility thruput, treatment of high cesium level waste, and treatment of organically complexed TRU and Strontium-90 waste. It is believed that by treating the different waste feedstocks identified during Phase 1, the majority of the waste types present in the tanks, including the SST sludges, would be adequately demonstrated to proceed with Phase 2. As explained in Volume One, Section 3.3, the contracting strategy known as privatization is not within the scope of the EIS. Please refer to the response to Comment number 0072.81.

Comment Number 0022.02

Sims, Lynn

Comment In terms of all human history we are treading on unchartered ground. Here we are confronted with a terrible cold war legacy which threatens our lives and environment. We are engaged in a monumentally serious and expensive undertaking which projects itself far into the future. Our current technology is not totally adequate, but we are morally obligated to do the very best we can NOW and not pass this dilemma to future generations.

We do know we are in this situation because of poor management and inadequate long-term planning during the production years. We do not wish to repeat these mistakes and impose disastrous results upon future generations by shortcomings in clean up decision making now.

Response The magnitude and potential impact of the tank waste are among the most extensive of the Cold War legacies. Moreover, the type and volume of waste and the scale of the technologies required for retrieval, treatment, and disposal are unprecedented. The waste poses substantial potential risks to human health and the environment. The costs for implementing any of the alternatives are substantial, and all alternatives would involve tasks that would continue for many years into the future.

It is for these reasons, among others, the Federal agencies are required to complete an EIS before decisions are made and before actions are taken. This allows decision makers and the public to be aware of the potential environmental consequences of the proposed action and ways to mitigate those impacts and for the public to be involved in decisions that affect the quality of the human environment.

Comment Number 0072.05

CTUIR

Comment The idea of NEPA is to identify and assess the full range of available options and technologies to address an issue -- in this case, the safe, effective, and protective treatment and disposition of dangerous Hanford high-level radioactive and hazardous mixed tank wastes. The current TWRS-EIS focuses only on retrieval of wastes and the explicit thermal treatment option of vitrification. Moreover, although 'closure' is not within the scope of the TWRS-EIS, a number of identified alternatives and considerable discussion throughout the EIS either pre-determine or limit ultimate closure options. The CTUIR SSRP, as a result of their interactions with other federal agencies, have noted that other potentially applicable technologies for tank waste treatment exist. A more broad range of applicable and feasible alternative treatment/disposal technologies needs to be systematically assessed with our consultation.

Additionally, NEPA requires a thorough scoping and assessment of key issues, a systematic set of screening or decision criteria, and a comprehensive consideration of a range of technological (or other) approaches to reach the desired endstate. The current TWRS-EIS examines only a limited set of treatment/disposal options and therefore cannot possibly compare the full spectrum of risks, costs, and benefits of alternative treatment/disposal options.

The Tank Waste Task Force (TWTF) identified that a "portfolio" of options for tank waste treatment and disposition should actively be explored, analyzed, and maintained for contingency planning purposes. The sheer complexity, diversity, and volume of Hanford tank wastes should intuitively mandate such an option-as-necessary-and-available approach.

Response A wide range of potentially applicable technologies exists for treating tank waste. One challenge was to eliminate from consideration technologies that were not viable and develop a range of reasonable alternatives for detailed analysis and presentation in the TWRS EIS. This discussion describes how the alternatives were developed.

There is a distinction between technologies and alternatives. Technologies are specific processes (e.g., cesium ion exchange) that relate to a component (e.g., retrieval or treatment) of an alternative. Alternatives include a set of technologies, or building blocks, that have been engineered to work together, forming complete systems for accomplishing the purpose and need for action. Alternatives are made up of a number of technologies linked together.

The evaluation of potential technologies for inclusion in the TWRS EIS began with a review of available technologies from a variety of sources including the Tank Waste Technical Options Report (Boomer et al. 1993), the Tri-Party

Agreement (Ecology et al. 1994), Hanford Defense Waste EIS (DOE 1987), and the engineering data packages prepared by the Site Management and Operations contractor (WHC 1995a, c, e, f, g, h, i, j, and h).

The first step in developing alternatives was to screen out technologies that were not viable. The full range of available technologies for each component of the proposed action was evaluated, and technologies that were not viable were eliminated from further consideration. The technologies eliminated by this screening process are described in Volume One, Section 3.8 and Volume Two, Appendix C.

After rejecting technologies that were not viable, a large number of potential technologies remained for inclusion in the EIS. It would not be practicable to develop alternatives that include all of the potential combinations of technologies. In accordance with NEPA, representative alternatives were developed for detailed analysis to bound the full range of reasonable alternatives (DOE 1993d). Upper, lower, and intermediate bounding alternatives were developed in terms of cost, risk, and technologies for the two primary decisions that affect environmental impacts: the amount of waste to be retrieved from the tanks and the degree of separations of retrieved waste into HLW and LAW. The full range of applicable technologies and alternatives therefore is included in the EIS.

Similar to the approach used by the Tank Waste Task Force, representative alternatives were developed for detailed analysis in the EIS. There are many other viable technologies for individual components of the alternatives that could not be included. These technologies are included in Volume Two, Appendix B and constitute the "portfolio" of options that could be substituted for one of the technologies that is included in an alternative without a substantial change in the impacts of that alternative. An evaluation was performed for each of the technologies identified in Appendix B. Where there would be changes in impacts, the changes are discussed in Appendix B. The level of analysis was dependent on the magnitude of the change on impacts.

The alternatives developed for presentation in the EIS were chosen to be representative of many of the possible variations of the alternative. The design information for all alternatives is at an early planning stage, and the details of the alternative that ultimately is selected and implemented may change as the design process matures. Therefore, the alternatives are intended to represent an overall plan for remediation at a level of detail sufficient for impact analysis and alternative comparisons.

DOE and Ecology are not aware of any other viable technology EIS for tank waste treatment. Please refer to the response to Comment numbers 0005.17 and 0072.08 for a discussion of the reasons closure was not addressed in the EIS.

Comment Number 0072.08

CTUIR

Comment The second major deficient factor is closure, both of waste treatment/disposal facilities and the tank farms themselves. The resolution of the tank waste issues are complex, time-transgressive, and fundamentally impact life-cycle costs. Closure issues, while not within the scope of this EIS, are essential to comprehensive planning for both waste retrieval and treatment from the tank farms. Additionally, closure will significantly impact long-term waste management and land consumption requirements on Hanford's Central Plateau -- a directly connected action which must be specifically assessed and coordinated with the CTUIR SSRP. A specific and incremental plan must be developed to accomplish safe and effective long-term waste management, and this necessarily requires a known endstate goal.

Response The final disposition of the tanks and associated equipment and the remediation of contaminated soil and groundwater associated with leaks from the tanks is a process called closure. Closure is not within the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. The amount and type of waste that ultimately remains in the tanks after remediation may also affect closure decisions. The Notice of Intent to prepare the TWRS EIS stated that: "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS to support tank closure, in the future (59 FR 4052)." However, some of the decisions made concerning how to treat and dispose of tank waste may impact future decisions on closure, so the tank waste alternatives provide information on how tank waste remediation and closure are interrelated. Closure options and assumptions are discussed in Volume One, Section 3.3.1 of the EIS.

Under the Tri-Party Agreement, the tanks are classified as hazardous waste management units that eventually would be closed under the State Dangerous Waste Regulations (WAC 173-303) and the requirements of the Tri-Party Agreement. Three options exist for closure of the tanks. The first option is clean closure, which would involve the removal of all contaminants from the tanks and associated equipment, soil, and groundwater until natural background levels or health-based standards are achieved. The second option is modified closure, which would involve a variety of closure methods and would require periodic (at least once after 5 years) assessments to determine if the modified closure requirements were met. If modified closure requirements were not being met, additional remediation would be performed. Modified closure is a method specific to the Hanford Site Permit under the State Dangerous Waste Regulations (WAC 173-303). The third option is closure as a landfill, which would involve leaving some waste in place with corrective action taken for contaminated soil and groundwater performed under postclosure requirements. This type of closure usually involves the construction of a low permeability cover over the contaminated media to reduce water infiltration and prevent inadvertent human intrusion. When sufficient information is available to evaluate the closure options, DOE will submit a final closure plan to Ecology for review and approval and an appropriate NEPA analysis will be completed.

Although sufficient information is not available to make final decisions on closure, some of the alternatives affect future closure decisions, so information is provided to allow the public and decision makers to understand how the alternatives would be interrelated with future closure of the tank farm system. For example, some of the alternatives addressed in the EIS involve removing most of the waste from the tanks (the ex situ alternatives) and would not substantially affect options for future closure decisions. Conversely, some of the alternatives do not involve removing the waste from the tanks (the in situ alternatives) but rather, would treat and dispose of the waste in the tanks. These alternatives include placing a low permeability cover over the tank farms to reduce water infiltration and prevent inadvertent human intrusion (e.g., Hanford Barrier). This would be considered closure as a landfill. Clean closure would be precluded by implementing one of the in situ alternatives. However, this would not address remediation of the soil and groundwater previously contaminated, so it would not represent complete closure of the tank farms. Therefore, the in situ alternatives would preclude clean closure of the tanks. The ex situ alternatives would not preclude any closure alternative. The decisions on closure will be made in the future when sufficient information is available.

For purposes of comparing the alternatives, a single and consistent method of closure was assumed for all of the alternatives. Closure as a landfill was chosen as the representative closure method for purposes of analysis and is included in all of the alternatives (except the No Action and Long-Term Management alternatives). This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. It is included to allow a meaningful comparison of the in situ and ex situ alternatives and to provide information to the public and the decision makers of the total cost and impacts of final restoration of the Site.

Because decisions on closure cannot be made at this time but are interrelated with decisions to be made on remediation of the tank waste, the EIS presents an analysis of impacts with and without closure in Section 5.0. In each applicable subsection of Section 5.0, the impacts of the activities associated with remediating the waste are presented first. This is followed by the presentation of the combined impacts of remediating the tank waste and closing the tank farms by closure as a landfill. This provides the public and the decision makers with information on the impacts of the issues that are ripe for decision making (remediation of the tank waste) and information on the total project impacts (remediation and closure) as well as how they may be interrelated with the decisions on remediation of the tank waste.

A comprehensive land-use plan (CLUP) is being developed for the Hanford Site, and another NEPA analysis will be prepared on the tank farm closure. The CTUIR will be consulted during the preparation of both documents.

Comment Number 0072.50

CTUIR

Comment It is not clear whether any of the alternatives will allow clean closure, and none of the alternatives include removal of tanks (or support structures).

Response Please refer to Comment number 0072.08 for a discussion of the relationship between the TWRS EIS and future closure decisions. Selection of the No Action, Long-Term Management, In Situ Fill and Cap, In Situ Vitrification (ISV), or Ex Situ/In Situ Combination alternatives would preclude clean closure. The extensive retrieval alternatives would not preclude any closure option. The discussion of closure in Volume One, Section 3.3 was modified to identify which alternatives would preclude clean closure.

Comment Number 0072.51

CTUIR

Comment There is an ongoing problem with failure to define retrieval and closure goals before retrieval is begun. At present, the action plan is to attempt retrieval, and then determine how well we did and therefore whether the tank farms will be closed as a landfill or clean closed.

Response DOE has plans to perform retrieval tests. The project is called The Hanford Tank Initiative and is discussed in Volume One, Section 3.2 of the Final EIS. The information gained from this program will provide data on the effectiveness of a variety of retrieval techniques. The waste retrieval goal is discussed in Volume One, Section 3.4 of the EIS. Please refer to the response to Comment number 0072.08 for a discussion of the relationship between NEPA requirements, the TWRS EIS alternatives, and closure. If an ex situ alternative is selected, the success of retrieval would be a factor in determining the type of closure performed.

Comment Number 0072.75

CTUIR

Comment P 3-18: PP 6: Because closure is not in the scope of this EIS, the CTUIR feels that this EIS is incomplete and actions to correct this should be taken, for example, by designing how a closure plan should be incorporated into this EIS.

Response Please refer to the response Comment number 0005.18 for a discussion of the reasons why tank farm closure alternatives cannot be analyzed at this time. The response to Comment number 0072.08 discusses the relationship between this EIS and future closure options. This response contains a discussion of the relationship between NEPA requirements, the tank waste remedial alternatives

evaluated, and related closure issues. DOE, in the Notice of Intent to propose this TWRS EIS, has committed to complete the appropriate NEPA analysis when data become available to support the analysis. The Tri-Party Agreement contains milestones relative to the preparation and approval of a closure plan for the SSTs.

Comment Number 0072.76

CTUIR

Comment P 3-20: PP 1: The CTUIR SSRP technical staff states that anything less than clean closure would result in excess risk to tribal members.

Response DOE and Ecology acknowledge the preference expressed in the comment and will consider this and other concerns when selecting the final action for TWRS waste. Closure will be addressed in a future NEPA analysis when sufficient data are available to provide a meaningful comparison of closure alternatives. Please refer to the response to Comment numbers 0072.08 and 0072.50.

Comment Number 0072.77

CTUIR

Comment P 3-20: PP 2: For the purposes of comparing the alternatives and as not to preclude ruling out any closure alternatives, the clean closure is, should, and will be replaced in all the following alternatives sections. Additionally it is impossible to do a meaningful comparison between in situ and ex situ alternatives.

Response Tank farm closure was presented in the EIS as a hypothetical closure scenario to demonstrate the relationship between remediation and closure to the public and the decision makers and so in situ and ex situ alternatives could be equitably compared. Using closure as a landfill as the hypothetical closure scenario does not mean that it has been or will be selected for implementation. Tank farm closure will be addressed in a future NEPA analysis when sufficient data are available to provide a meaningful comparison of closure alternatives. Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives are not appropriate for inclusion in the EIS.

Comment Number 0072.78

CTUIR

Comment P 3-20: PP 3: S 4 : Environmental restoration, waste management, and remediation together which define clean-up have been and are ripe for tank farm decision making. You can not separate a removal process from a closure process and plan for privatization without truly considering the future. This process has to be fair, open, meaningful and involve the complete integration of the affected tribes in order to insure true tank farm closure.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives are not appropriate for inclusion in the EIS. Volume One, Section 5.13 of the EIS presents an analysis of the cumulative effects of tank farm remediation and other projects at the Hanford Site. Section 5.13 has been updated to include emerging information concerning the environmental remediation program.

Comment Number 0072.79

CTUIR

Comment P 3-21: PP 4: S 2: Why is it not practical to compare the potential acceptable technologies with the alternatives considering the time and effort used to produce this document? It would seem at the very least to be a reasonable thing to do. If you could not include all of the potential combinations of technologies, how can a reader be sure you have included a full range of applicable technologies?

Response In accordance with the regulations (40 CFR 1500 to 1508) that implement NEPA, the full range of reasonable alternatives were developed and analyzed in the EIS. All other viable technologies and their impacts were also addressed in Volume Two, Appendix B. The purpose of the TWRS EIS was to evaluate reasonable methods or processes (i.e., alternatives) of removing, treating, and disposing of tank waste at the Hanford Site. Including all of the potential combinations of technologies in full alternatives would result in dozens of alternatives to be addressed in the EIS. This would be unmanageable and confusing to the public and the decision makers. Specific removal, treatment, and disposal technologies will be evaluated during the detailed design phase following approval of the Final EIS. Selected technologies will be tested against specific effectiveness and efficiency criteria during the Phase I demonstration (preferred alternative). Please also refer to the response to Comment number 0072.05 and Volume One, Section 3.3 for a detailed explanation of the process used to determine the range of technologies to include in the evaluation.

The Draft EIS addressed the full range of reasonable alternatives. The alternative identified in the comment (i.e., evaluate all potential technologies) is bounded by the alternatives addressed in the Draft EIS, and therefore, DOE and Ecology believe that including the analysis of all the potential combinations of technologies would not provide valuable additional information to the public or decision makers.

Comment Number 0072.177

CTUIR

Comment P B-29: PP2: The in situ alternative may be required by NEPA, but it violates the Tri-Party Agreement. Please insert language regarding this with all in situ alternatives for clarification purposes.

Response The in situ alternatives would not meet the requirements of the Tri-Party Agreement. The Summary, Section S.7 and Volume One, Section 6.2 discuss whether the alternatives meet all applicable laws, regulations, and agreements (including the Tri-Party Agreement). As required by CEQ, the TWRS Draft EIS identifies and analyzes the range of reasonable alternatives for the proposed action. Potential violation of existing laws, regulations, or agreements (any of which may be revised) is not considered basis for eliminating an otherwise reasonable alternative from consideration. Please refer to the response to Comment numbers 0072.80 and 0072.52.

Comment Number 0089.07

Nez Perce Tribe ERWM

Comment Page 3-32, Paragraph 1

The EIS assumed that 99 percent recovery of the tank wastes would be achieved. The remaining 1 percent of tank waste volume left in the tanks will leave a sizable volume of contamination in the tanks to continue to contaminate the vadose zone and groundwater. Future tank closure and soil remediation will not be possible without removal of all tank wastes.

Response The residual waste would likely contain a very low concentration of soluble contaminants because the large volume of liquids used to retrieve the waste would leach the soluble contaminants from the residual waste. The Final EIS presents human health risks based on two scenarios: 1) that the residual waste would contain the average tank contents; and 2) that the residual waste would have been leached to reduce the concentration of soluble contaminants that could be leached into the groundwater. Closure of the tank farms is not within the scope of the EIS. Please refer to the response to Comment number 0072.08 for a discussion of the reasons why closure of the tank farms will be addressed in a future NEPA analysis and 0005.18 for a discussion of the waste retrieval assumption.

Comment Number 0094.01

Moore, Jennifer

Comment I just want to say the thing I find the most disturbing about this EIS, well one of the things I find the most disturbing about this EIS, is the fact that they list not one, not two, but quite a few alternatives which violate the Tri-Party Agreement and other laws and standards. We are dealing with a ... laws which were put so that the public would be protected and that this clean up would keep going at a standard that eventually can ensure that people can live around this area and use the drinking water and basically not live in fear of dying of fatal cancer from being exposed to nuclear waste. The fact the Department of Energy is listing these as viable alternatives, viable options indicates that they do not seem to take the public safety into account very much and somewhat see themselves as above the law which they themselves entered into.

Response The NEPA regulations (40 CFR Parts 1500 to 1508 and 10 CFR 1021) require DOE to evaluate reasonable alternatives even if they do not comply with laws and regulations, so it was necessary to include such alternatives in the EIS. The response to Comment number 0072.80 contains an extensive explanation of NEPA requirements and the criteria used in this EIS to analyze the tank waste alternatives. Please refer to the response to Comment number 0072.05 and Volume One, Section 3.3 for a discussion of how DOE and Ecology identified the alternatives to be analyzed in the EIS. DOE and Ecology's preferred alternative would meet all applicable laws and regulations. Please also refer to the response to Comment numbers 0072.52 and 0072.177.

Comment Number 0097.01

Perry, Henry

Comment Considering that the DOE is representing us, the public, and is playing with more than fire in this situation with the possibility of placing the environment of the entire Pacific Northwest at risk, can there be any question that the EIS, that it prepares, should be prepared on the basis of the worst-case scenario and certainly in accordance with the Tri-Party Agreement previously agreed to.

Response The EIS presents a bounding analysis of the reasonable alternatives. Conservative assumptions and calculation methods are used to provide the public and decision makers with an assessment of the reasonable upper limit of the potential impacts of each alternative if implemented. These assumptions and calculation methods are fully presented in the appendices. The preferred alternative is in full accordance with the Tri-Party Agreement, and in the EIS, the Summary and Volume One, Section 6.2 identify regulatory compliance issues for each alternative. The regulations (40 CFR 1500 to 1508) which implement NEPA and other NEPA implementation guidance discourage the use of "worst case" analyses because these scenarios become unrealistic and blur the differences in impacts between alternatives. The EIS was modified to include an expanded consideration of uncertainties associated with the assumptions and analysis of environmental and human health impacts. The information is presented in Volume Five, Appendix K.

Comment Number 0098.02

Pollet, Gerald

Comment Secondly, in regards to the cost issues, the EIS should clearly compare the cost of the Phased Implementation Tri-Party Agreement path against the risks and costs of the prior Tri-Party Agreement path that were in place for a short period of time before 1994. Under the prior Tri-Party Agreement path, we would retrieve and process approximately twice as much waste by the year 2010 as we will under so-called Phased Implementation. As part of that clear analysis and depiction, the State and the U.S. Department of Energy owe the public and decision makers a clear presentation of the risk each year from delay. In other words, every year you leave more waste in a tank, you have a set of risks. That is why we are hear tonight. You can not deny it. That is ... we all agree that is why we are here. So the question is, does the public deserve to see what is the risk every year from delay. What is the risk from going forward with a path that the General Accounting Office has said may fail. That the State has said is likely to fail. Because of the Department of Energy's contracting decisions which are outside scope of this EIS, but the risks of failure are in the scope of this EIS and need to be disclosed because decision makers for the next decade sitting 3,000 miles away or in the State capital are going to look at this EIS and say, Ah, the risk of another change in the Tri-Party Agreement and another delay in vitrification of 2, 3, 4, 5, 10 years is not so great and we can not let them say that the risks are not so great.

Response The costs of the prior Tri-Party Agreement path are shown in the EIS as the Ex Situ Intermediate Separations alternative costs and the costs of the revised Tri-Party Agreement path are shown as the Phased Implementation alternative costs (without any adjustments for privatization). This information is presented in Volume One, Section 3.4 and Volume Two, Appendix B.

The Phased Implementation alternative would result in less waste being treated during the first 10 years of the project but also would result in all of the waste being treated 4 years earlier than previously required. These two factors would offset each other in terms of releases to the vadose zone before treatment. In any case, the leaks prior to completion are expected to be greatly reduced by the salt-well pumping program, which is currently underway. The Phased Implementation alternative also would decrease the potential for construction of a facility that does not function effectively and thereby reduce the potential for long program delays.

Comment Number 0101.06

Yakama Indian Nation

Comment Invalid Constraints on Scope of EIS Reflecting Lack of Systems Engineering Integration -- The lack of consideration of the impacts associated with the closure of the tank farms following removal of the bulk of the wastes and remediation of the hazardous vadose zone around the tanks is unreasonable, since an integrated systems approach to develop low impact alternatives for tank waste retrieval and tank farm decontamination and decommissioning is warranted to save financial resources and reduce worker exposure. For example, actions required to remediate vadose zones at the tank farms as part of the closure actions may greatly simplify tank waste retrieval actions, reducing costs and expediting retrieval. Cumulative impacts can only be attained when related/integrated actions are evaluated.

Response DOE and Ecology believe that there is sufficient information available to analyze alternatives for remediation of the tank waste even though a number of uncertainties exist for various aspects of the action. These uncertainties are identified in the EIS. DOE is implementing a systems engineering approach to remediation of the tank waste. The integration of tank waste remediation with tank farm closure has been difficult because there is insufficient information available on contamination in the vadose zone and past practice releases. The Notice of Intent to prepare this EIS stated that, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS to support closure, in the future" (59 FR 4052).

There is a relationship between closure and tank waste remediation because certain alternatives for tank waste remediation would preclude clean closure of the tank farms. This relationship was discussed in the Draft EIS in Volume One, Section 3.3 on pages 3-18 to 3-20. In addition, a representative closure option, closure as a landfill, was included in all of the remediation alternatives to demonstrate the relationship of closure to remediation and to allow an equitable comparison of the alternatives. This does not mean that closure as a landfill will be selected as the closure alternative, but it provides an assessment of the total potential impacts for the environment. Consistent with NEPA regulations (40 CFR 1500 to 1508), the EIS has been prepared with the most current available information.

The emerging information concerning contamination in the vadose zone was mentioned in the Draft EIS in Volume One, Section 3.4, and the Final EIS has been modified to address the data, as appropriate, in Volume One, Section 4.2 and Volume Five, Appendix K. A systems engineering approach also will be taken to the development of data and engineering when DOE performs a NEPA analysis for closure.

L.3.3.2 Cesium and Strontium Capsules

No comments were submitted for this topic.

L.3.4 TANK WASTE ALTERNATIVES

L.3.4.1 Preferences for Tank Waste Alternatives

<u>L.3.4.1.1 Specific Preferences</u>

Comment Number 0008.06

Evett, Donald E.

Comment I consider the No Action and Long-Term Management alternatives to be unsuitable for consideration. I believe the impact study reveals significant rationale making this alternative too high of a risk, especially for many years into the future.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please also refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives, and the response to Comment number 0072.80 for issues related to the CEQ, NEPA and the 100-year administrative control period.

Comment Number 0009.07

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) has acceptable risks to workers and offsite public. The other alternatives do not have a significant reduction in fatalities. (About 75 in 10,000 years.) It should be kept in mind that even though statistics indicate a certain level of health effects will be experienced, Hanford will continue to reduce them. The current safety record of Hanford is much better than the national average. We must assume that the good record will continue, and in fact, we must ensure it.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. As noted, the Hanford Site does have a safety record that exceeds the national average, and DOE is committed to continuing improvement of its safety performances. Please refer to Volume One, Section 5.12 and Volume Four, Appendix E, which discuss accident risk during and after remediation. Please also refer to the response to Comment number 0009.06.

Comment Number 0009.08

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) is one of the lowest cost to perform. In addition, it minimizes repository costs. We do not know what the repository costs will be, but it is unlikely that they will be lower than the current estimates.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. A discussion of factors influencing the evaluation of alternatives is provided in the Summary (Section S.6), a comparison among the alternatives is provided in the Summary (Section S.7), and a summary of the environmental impacts is presented in Volume One, Section 5.14.

A reevaluation of repository costs, which accounted for the use of larger canisters in the geologic repository, led to a reduction in repository costs for some alternatives. These revised costs have been presented in the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B. The response to Comment numbers 0081.02, 0004.01, and 0008.01 extensively discuss the issues related to repository costs.

Comment Number 0009.09

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will have the facilities constructed by 2007. This is faster than most of the alternatives. Speed is very important because it seems that Hanford, as time goes on loses its concentration and wants to do something else. The number of canceled projects is very large, and very expensive.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of project completion is but one of many factors that influence the evaluation of alternatives. Other factors analyzed include short- and long-term risk to human health and the environment, technical uncertainty, cost, and regulatory compliance. Please refer to the response to Comment numbers 0009.08 and 0009.10.

Comment Number 0009.11

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) does not meet all of the regulations; however, they can be negotiated to be modified to assure that the public is adequately protected. The Tri-Party Agreement is a good place to document the negotiations.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The ability of the alternatives analyzed in the EIS to comply with Federal and State regulations is presented in the Summary (Section S.7) and discussed in detail in Volume One, Section 5.7.

Comment Number 0009.16

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the cost (for the Preferred Alternative) is not the lowest that provides adequate protection of the public.

Response DOE and Ecology acknowledge the objection to selection of the Phased Implementation alternative as the preferred alternative, and this comment and other public comments will be taken into consideration when making a final decision on remediating TWRS waste. Please refer to the response to Comment number 0009.15. As discussed in the Summary (Section S.6), there are a number of factors that influence the evaluation of the alternatives. Cost was one factor analyzed for each alternative. The results of the impacts analysis are presented in the EIS in an objective, nonvalue-laden (e.g., less or more cost is preferable) manner for careful consideration by the public and decision makers. Cost comparison of the alternatives was never conducted in the absence of all other factors, which included risk to human health and the environment, long-term land use restrictions, and regulatory compliance. Furthermore, for the final EIS cost impacts associated with HLW storage at the proposed geologic repository have been presented separate from costs associated with the waste management, retrieval, treatment, and disposal or disposal onsite. For example in comparing the Ex Situ/In Situ Combination 1 alternative to the Phased Implementation alternative, the cost of long-term land use restrictions and risk to human health and the environment, as well as cost, monetary or other, of not complying with current regulatory requirements were analyzed equally. Please refer to the response to Comment number 0081.02 for discussions of cost issues related to the alternatives.

Miscellaneous Preferences

Comment Number 0001.01

Bell, Robert C.

Comment There currently exists containment technology that could completely seal off the leaking nuclear contaminants from migrating through the earth and contaminating the groundwater. However, it appears that no monies have been budgeted for the containment of the leaking nuclear waste. By containing the leaking storage tanks the public along with all life would be protected from the most toxic and deadly nuclear waste. I urge you to actively support the request to the United States Congress for funds to pay for the containment of the leaking tanks at Hanford.

Response Subsurface barriers are addressed in the EIS as a containment technology that could be applied to control tank leakage. The function of the subsurface barriers would be to prevent leakage of tank waste from migrating beyond the barrier into the vadose zone, which would help minimize the volume of contaminated soil. The possible use of subsurface barriers was derived from concerns about using hydraulic sluicing for retrieval, and because some of the SSTs either are confirmed or assumed leakers. Also, a study titled Feasibility Study of Tank Leakage Mitigation Using Subsurface Barrier (Treat et al. 1995) was completed in support of a Tri-Party Agreement milestone and was one of the references used during preparation of this EIS. The feasibility study assessed the application of existing

subsurface barrier technologies and the potential of existing technologies to meet functional requirements for SST waste storage and retrieval activities. Information on subsurface barriers is included in Volume Two, Section B.9.

In addition, the current TWRS program involves a wide variety of ongoing activities that include monitoring the integrity of tanks and characterizing the vadose zone around the tank farms to detect leaks. DOE also conducts numerous activities to provide continued safe storage of the tank waste, such as the saltwell pumping program, which involves removing retrievable liquids from SSTs to minimize potential future leaks. These ongoing programs are described in Volume One, Section 3.2.

This EIS addresses the full range of reasonable alternatives. This includes 10 tank waste alternatives ranging from no action to extensive retrieval. Risk to human health and the environment was among the factors considered by DOE and Ecology in identifying the preferred alternative, Phased Implementation (a discussion of factors that influence the evaluation of alternatives is presented in the Summary, Section S.6). Volume One, Section 5.13 (Cumulative Impacts) addresses actions at other DOE sites, programmatic actions, and actions at the Hanford Site that could impact the TWRS actions, including the Hanford Remedial Action Program. The proposed TWRS activities would be carried out against the baseline of overall Hanford Site operations. Volume One, Section 5.11 and Volume Three, Appendix D detail the anticipated risk for each alternative.

DOE and Ecology acknowledge the recommendation expressed in the comment regarding funding. However, Congressional funding issues are not included in the scope of this EIS.

Comment Number 0040.01

Rogers, Gordon J.

Comment The In Situ Fill and Cap alternative is clearly the best choice. The cost is low enough to have some real chance of being funded by Congress. It reaches a reasonable stage of completion in the shortest time. The short-term impacts are trivial. The long-term impacts appear likely to be small and acceptable providing that onsite use of groundwater is prohibited; and further than onsite farming and irrigation is prohibited.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Short- and long-term environmental impacts, uncertainties, and regulatory compliance are among the factors influencing the evaluation of alternatives. A discussion of these and other factors influencing the evaluation of alternatives is provided in the Summary, Section S.6, a comparison among the alternatives is presented in the Summary, Section S.7, and a summary of environmental impacts is provided in Volume One, Section 5.14.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, although Congressional funding issues associated with implementation of the alternatives were not included in the scope of the EIS. Please refer to the discussion contained in the response to cost concerns related to a comparison of the alternatives contained in Comment number 0081.02.

Comment Number 0072.11

CTUIR

Comment Of the alternatives presented, the CTUIR SSRP technical staff prefers Ex Situ with Extensive Separations because the cost is comparable, the volume of waste is comparable, the technical uncertainty is no higher than the other ex situ alternatives, and the activity of the LAW would be substantially lower than with less extensive separations. The phased approach will not be practical since substantially more land is required for two sets of vitrification facilities rather than the one set required for the non-phased options.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Multiple factors, including land-use commitments, influence the evaluation of alternatives. Among the factors are short- and long-term environmental impacts, regulatory compliance and uncertainties. These factors are addressed in the EIS in the Summary, Section S.6. In the Summary, Section S.7 contains a comparison of the alternatives based on various evaluation factors and Volume One, Section 5.14 provides a summary comparison of all of the environmental impacts addressed in the various sections of Volume One, Section 5.0 and the supporting appendices. The response to Comment number 0081.02 contains a discussion of the comparison impact of separating repository costs from retrieval and treatment costs of the ex situ alternatives.

Land use commitment impacts were analyzed in detail in Volume One, Section 5.7. Based on that analysis, Volume

One, Section 5.19 identifies potential land use restrictions as a potential environmental justice concern for affected Tribal Nations. Volume One, Section 5.20 identifies potential mitigation measures that could be implemented to address the land use impacts identified in Section 5.19. For the Final EIS, these sections of the Draft EIS were revised to reflect technical information unavailable at the time the Draft EIS was published.

Comment Number 0085.02

Klein, Robin

Comment While it is true that a clearly proven, good solution does not exist, it is also true that the liquid wastes must not remain in these tanks. The leaking tanks are the greatest source of waste contaminations to the soils. Contaminated waste originating from the tanks are moving toward groundwater. Groundwater contaminated with Hanford pollutants already in the soils is now in communication with the Columbia River. Cleaning up waste once in the soils will take heroic efforts. Once they get into the river, the long lived contaminants are practically irretrievable. The single most affective measure we can take to protect the river in the long run is to stop the driving force that enables rapid migration of the wastes offsite, get the waste out of the leaking tanks soon. So it is important to have an aggressive plan in place.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology are committed to protecting the Columbia River. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0088.03

Porter, Lynn

Comment There's an article in the Oregonian Sunday March 17th, that raised a whole lot of questions. This was a large article beginning on the front page quoting a panel of scientists from the National Research Council, whoever that is, I probably should know, but I don't. And they're saying just leave the stuff in the tanks. They quote some DOE engineers saying yes we can do it. And one of the points that puzzled me was they're saying in this article, the National Research Council says that before you can sluice out these tanks you have to seal the ground underneath them. I didn't find anything about that in the summary of the Draft EIS, except for the ISV option. So I don't know where this comes from, but their point seems to be that if you're going to have to seal the ground anyway, you might as well leave the stuff in the tanks. That's something I would have like to of heard discussed.

I think the problem is that this kind of thing keeps coming up. And so of course we wonder where's it coming from. There seems to be a lot of energy behind this idea we'll just leave the stuff in the tanks and put it cap on it and walk away. I'm glad to hear that isn't the feeling at the top. But since it keeps coming up in such volume, we wonder what's going on, like is this a trial balloon. If it is, I'd like to shoot it down. I just think leaving the stuff in the tanks is a completely unacceptable alternative. And I wish someone would take this idea out and bury it and drive a stake through it's heart.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The National Research Council, in the cited article, advocated an alternative that evaluated the impact of not removing waste from selected tanks. This alternative, which corresponds to the Ex Situ/In Situ Combination 1 and Ex Situ/In Situ Combination 2 alternatives evaluated in the EIS, is not the preferred approach endorsed by DOE and Ecology. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and Comment number 0001.01, which discusses subsurface barriers as this issue relates to leak containment.

Specific Preference for Ex Situ/In Situ Combination Alternative

Comment Number 0009.05

Broderick, John J.

Comment The above reasoning has lead me to recommend you select the following remediation alternative: Ex Situ/In Situ Combination. I believe the Preferred Alternative is doomed to be not completed because it is trying to avoid leaving waste in place, will take too long to construct, and will cost too much. In addition, there is a possibility that the whole issue will again be revisited at the beginning of the second phase. This will be another opportunity to change the remediation approach.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0009.06 for a description of revisions to the alternatives in the Final EIS, 0009.08 for a description of the factors considered when evaluating alternatives, and 0009.09 for a description of the time required to implement alternatives.

Comment Number 0009.06

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) selects the actions based on long term health effects, rather than a "one size fits all" approach.

Response The ex situ/in situ combination alternatives are based on reduction of human health risk and different tanks having much different contents, therefore representing differing potential long-term impacts to human health. For the Final EIS, two ex situ/in situ combination alternatives are analyzed in detail. Volume One, Section 3.4 and Volume Two, Appendix B provide a description of the two alternatives and the potential impacts associated with each alternative are analyzed in Volume One, Section 5.0 and associated appendices.

Comment Number 0009.10

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will deal with more waste faster than other, more extensive alternatives. Thus there will be less effort expended in just managing the waste.

Response DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of completion of the project was one of many factors that influence the evaluation of alternatives (please refer to the response to Comment number 0009.08). Duration of construction and remediation is directly proportional to the nature and volume of tank waste, as well as the complexity of the tank farms as a whole (i.e., vadose zone contamination, groundwater migration, and closure). The preferred alternative, using a phased approach, would allow evaluation and optimization of the technologies used to treat the waste form and nature to be retrieved, which would enable the Agencies to apply "best fit" for the waste type. A summary of the environmental impacts of all alternatives analyzed in the EIS is presented in Volume One, Section 5.14 and a comparison of the alternatives is presented in the Summary (Section S.7).

Comment Number 0009.12

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will provide means so the waste will not migrate from its disposal location. Still, there will be waste present, so there must be a continuing program to restrict farming, groundwater use, and intrusion. This program will be much less expensive and less complicated than removing all waste from Hanford.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. For purposes of analysis in the EIS, institutional controls for this and other alternatives would end 100 years following the end of remediation. Thus, the long-term impacts assume unrestricted use of the Site for farming and potential use of groundwater as well as intrusion into the waste disposal onsite. Therefore, while the cost, technical complexity, and short-term impacts of the combination alternatives are less than that of the ex situ alternative; long-term impacts tend to be higher. For a comparison of the alternatives, please refer to the Summary, Section in 5.7.

Comment Number 0009.15

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the extra effort (for the Preferred Alternative) does not significantly reduce the fatalities expected, even though all the waste is removed.

Response DOE and Ecology acknowledge the preference expressed in the comment, but have identified the Phased Implementation alternative as the preferred alternative for the reasons described in the Summary (Section S.7). As discussed in Section S.6, there are a number of factors that influence the evaluation of the alternatives including short-term and long-term impacts, uncertainties, and compliance with laws and regulations. Please also refer to the response to Comment number 0098.06 for more information about risk calculation. Reduction in fatalities is one method of comparing alternatives; however, other issues such as regulatory compliance, long-term reduction in potential risks to human health and the environment, and implementability in light of technical uncertainty must also be considered.

Comment Number 0009.17

Broderick, John J.

Comment The Preferred Alternative is not acceptable because there will be significant repository costs (for the Preferred Alternative). The costs are uncertain now because we do not have a repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The repository cost for each alternative was calculated to provide the public and decision makers with information associated with the total potential costs of the various alternatives. Based on new information made available since the publication of the Draft EIS, repository costs have been substantially revised for the Final EIS (Volume One, Section 3.4 and Volume Two, Appendix B). A discussion of the methodology used to calculate repository costs, the cost associated with each alternative, cost formulas, and canister size issues, is contained in the response to Comment numbers 0081.02, 0004.01, and 0008.01.

Comment Number 0009.18

Broderick, John J.

Comment The preferred alternative is not acceptable because the construction of facilities will not be completed until 2012 (for the preferred alternative). This is way too long, our experience is that long duration projects often do not reach the operational phase.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Phase 1 of this alternative (construction and operations) would be completed in 2007. Phase 2 construction would be completed in approximately 2011. DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of completion of the project is but one of many factors that influence the evaluation of alternatives. Please refer to response to Comment numbers 0009.09, 0009.10, and 0098.02, which discusses issues related to construction starts and duration and the impact of the phased approach on the volume of waste treated.

Comment Number 0009.19

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the phased approach is not needed. We can build the facilities with existing technology. As our knowledge and experience increase over the next 45 years, we can modify the facilities. We will need to do that anyway to keep up with technology and safety requirements.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The preferred alternative, Phased Implementation, represents near-term use of currently available technologies to the extent possible. Phase 1, also known as the demonstration period, will assess the capability and effectiveness of existing technologies to retrieve and treat the waste and provide DOE with information on retrieval efficiencies, blending practices, separation efficiencies, vitrification techniques, and costs prior to constructing and operating full-scale facilities. This will result in more efficiently designed and operated facilities for Phase 2. The implementation schedule for the preferred alternative is consistent with Tri-Party Agreement milestones, as well as concurrent with other programmatic and systems activities currently conducted at the Site. Because the phased approach is designed to implement "learn as you go" improvements, system optimization and cost savings are expected. This approach and resulting benefits may be less likely with a fixed, less flexible technology or implementation of full-scale facilities without a demonstration phase. For a discussion of the phased approach to alternative implementation, see Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to the response to Comment number 0098.02 for a discussion of schedule and treatment volume estimates associated with the preferred alternative.

Comment Number 0029.01

Bartholomew, Dale C.

Comment I believe that the Ex Situ/In Situ Combination alternative offers the best balance between risk and benefit of the proposed alternatives and should be selected as the preferred alternative for the following reasons:

It offers the highest real value. It provides a level of safety to the public commensurate with other sub-surface contamination immediately adjacent to some of the tanks, adjacent to the 242-S evaporator, and sites such as cribs throughout the 200 Areas as well as other contaminated areas adjacent to the 200 Areas such as BC Crib. If my understanding is correct, no further action is planned on these other sites. Therefore, totally uncontrolled access by the public would be unacceptable, and I recommend that a waiver be obtained for relief for tank wastes from the regulations. This may be politically incorrect, but makes the most sense in the context of a balanced total system.

Retrieval of wastes from all SSTs, DSTs, and MUSTs is a huge waste of money if the soil contamination sites outside the tanks are not also ameliorated.

I also believe retrieval of wastes from all tanks creates a higher-than-projected exposure of working personnel to both occupational and radiological accidents and injuries. I have no data to support this. However, my experience suggests that the input data for the calculations may not be realistic.

The Summary Table indicates that the Ex Situ/In Situ Combination alternative and the preferred alternative are both rated "moderate" with respect to Technical Uncertainty. I believe the degree of technical uncertainty associated with the Ex Situ/In Situ Combination is less than the preferred alternative because only one-half of the waste volumes would be vitrified and sent to the repository with the Ex Situ/In Situ Combination alternative, (50 percent of the tanks would be filled and capped). It should have received a lower Technical Uncertainty rating because of scaled-down throughput requirements.

I suspect when wastes from all of the tanks are retrieved, there will be several SSTs thought to be non-leakers that will be found to be leakers. That will only add to existing soil contamination during sluicing.

I noticed where the U-238, Tc-99, C-14, and I-129 isotopes were to be retrieved. I fully support this action. I may have read the document too quickly, but I did not notice any reference to TRU wastes. Obviously, these must also be removed and vitrified.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The following responses are in the same order as the comments.

Short-term and long-term impacts to human health and the environment, managing the uncertainties associated with the waste characteristics and treatment technologies, cost, and compliance with laws, regulations, and policies are among the factors considered when evaluating the alternatives (please refer to the response to Comment number 0009.08). No decision has been made regarding remediation of subsurface contamination adjacent to the tanks or in the other areas referred to in the comment. Contamination from past tank leaks is beyond the scope of this EIS (see Volume One, Section 3.3 and the response to Comment number 0072.08). Other contamination of soils in the 200 Areas is the subject of the Hanford Remedial Action EIS and subsequent Comprehensive Environmental Response, Comprehensive Environmental Response Compensation and Liability Act (CERCLA) decisions. The TWRS EIS presents the cumulative impacts of the tank waste alternatives and the 200 Areas contamination in Volume One, Section 5.3).

The retrieval of wastes from the SSTs, DSTs, and MUSTs and their subsequent remediation is considered in this EIS. Tank waste retrieval and treatment is the first step in remediation of the tank farms. The remediation of soil contaminated sites outside the tanks will be considered in other environmental documentation, such as the Hanford Remedial Action EIS. The EIS analyzes a range of alternatives from no waste retrieval to extensive waste retrieval. Each of the alternatives presents differing trade-offs among short-term and long-term environmental impacts, technical uncertainty, and regulating compliance. Additionally, alternatives that involve no retrieval or partial retrieval, such as the ex situ/in situ combination alternatives would influence the closure actions that could be implemented, as discussed in Volume One, Section 3.3. Implementation of these alternatives would limit or potentially increase the cost and complexity of the future closure actions such as remediation of contaminated soils. Extensive retrieval alternatives would provide the least complications and cost impacts on future closure actions.

The risks to the workers during construction and operation of the retrieval and transfer facilities for the ex situ alternatives have been analyzed for all the alternatives. The results of this analysis are given in Volume Four, Appendix E and in Volume One, Section 5.12. In general, risks to the workers are less when less retrieval and transfer are conducted. Regardless of the alternative selected, DOE would complete a detailed safety analysis of the alternative to determine additional safety measures for implementation. Please refer to the response to Comment number 0098.06 for risk calculation information.

The technical uncertainty of an alternative is a compilation of numerous factors, such as similarity to other like operations, the history of demonstrated performance of the technology, the ability to construct and operate the alternative given the conditions at the Site, and others. However, if two technologies are operating at roughly the same scale and production rate, the technical uncertainty is not a direct function of the throughput requirement. The ability to design, construct, and operate the Phased Implementation alternative and the ex situ/in situ combination alternatives are approximately the same. Both alternatives have approximately the same degree of process development, consequently, the two processes will be rated about equal in their technical uncertainty.

To account for leakage from the SSTs during retrieval, the EIS assumes an average of 4,000 gallons of leakage from each tank (see Volume One, Section 5.2 and Volume Four, Appendix F). It is not expected that all SSTs will leak this amount. Some SSTs will not leak during retrieval, and as the comment suggests, some SSTs will develop unexpected leaks. It has been assumed in the EIS that the total leakage divided by the number of tanks will be bounded by the 4,000-gallon figure. For tanks that are known leakers or that develop leaks during retrieval, the EIS presents technology options to sluicing, such as robotic arm-based retrieval, that would involve substantially lower volumes of liquids (see Volume One, Section 3.4 and Volume Two, Appendix B).

The purpose is to retrieve the radionuclides that are the chief contributors to long-term risk (i.e., uranium-238, technetium-99, carbon-14, and iodine-129). Neptunium-237, a TRU isotope, is also a contributor to long-term risk, and this alternative shows a calculated retrieval of approximately 93 percent for this isotope. There is a large calculated proportion of other TRU elements that would be retrieved, but do not move quickly enough in the vadose zone and groundwater to contribute to risk within 10,000 years.

Specific Preference for the Phased Implementation Alternative

Comment Number 0012.01

ODOE

Comment Governor Kitzhaber and Oregon strongly support the preferred alternative in the environmental impact statement (EIS). This alternative calls for a retrieval of all of the tank wastes technically possible (estimated at 99 percent of the wastes) and vitrifying the wastes. While the vitrified wastes will still be radioactive, they will be safer to store and not susceptible to leakage pending ultimate disposal.

Although we support the preferred alternative, it will not resolve all the issues related to the high-level wastes at Hanford. We believe there will continue to be the need for ongoing monitoring, characterization, and pumping and treating of groundwater contamination caused by waste which has leaked and migrated from the tanks.

Response DOE and Ecology acknowledge the preference of the State of Oregon for the preferred alternative, and will take this preference and other public comments into consideration when selecting the final action for TWRS waste. The issues identified were among the factors considered by DOE and Ecology in identifying the preferred alternative.

The Hanford Site will require ongoing monitoring and characterization relative to past tank leaks and the migration resulting from those leaks into the surrounding environment. The characterization and monitoring programs are discussed in the response to Comment numbers 0072.61, 0072.63, 0072.67, and 0072.70. Each of the alternatives includes continuation of existing programs to characterize vadose zone and groundwater contamination and long-term monitoring programs that extend beyond the completion of the tank waste action (Volume One, Section 3.4 and Volume Two, Appendix B). As more information becomes available regarding the environmental consequences of past leaks and the nature of residual waste remaining in the tanks following retrieval, DOE will be able to address actions associated with tank farm closure, including the potential for pumping and treating groundwater contamination beneath the 200 Areas (see Volume One, Section 3.3 for a discussion of closure). It is because of the lack of adequate data regarding these issues that the closure of the tank farms is not included in the scope of this EIS. Please refer to the response to Comment number 0072.08.

Comment Number 0012.03

ODOE

Comment Leaving wastes in the tanks poses huge risks. The tanks are corroding and failing. As they fail, the radioactive waste is released to the soil and ultimately to the groundwater and to the Columbia River. Vitrifying the tank waste makes it far more stable and greatly reduces the threat to the public and the environment. While the cost of the preferred alternative is substantial, it is the only alternative which satisfactorily deals with the dangers presented by these wastes as quickly as practical. The phased approach allows USDOE to get on with cleanup while allowing for possible development of better approaches which remove all tank wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The issues identified were among the factors considered by DOE and Ecology in identifying the preferred alternative, Phased Implementation. Please refer to the response to Comment number 0009.19 for reasons the Phased Implementation was identified as the preferred alternative.

Comment Number 0012.07

ODOE

Comment The preferred alternative relies on proven technology and a phased approach. This allows a "learn as you go approach" which should identify problems earlier and at a smaller economic and environmental cost.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The issues identified were among the factors that influence the evaluation of alternatives. Please refer to the Summary, Section S.6 and S.7 and the response to Comment numbers 0009.08 and 0009.19.

Comment Number 0012.09

ODOE

Comment The current risk modeling and analysis are too simplistic to allow detailed decisions which call for leaving part of the wastes in place and still protect human health and the environment. We believe the risk assessment in this EIS is sufficient to support the proposed alternative and to conclude that the risks are too large to allow any of the tank waste to remain in the tanks at the end of cleanup.

Response The risk modeling and assessment performed for this EIS used the best available data, state-of-the-art models, and industry standard approaches and techniques and is both comprehensive and detailed. The data generated by the modeling and assessment provided for a balanced and equitable comparison among the alternatives and as such, provided results that were useful in comparing the potential short-term and long-term human health and environmental impacts. To the extent that the risk assessment provided sufficient data to evaluate the preferred alternative, it also provided equally valid data to support the evaluation of all alternatives, including alternatives involving leaving some or all of the waste in place. For the Final EIS, an appendix (Volume Five, Appendix K) was added to the EIS to provide a basis for understanding uncertainties associated with the risk assessment, as well as other areas of uncertainties.

Comment Number 0022.03

Sims, Lynn

Comment We know millions of gallons of waste have already leaked from the tanks and migrated towards groundwater. This relentless assault upon the environment will not cease without intervention. We are not certain of the environmental and human health damage which has and will result from leaking tanks, but forecasts are ominous. The only responsible alternative is the preferred alternative which removes as much waste as possible and isolates them from the environment by vitrification.

Response DOE and Ecology acknowledge the preference expressed in this comment and will take into consideration this preference and other public comments when selecting the final action for TWRS waste. DOE has implemented a program to remove as much of the liquids as practicable from the SSTs to reduce the likelihood of future leaks. A discussion of this program is provided in Volume One, Section 3.4 and Volume Two, Appendix B. An analysis of potential cumulative impacts, including past leaks is presented in Volume One, Section 5.13 and new information regarding the extent of migration of past leaks to the vadose zone and groundwater has been included in Volume Five, Appendix K. The ongoing characterization and monitoring program is discussed in the response to Comment numbers 0072.61, 0072.63, 0072.67, and 0072.70.

Comment Number 0032.04

Heacock, Harold

Comment We support the Department's preferred alternative of phased implementation of an ex situ intermediate separations process, which provides for the greatest protection of the environment, including protection of the groundwater consistent with a reasonable projected cost, the disposal of the vitrified high-level waste at a national waste repository, and an acceptable degree of risk.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. Pleaser refer to the response to Comment number 0009.19 for a discussion of the reasons Phased Implementation is the preferred alternative.

Comment Number 0035.08

Martin, Todd

Comment I would like to address what I think is good in the EIS. We support the pretreatment selection in the preferred alternative.

Intermediate separations is appropriate. HEAL would vigorously oppose any movement towards extensive separations pretreatment process.

The stakeholder community in the Northwest has made it very clear that intermediate separations is responsive to our values. It is available relatively, and it will reduce the waste volume by a satisfactory amount.

Secondly I support the assumption that 99 percent of the waste will be retrieved. The risks in the EIS show very clearly that the only responsible alternative is to retrieve all of the waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0005.38 for a discussion of issues related to pretreatment. The response to Comment number 0012.19 contains a detailed discussion of the extent to which the public has made a positive impact on this document.

Comment Number 0036.10

HEAL

Comment HEAL supports the full retrieval of Hanford's tank wastes. The preferred alternative's retrieval scenario is responsive to the stakeholder values. It has always been assumed that Hanford's tank wastes post a great risk to future generations. This EIS confirms the assumption. The EIS shows that future risk is directly correlated to the amount of waste left behind. The impact of leaving only a small portion of contamination behind is evidenced by the difference in long-term risk for the preferred alternative where 1 percent of the waste is left and the Ex Situ/In Situ alternative where 10 percent of the waste is left behind. By leaving 9 percent more waste behind, the risk for residential farmer at 5,000 years would increase by a factor of 10. These high risks clearly show that the only responsible solution is to retrieve all of the waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Impact to the public welfare, including residential farmers, was a factor analyzed for all alternatives. Please refer to the response to Comment number 0009.05. The environmental impacts of all the alternatives analyzed in the EIS are summarized in Volume One, Section 5.14. Potential long-term health effects are summarized for each alternative in the Summary, Section S.7.

Comment Number 0038.03

Reeves, Merilyn

Comment Now, the board supports the full retrieval from Hanford tank waste. The preferred alternative retrieval scenario is responsive to the board's value.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0009.19 for a discussion of the reasons the Phased Implementation alternative is the preferred alternative.

Comment Number 0038.05

Reeves, Merilyn

Comment The Board supports the preferred alternative's pretreatment process. And again, we go back to the Tank Waste Task Force, which stated the high cost and uncertainty of high tech pretreatment and R and D threatens funding for higher performance low level waste form vitrification and cleanup.

Use the more practical, timely, available technology while leaving room for future innovations. Keep a folio of technology options and make strategic investments over time to support the limited number of promising options. Give up further research on unlikely options. Again a statement from 1993.

The intermediate separations case is responsive to this value although the difficult challenge of technetium removal in the Phased Implementation alternative is a concern to the Board.

And the Board would strongly oppose any movement towards extensive separations pretreatment technology.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.05 for a description of how the alternatives analyzed in the EIS were identified and methods for analyzing technology options in the EIS.

Implementing Phase 1 of the preferred alternative would allow evaluation of existing technologies while moving forward on retrieval and treatment goals. As the demonstration phase progresses, the efficiencies and effectiveness of the retrieval and treatment technologies, including technetium separation, can be evaluated and optimized. Technetium removal could be implemented during Phase 1 using established separations technology or emerging technologies that show promise in keeping with recommendations of the board. One way of removing technetium-99 from alkaline waste solutions is to selectively sorb the isotope, as TcO_4, using a strong-base organic ion-exchanger (WHC 1995a).

Comment Number 0042.01

EPA

Comment The EIS addresses the treatment, storage, and disposal of Hanford Tank Waste to meet the requirements of the Hanford Federal Facility Agreement and Consent Order and the Resource Conservation and Recovery Act as amended by the Hazardous and Solid Waste Amendments of 1984. As a signatory to the Agreement and Consent Order, EPA has endorsed the approach identified in the Draft EIS as the preferred alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0005.07.

Comment Number 0043.02

Hanford Communities

Comment In its selection of an alternative for the cleanup of tank wastes, we believe that the Department of Energy must comply with State and Federal laws and must also comply with its commitments under the Tri-Party Agreement. We believe that the Department should proceed with an ex situ process of extensive waste retrieval with phased implementation. This process appears to have the strongest backing of people in this area and provides the best long-term environmental solution.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology intend to comply with all Federal, State, and local regulations and ordinances applicable to tank waste remediation. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0076.01

Blazek, Mary Lou

Comment I had passed out a comment, or a formal comment that I would like to have read into the record. I won't do that now, it would be lengthy. I just like want to say on the record that Governor Kitzhaber and the Oregon Department of Energy strongly support the proposed alternative in this Environmental Impact Statement. The retrieval for all the tank waste that are technically possible, up to 99 percent we think is critical that occur. The need for this undertaking is compelling in our minds. The potential impact to the Columbia River cannot be impacted in this way.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology remain committed to protecting the Columbia River and the analysis of potential impacts of TWRS alternatives includes impacts to the River as presented in Volume One, Section 5.2 and Volume Four, Appendix F. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0076.02

Blazek, Mary Lou

Comment The other alternatives under consideration leave most, or all of the waste in the tanks, with the exception of the in situ vitrification, which is an immature and unproven technology. Other alternatives do little to remove the hazards posed by the waste. The major criteria that must be applied to any decision is the protection of public health and safety and the environment. This criteria eliminates all of the alternatives, which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, although it's an immature and unproven technology. Because the in situ vitrification technology is uncertain, we oppose all of the alternatives, which leaves the waste in Hanford tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and 0005.18, which discusses tank waste residuals.

Comment Number 0077.03

ODOE

Comment Sacrificing Hanford in this way does not adequately reduce the harm and risks to the environment or to future generations. For these alternatives, the risk analyses in the EIS show massive plumes of radioactive material slowly moving across the Hanford site and into the Columbia River for hundreds to thousands of years.

Cost should not be the sole or even predominant criteria used to select among the alternatives. The first criteria that must be applied is protection of public health and safety and the environment. This criteria eliminates all of the alternatives which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, although it is an immature and unproven technology for tank waste. Because in situ vitrification technology is uncertain, the potential for failure is unacceptably high. We strongly oppose all of the alternatives which leave the waste in Hanford's tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Removing, treating, and disposing of the tank waste would be the first step in providing protection to the vadose zone, groundwater, and the Columbia River. Please refer to the response to Comment numbers 0076.02, 0040.01 and 0005.18 for more information. The response to Comment number 0009.16 contains a discussion of the analysis of cost alternatives.

Specific Preference for Vitrification

Comment Number 0047.01

Ahouse, Loretta

Comment The wastes that are in the tank farms at Hanford must be dealt with at all costs. My preference is to see that all of the tank waste be removed and vitrified, regardless of whether or not the vitrified logs are ever moved to Yucca Mountain, Nevada.

It is an undisputed fact that the tanks at Hanford have leaked, although there appears to be a question of how far and how fast. Despite this, we do know that the tanks leak and may pose a potential danger to the groundwater under the Hanford site, and ultimately the Columbia River. For this reason, all of the waste that is technically feasible to remove, must be removed and immobilized in a safe manner. This should not be an issue of costs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. As more information becomes available from the ongoing vadose zone and groundwater monitoring and characterization program, DOE will be able to address issues related to tank farm closure. The EIS has been modified to include information on vadose zone contamination in Volume One, Sections 4.2 and 5.13 and in Volume Five, Appendix K. Vadose zone contamination is also discussed in the response to Comment number 0012.15.

Comment Number 0047.02

Ahouse, Loretta

Comment I do not agree with any plans which would leave a portion of the waste behind in the underground tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

The preferred alternative assumes 99 percent retrieval of the tank waste. In a separate NEPA review, DOE intends to consider alternatives to tank farm closure. The EIS analysis addresses a range of alternatives that includes leaving all or a portion of HLW onsite, as well as alternatives that retrieve from the tanks as much waste as practicable (assumed to be 99 percent). Decisions associated with the

extent of retrieval will be supported by the TWRS EIS; however, the decisions on closure are not within the scope of the TWRS EIS. Please refer to the response to Comment numbers 0005.18 (assumption used in analysis of alternatives), 0072.08 (a discussion of closure), and 0072.05 (NEPA requirements for analysis of alternatives).

Comment Number 0079.02

Knight, Page

Comment One of the proposal alternatives is to take wastes from only from the double-shell tanks which are not yet leaking, vitrify them, and fill the single-shell tanks with sand and in effect walk away. This would possibly push the liquid waste deeper into the ground, hastening the contamination flow to the groundwater, and thus to the Columbia River. Presently, at the T tank farm, plutonium has become bound up in chemicals of the tank waste, and is moving rapidly toward groundwater. This is an inkling of what is to come in the next 100 years if the waste is left in the tanks. This is thus, an unacceptable alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The TWRS EIS addresses the management, retrieval, treatment, and disposal of the tank waste and does not address closure of tank farm residuals, equipment, or soil contamination. For the purposes of this EIS, closure as a landfill was assumed, but this closure assumption contained in the EIS will not be used to identify a closure alternative in the TWRS ROD. Closure will be addressed in future NEPA documents. Please refer to response to Comment number 0072.05 for additional closure information.

DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River. The EIS analyzes the impacts to groundwater associated with each of the alternatives in Volume One, Section 5.2 and Appendix F. The Final EIS has been modified to include a discussion of emerging data on vadose zone contamination beneath the tank farms. This discussion is provided in Volume Five, Appendix K. Please refer to the response to Comment number 0076.02.

L.3.4.1.2 General Preferences

Miscellaneous Preferences Related to Remediation

Comment Number 0009.03

Broderick, John J.

Comment Over the past decade, Hanford has demonstrated that it can not complete a project that takes a long time to construct. Grout, the new tank farm and HWVP come to mind in this regard, but there are many others. The many canceled projects have spent hundreds of millions of dollars with nothing to show for the effort. Each time there seems to be a good reason to cancel - but the percentage of canceled projects is very high. For this reason, the remediation of the tank waste must be done in facilities that can be constructed in a short period of time.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Volume One, Section 3.4 and Volume Two, Appendix B contain the implementation and completion schedule for each alternative. The Preferred Alternative identified in the EIS is consistent with the proposed remedy contained in the Tri-Party Agreement and the remediation schedule milestones in the Tri-Party Agreement. In addition, the existing schedule has been accelerated by approximately two years as a result of concurrent TWRS activities. Please refer to the response to Comment numbers 0009.10 and 0009.18 for a discussion of issues related to implementation of the preferred alternative, including projected construction completion dates. Please also refer to the response to Comment numbers 0055.06 and 0009.16 for a discussion of issues related to the consideration of cost in the alternatives analysis and the applicability of the HWVP to the preferred alternative.

Comment Number 0009.04

Broderick, John J.

Comment The National debt is increasing every year. There are strong pressures to reduce the deficit, and the debt itself. We have already seen the DOE budget drop substantially; and there are pressures to cut it even more. For this reason, the remediation of the tank waste must be done at the lowest possible price.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. DOE and Ecology believe that there is a potential to reduce the cost for tank waste remediation by allowing the market place to establish, through the competitive bidding process, the cost for waste treatment. Please refer to the response to Comment number 0036.15 for more information. The environmental impact of all factors analyzed during the evaluation of each alternative included in the EIS is presented in Volume One, Table 5.14.1.

Comment Number 0014.03

Bullington, Darryl C.

Comment Further proposals of hazardous chemical processes based upon unproven technology using insupportable assumptions such as a ninety-nine percent retrievability of sludge to generate so much high-level waste that it can not be safely contained in existing repositories continues to erode any credibility that may yet exist between the DOE and the public. Such reports not only wasted resources, they assure continued inaction and indecision.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. For each of the alternatives, technical uncertainties were addressed in Volume One, Section 3.4 and Volume Two, Appendix B. For the Final EIS, Volume Five, Appendix K was added to the EIS to consolidate discussion of uncertainties associated with the analysis of environmental and human health impacts. The EIS also analyzes alternatives involving retrieval of less than 99 percent of the tank waste. These alternatives include the in situ alternatives which would involve minimal waste retrieval and the ex situ/in situ combination alternatives which would involve partial waste retrieval. For more information regarding the 99 percent retrieval assumption, please refer to the response to Comment numbers 0005.18 and 0089.07. Please also refer to response to Comment numbers 0069.04 and 0037.03 for issues related to regulatory compliance requirements associated with disposal of tank waste and geologic repository availability.

Comment Number 0021.01

Shilling, Fred E.

Comment Our concerns regarding the storage of nuclear wastes at Hanford: some of the stuff is leaking and it was not supposed to; some of it presents the threat of explosion, and it was not supposed to; some sort of omnibus cleanup was supposed to be under way by now but it is not; all the while the costs keep escalating while axe grinders argue for use of the plutonium for fuel for their profit and our disposal problem. And there is still no safe disposal.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The TWRS EIS was initiated because DOE needs to manage and dispose of tank waste to "reduce existing and future risk to the public, Site workers, and the environment" (Draft TWRS EIS, Section 2.0). The EIS addresses the DOE proposed action to manage and dispose of tank waste, as well as a range of reasonable alternatives. The use of plutonium for fuel is beyond the scope of this EIS. For each alternative, the EIS analyzes potential impacts to the human and natural environment including potential impacts from future releases to groundwater in Volume One, Section 5.2, releases to the air in Section 5.3, impacts to ecological and biological resources in Section 5.4, impacts to human health in Section 5.11, and impacts from explosions and other accidents in Section 5.12. Each of the alternatives, except No Action and Long-Term Management identify how tank waste would be disposed of. For HLW retrieval from the tanks, disposal would be offsite in the proposed geologic repository. For discussion of waste disposal under each alternative see Volume One, Section 3.4, and Appendix B.

Comment Number 0026.01

Blazek, Mary Lou

Comment I see three long-term strategic hazards that must be considered:

1. prevention of dispersal into the environment
2. prevention of direct human exposure (i.e., Site workers, etc.)
3. prevention of misappropriation by terrorist/criminal groups.

These concerns are not limited to high-grade plutonium.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment number 0021.01 for a discussion of EIS analysis regarding disposal of water into the environment. Prevention of direct human exposure is addressed for each alternative in Volume One, Section 3.4, and Appendix B. All alternatives would provide for appropriate security to minimize the risk of misappropriation.

Comment Number 0026.02

Blazek, Mary Lou

Comment I believe there are reasons to select a variety of processes in management. Some elements will be best served by vitrification, and others by simple long-term storage. I see no reason why at least a portion of the waste should not be stored at ground level, where it can be adequately monitored for leakage or casket deterioration and repackaged as indicated.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The bounding approach to the evaluation of reasonable alternatives provides the option for the decision makers to select a variety of processes in the ROD. The EIS range of alternatives included retrieval from zero to 99 percent of the waste, as well as a discussion of those technologies currently available for retrieval, separations, and immobilization. In addition, the EIS addresses four alternatives (i.e., ISV, In Situ Fill and Cap, and Ex Situ/In Situ Combinations 1 and 2) that include storage and/or disposal of all or part of the waste near surface onsite.

Risks to human health associated with transportation of HLW to the proposed geologic repository were analyzed and compared for each alternative in the accident scenarios discussed in Volume One, Section 5.12, and Volume Four, Appendix E. This analysis in conjunction with the analysis of risks associated with onsite disposal versus offsite disposal of HLW, supports the comparison of alternatives. Long-term risk to human health and the environment specific to onsite and offsite storage and risks in general were discussed in Volume One, Section 5.11 and Volume Three, Appendix D. All ex situ alternatives, except for the Ex Situ No Separations alternative, specify that the LAW be stored onsite in a near surface vault and that the remaining HLW be stored onsite pending disposal at the proposed geologic repository. The Ex Situ No Separations alternative would result in offsite disposal of the tank waste. Please refer to the response to Comment numbers 0026.01 and 0072.05.

Comment Number 0026.03

Blazek, Mary Lou

Comment In general I do not favor transfer to other sites. I believe the actual transfer would often times be hazardous, I see no advantage to deep burial over surface interment, and it is generally viewed as a means of "getting it out of my backyard" with all the political overtones and delays involved.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0026.01 for discussion of the analysis of impacts in the EIS, and 0026.02 for a discussion of a comparison of alternatives relative to onsite verses offsite disposal.

Comment Number 0026.04

Blazek, Mary Lou

Comment I see a need for use of a variety of separation/purification techniques, a variety of storage techniques, and a sense of urgency to start the process. We have spent far too long on looking for a single perfect solution and site. Technology will change over the next 50-100 years, and we can neither wait for that to happen nor insist on locking ourselves into a single process.

Response Please refer to the response to Comment numbers 0026.01, and 0026.02 for a discussion of the range options available for the decision makers based on the EIS analysis and the response to Comment number 0072.05 for discussion of NEPA requirements for analysis of a range of alternatives. The response to Comment number 0076.03 addresses modification to technologies over time, and the response to Comment number 0009.01 discusses technology optimization and the urgency associated with tank waste remediation.

Comment Number 0032.02

Heacock, Harold

Comment The continued management and minimum waste retrieval alternatives are not acceptable solutions to a major environmental problem since they do not include the retrieval of waste from the single-shell tanks.

We believe that any tank waste remediation program must include removal and processing the waste to an acceptable solid in order to eliminate the environmental threats resulting from any retention of the waste in tanks of questionable integrity and lifetime.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

The EIS analysis presents data to support a comparison of the potential environmental impacts form retention of waste in the tanks (No Action and Long-Term Management alternatives) verses various waste management and disposal strategies represented by the other alternatives analyzed in the EIS. Please refer to the response to Comment numbers 0026.01 and 0026.02 for more information.

Comment Number 0034.02

Belsey, Richard

Comment So there are real compelling reasons to do the one thing that will most increase the safety and health issues for workers, people, and the environment. And that is this material needs to be stabilized so it does not and cannot move.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to response to Comment numbers 0026.01, 0026.02, and 0072.05 for a discussion of the range of alternatives addressed in the EIS, including alternatives involving immobilization of all or portions of the waste.

Comment Number 0034.03

Belsey, Richard

Comment Waste management side there are compelling reasons too. Interestingly they are dollars. The cost of sitting or baby-sitting these tanks is the most frustrating thing that I can think of.

It costs -- has costs anywhere from 200 to 300 million dollars a year. Finally, the people in the Tank Waste Remediation System are beginning to bring this mortgage down by a variety of techniques, but it is still the largest single overhead -- and I put it in as overhead because it does not produce any cleanup.

It does not produce any movement. Those resources are needed to do actual cleanup work. And the meter is running. As we sit here, the meter runs every single day.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Reduction in mortgage costs associated with continued management of tank waste was accounted for in the cost estimates for each alternative analyzed in the EIS. The No Action alternative cost estimate represents the 100-year mortgage for tank waste management. Please refer to the response to Comment number 0009.16, which discusses the methods by which cost was incorporated into the alternative analyses.

Comment Number 0034.04

Belsey, Richard

Comment And these were because people knew or had learned about the problems in the tanks, and they wanted to do something about it. This was an intense five or six-month period. And the Tank Waste Task Force came out and said we have to change what we were doing. We need to put both the high-low-level activity fractions into glass, different kinds of glass.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The approach to tank waste identified in the Comment is represented in the EIS in the various ex situ alternatives presented in Volume One, Section 3.4. The ex situ alternatives provide for varying Volumes of low-activity verses HLW to be vitrified based on the level of separations (i.e., from separations to extensive separations).

Comment Number 0034.06

Belsey, Richard

Comment And I say all of this because -- as background to the fact that the committee and the board now has supported the alternative path as the one that is most likely to meet the needs of the Tri-Party Agreement, not the milestones.

The milestones are just indicators of how you are working on health and safety issues, moving toward the ultimate first step, the biggest step, which is taking it from being in a soluble form which can migrate into the ground, into the groundwater, into the Columbia River, and stabilizing that so it will keep in place for thousands of years.

Response DOE and Ecology acknowledge the concern expressed in the comment. DOE and Ecology are fully committed to the intent, as well as the milestone requirements in the 1994 Tri-Party Agreement and amendments to the Tri-Party Agreement.

Comment Number 0074.01

Sims, Lynn

Comment I think one of the issues here is that this project that we're talking about is probably the largest civil works project, the most expensive, and the most dangerous project ever attempted by mankind in history. And we're all very concerned about it and want to do the best we can to make it work. And that's, everybody is emotionally involved with this, and there might not be any good solutions, except to try to keep it out of the water, out of the Columbia River.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and the response to Comment number 0026.02 for a discussion of impacts analyzed in the EIS, including impacts to groundwater and the Columbia River.

Preferences Related to Tank Waste Removal

Comment Number 0012.02

ODOE

Comment Oregonians oppose all tank waste options which leave significant amounts of waste in Hanford tanks. The cumulative impacts from all of the past activities at Hanford on public health and safety, the environment and the Columbia River make it inappropriate to consider leaving any of the tank wastes in place. The Northwest has shouldered more than a fair share of the cold war burden and its legacy. Hanford's cleanup mission must proceed.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Cumulative impacts from the TWRS alternatives and other proposed or reasonably foreseeable related actions are presented in Volume One, Section 5.13.

Comment Number 0012.04

ODOE

Comment The other alternatives under consideration leave most or all of the wastes in the tanks. With the exception of in situ vitrification, which is an undeveloped and unproven technology, other alternatives do little to remove the hazards posed by the wastes. To reduce the risks to people, these alternatives would require permanent closure of Hanford lands to other uses. Sacrificing Hanford in this way does not adequately reduce the harm and risks to the environment or to future generations. For these alternatives, the risk analyses in the EIS show massive plumes of radioactive material slowly moving across the Hanford site and into the Columbia River for hundreds to thousands of years.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Technical uncertainty of undeveloped or unproven technology, and the long-term risk associated with the various alternatives were factors analyzed by DOE and Ecology for each alternative. This information is presented in Volume One, Section 5.4. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. As stated in Volume One, Section 3.3, decision on closure of the tank farms will be made in the future. Additional analysis will be performed at that time concerning any additional measures that need to be taken to protect the groundwater and its future potential users. The TWRS EIS addresses the management, retrieval, treatment, storage, and disposal of the tank waste and does not address final remediation of the tank farm residuals, equipment, or soil contamination. For more information on closure, please refer to the response to Comment number 0072.08.

Comment Number 0012.05

ODOE

Comment Cost should not be the sole or even predominant criteria used to select among the alternatives. The first criteria that must be applied is protection of public health and safety and the environment. This criteria eliminates all of the alternatives which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, but because in situ vitrification technology is uncertain, the potential for failure is unacceptably high. We strongly oppose all of the alternatives which leave the waste in Hanford's tanks.

Also, the cost analyses do not include the lost value of the lands or the costs from harm to future generations or the environment. Ultimately, the costs of these alternatives would prove to be much greater than removing and cleaning up the wastes, as called for by the preferred alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume One, Section 5.12 contains discussions of accident risk for each alternative. The EIS discusses long-term loss of land use and immediate and potential future risks to human health impacts. Neither is analyzed in terms of cost because a dollar value to human life and the land cannot be assumed.

Cost and risk to human health and the environment were several factors analyzed by DOE and Ecology for each alternative. Assessing the economic impact due to lost land value or harm to future generations other than health impacts or the environment were beyond the scope of this EIS and were not considered. Each impact was analyzed using a consistent methodology. The results were objectively presented in the EIS for the public and the decision makers. DOE and Ecology are committed to the Tri-Party Agreement requirement that no residual volume greater than 1 percent remain in the given tank, unless this requirement is not technically achievable.

Comment Number 0037.01

Eldredge, Maureen

Comment The risks in this EIS show clearly that the only responsible option is retrieving all the waste. This needs to start happening now.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0021.01.

Comment Number 0073.01

Yazzolino, Brad

Comment I simply wanted to put this in perspective, in the sense that I'm in the art world. The art world is basically lasts for thousands of years in the same sense that the radioactivity does. And I've been immersed in the geology of the Hanford area for the last year or so, and some other aspects about the river. And basically you need to remove the radioactive material from its proximity to the river because in fact that river valley has been there for about 21 million years. And it's going to persist in that area, and it's going to eventually wash your radioactivity to the sea, and spread it all over the river valley if you leave it there. It needs to be removed.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The long-term impacts associated with tank waste alternatives, including impacts for alternatives that would leave all or part of the waste in place in the tanks and others that would retrieve the greatest extent of waste practicable, were among the factors analyzed in the EIS. This analysis included human health and groundwater impacts that were calculated to 10,000 years in the future, as well as impacts associated with climate changes that potentially would result in the situation described in the comment. The response to Comment numbers 0012.01 and 0012.15 discusses the impact of past tank leaks and current efforts to determine the extent to which these leaks have impacted the area beneath the tanks.

Comment Number 0090.04

Postcard

Comment Please listen to us say no:

to leaving High-Level Nuclear Waste in our ground.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0026.02 for a discussion of the extent to which each of the alternatives would result in onsite disposal of HLW.

Comment Number 0091.02

Dyson, Jessica

Comment It is time to stop being in denial and start making public safety your utmost concern. In doing so, you must follow the Tri-Party Agreement and vitrify all the waste in the tank and it is not acceptable to leave any waste in the tank because that could pose a danger to the public in the future.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The DOE and Ecology preferred alternative, Phased Implementation, would comply with the requirement of the Tri-Party Agreement. As indicated in Volume One, Section 2.0, the underlying need for action is to "reduce existing and potential future risk to the public, Site workers, and the environment." DOE also must take action to "ensure compliance with Federal and Washington State laws regulating the management and disposal" of the tank waste and the cesium and strontium capsules. These underlying needs for the proposed action are also the basis for the continued management of the tank waste by the TWRS program, as described in Volume One, Section 3.2. Please refer to the response to Comment number 0026.02 for a discussion of the extent to which each alternative would retrieve waste from the tanks.

Preferences Related to Privatization

Comment Number 0014.04

Bullington, Darryl C.

Comment If Congress is really serious about containing existing hazardous wastes along with adequate monitoring and emergency planning it should set aside funds in separate easily identified accounts which are not subject to whatever political whim that comes along to be used exclusively to:

1. Identify the size of all waste streams from all anticipated future sources and then establish a final repository sufficiently large to accommodate the demand for storage as required.
2. Monitor the integrity of all existing tanks and establish plans and funds to reduce the danger of further leakage including emergency plans should further leakage occur.
3. Reduce the options for safely confining stored wastes to several that can be achieved in the time frame established using existing technology and involving a minimum of time consuming and costly research and development. Chosen methods should have a high probability of accomplishing all milestones with the least risk to the public and the workers involved. Funds should also be set aside for insurance purposes should accidents occur. Safety of the public and the environment should take precedence over providing jobs or solving other social needs. These few alternatives, assuming that all the 50,000 curies of plutonium can be excluded from the biosphere, should then be contrasted with the do-nothing alternative. The report should show the costs and consequences of each alternative including a discussion of accidents that may occur along the entire pathway until confinement.

Response The purpose of this EIS is to present and analyze the range of reasonable alternatives that are available to remediate the tank waste at Hanford. Please refer to the response to Comment number 0072.05. DOE Richland Operations Office prepares a budget each year, which includes requests for funds used for cleanup; however, only

Congress has the authority to appropriate funds. Congressional funding issues were not included in the scope of this EIS.

There are several ongoing activities involved with collecting and analyzing data on tank contents. Tank inventory data are presented in Volume Two, Appendix A (Tables A.2.1.1, A.2.1.2, and A.2.1.3), and waste projections for future tank waste additions are shown in Table A.2.4.1. Please refer to the response to Comment numbers 0012.14 and 0072.07 for a discussion of the tank waste inventory and characterization methods planned or currently under way.

Establishing a final repository is not included in the scope of this EIS; however, for the purposes of analyzing the alternatives presented in this EIS, a potential geologic repository candidate site at Yucca Mountain, Nevada was assumed to be the final disposal site. A discussion of the requirement for HLW disposal in a geologic repository is provided in Volume One, Section 6.2.

The TWRS program also includes monitoring the integrity of tanks and characterizing the vadose zone around the tank farms to detect leaks. DOE also conducts numerous activities to provide continued safe storage of the tank waste, and emergency plans have been developed and are in place. Descriptions of ongoing programs and tank safety issues are presented in Volume One, Section 3.2 and Volume Two, Appendix B, respectively. All monitoring and safety programs (Section 3.4) would continue through remediation. DOE is required to mitigate all accidents involving releases to the environment and Volume One, Section 5.20 identifies potential mitigation measures that could be implemented to alleviate the environmental impacts of the alternatives.

A range of reasonable alternatives was analyzed for the TWRS EIS, including the No Action alternative and alternatives involving extensive retrieval. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The purpose of the EIS is to present the results of impact analyses in the most objective manner possible. These results will also be used by the decision makers to select an alternative and prepare the ROD. Volume One, Section 3.7 and Volume Two, Appendix B contain summary discussions of the alternatives comparisons. The Summary, Section S.7 contains an alternatives comparison, based on impact type and Volume One, Section 5.14 summarizes the environmental impacts of each alternative.

Comment Number 0017.01

Fisk, Charles P.

Comment Given Westinghouse's, Battelle's, etc. dismal performances, I certainly would <u>not</u> recommend privatization! Government created the mess and government should accept cost of remediation, <u>not</u> some for-profit corporation.

Response DOE and Ecology acknowledge the recommendation expressed in the comment. Although the contracting strategy known as privatization is not addressed in the EIS, the discussion of the Phased Implementation alternative does address the technical strategy of an incremental approach to tank waste remediation. Please refer to Volume One, Sections 3.3 and 3.4 of the EIS for more information on alternatives implementation and the Phased Implementation alternative.

Comment Number 0017.02

Fisk, Charles P.

Comment The "preferred alternative" is full of holes, as HEAL has persuasively analyzed far better than I can.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and the response to Comment number 0009.19 for reasons Phased Implementation is the identified preferred alternative.

Comment Number 0017.03

Fisk, Charles P.

Comment The entire amount of waste needs to be vitrified, not just 25 percent of it, regardless of the cost. If, as Republicans propose, we could afford a continuation of "Star Wars", we can be assuredly cancel that wasteful idea and put the money into a completed and thorough clean up of the mess.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Cost was one factor analyzed by DOE and Ecology for each of the alternatives. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. For a discussion of the extent to which each alternative would result in waste retrieval and/or treatment please refer to the response to Comment number 0026.02. DOE and Ecology note that the preferred alternative would result in remediation of all waste practicably or no less than 99 percent.

Comment Number 0017.04

Fisk, Charles P.

Comment We have the technology for vitrification; now get with it and DO IT! The Columbia River deserves maximum protection as soon as possible.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology are committed to protecting the Columbia River. The response to Comment number 0012.01 addresses groundwater contamination and vadose zone characterization and monitoring. Please also refer to the response to Comment number 0072.05 for discussion of the approach to analyzing alternatives and technologies in the EIS.

Comment Number 0060.01

Davenport, Leslie C.

Comment I support the preferred Phased Implementation alternative, but with some changes; primarily that only one separations/LAW/HLW processing facility be built by a private contractor during Phase 1. The primary reason for this choice is that it can meet the Tri-Party Agreement and yet result in the minimization of overall costs and ultimately facilities needing decontamination and disposal. Whether additional separations should remove technetium, cesium, strontium, and TRU elements should be left to engineering judgement, dependent primarily on meeting required LAW product specifications for disposal onsite in near-surface retrievable disposal vaults. The other primary consideration would be to ensure that interim and final disposition methods for TRU elements always are critically safe.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. DOE and Ecology remain committed to compliance with the Tri-Party Agreement under which the general requirements for the preferred alternative were renegotiated in 1994. Specific separations technologies will be evaluated during the detailed design phase that will follow the final remedy selection and the ROD. Separation technologies, along with removal and immobilization technologies, will be tested during the demonstration phase (Phase 1).

Comment Number 0078.07

ODOE

Comment USDOE must move forward with cleanup as quickly as possible. USDOE must commit to remove all the waste from the tanks and convert it to a durable and stable waste form. The privatization alternative is the only alternative of the four acceptable alternatives that can be done soon. All of the others will involve extensive delays.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05, 0076.03, and 0009.19.

Miscellaneous Preferences Related to the Alternatives

Comment Number 0032.03

Heacock, Harold

Comment We also do not believe the technical feasibility of several of the in situ treatment processes has been demonstrated adequately to seriously consider them as viable alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. ISV is a relatively new process that has not been tried at this scale previously, but was considered a potentially viable alternative. Implementability issues for each of the alternatives are discussed in Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to response to Comment numbers 0072.10 and 0072.80 for information on NEPA requirement to consider reasonable alternatives in the EIS.

Comment Number 0035.02

Martin, Todd

Comment It continues to debate issues that have long been laid to rest, such as what is the waste form that we will use at Hanford. The preferred alternative does not mandate the glasses used. It does not mandate vitrification. It should. We have made that decision. Let's go forward.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Vitrification and glass-types were analyzed for the HLW disposal; however, DOE and Ecology have identified the treatment process for the LAW as immobilization rather than vitrification for the Phased Implementation alternative. As identified in Volume One, Section 3.4 and Volume Two, Section B.3 of the EIS, LAW would be processed using a technology that would meet LAW specifications. These specifications would be performance based, using vitrification as a benchmark, and would have specific requirements for size, chemical composition limits, isotopic content, and physical parameters. Even though the Tri-Party Agreement suggests that certain decisions have been made, NEPA requires an objective analysis of all reasonable alternatives. Please refer to the response to Comment numbers 0060.02, 0005.07, and 0034.05.

This approach to LAW treatment is consistent with the Tank Waste Task Force (HWTF 1993) recommendation to use the most practicable, timely, available technology, while leaving room for future innovation. All HLW removed from the tanks and that remains after separations will be vitrified under the preferred alternative. Please refer to the response to Comment number 0009.19 for a discussion of the reasons Phased Implementation is identified as the preferred alternative.

Comment Number 0036.09

HEAL

Comment HEAL supports the preferred alternative's pretreatment process.

The TWRS Task Force values on pretreatment are explicit and strongly held. According to the TWRS Task Force Final Report:

The high cost and uncertainty of high-tech pretreatment and R&D threatens funding for higher performance low-level waste forms, vitrification, and cleanup. Use the most practicable, timely, available technology, while leaving room for future innovation. Keep a folio of technological options and make strategic investments over time to support a limited number of promising options. Give up further research on unlikely options (TWTF p. 11)

The intermediate separations case is response to this value (although the difficult challenge of technetium removal in the Phased Implementation alternative is a concern). HEAL strongly opposes any movement toward an extensive separations pretreatment technology.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0098.02.

Comment Number 0046.04

DiGirolamo, Linda Raye

Comment Yes, encase in glass and bury this "CRUD" and more importantly... Stop all future plutonium fuel rod production at once. New Age Energy must be embarked upon at once to save man and the earth.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0059.01

James Jordan Associates

Comment JJA recommends that the Environmental Impact Statement include in its analysis an alternative concept invented by Drs. Morris Reich, James Powell, and Robert Barletta of Brookhaven National Laboratory for the safe immobilization and isolation from-the-environment radioactive waste. This novel concept has the potential of being the safest, least costly, and most expeditious method for the disposal of the various radioactive wastes currently stored in the underground storage tanks at Hanford, including, if desired, the vitrification of the cesium and strontium capsules located at the Hanford Site.

This system which uses modular canisters with integral vitrification capability does not require an upgrade to the tank farm waste transfer system. This system will not require the construction of extensive buried transfer lines that is included in all of the alternatives except the No Action alternative. Indeed, the elimination of the complex tank farm waste transfer system significantly reduces the potential for short-term impacts of human health and the environment. Using modular canisters with integral vitrification provides for a dramatic reduction in the risk of long-term impacts on the public health and the environment in that the system does not have a large central vitrification facility to deactivate and dispose of at the end of the vitrification campaign. Compared to a conventional vitrifier, the in-can vitrifier does not require the pouring of molten radioactive glass.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Draft EIS addressed the full range of reasonable alternatives. The alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS. DOE and Ecology therefore believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment numbers 0072.05, 0072.79, and 0097.01.

Comment Number 0060.02

Davenport, Leslie C.

Comment Both continued management alternatives are unacceptable for the long term.

The Minimal Waste Retrieval (In Situ) alternatives do not meet waste disposal laws, regulations, and policies and I feel are unacceptable in the long term. The In Situ Fill and Cap would not immobilize the wastes, only fill the tanks with gravel (creating more contaminated waste) and keep it all onsite in a form that would eventually leach to the groundwater. The In Situ Vitrification alternative is interesting and perhaps could be used on some of the small Multiple Underground Storage Tanks (MUSTs) that contain lower amounts of radioactivity, but the degree of technical uncertainty is too high to consider application to an entire tank farm of up to 20 tanks at once. Verifying that all tanks are completely vitrified down to 60 ft below the ground surface is nearly impossible, and there is no way to immobilize radionuclide plumes below the leaking SSTs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not comply with laws and regulations. The TWRS EIS addresses 10 alternatives for tank waste, ranging from No Action to extensive retrieval, and four alternatives for the cesium and strontium capsules. Please refer to the response to Comment numbers 0072.80 and 0072.10 for a discussion of the NEPA requirement to include a No Action alternative in the EIS analyses.

Comment Number 0060.03

Davenport, Leslie C.

Comment The partial waste retrieval alternatives do not meet waste disposal laws, regulations, and policies because they would retrieve only 90 percent or less of the radionuclides. I feel they will be deemed unacceptable in the future, thereby necessitating additional future operations to finish the job.

Response DOE and Ecology acknowledge the concerns presented in the comment. DOE and Ecology remain committed to compliance with the Tri-Party Agreement, which requires removal of all technically achievable waste or no less than 99 percent of the waste from each tank. Please refer to the response to Comment number 0060.02 and for discussions of the NEPA requirement to address a range of alternatives including alternatives that do not comply with regulations. Refer to the response to Comment numbers 0072.80 and 0072.10.

Comment Number 0060.04

Davenport, Leslie C.

Comment The extensive waste retrieval (ex situ) alternatives appear to be the only acceptable methods to deal with the approximately 200 MCi of radionuclides. However, the Ex Situ No Separations alternative appears to be too expensive because all tank wastes would be vitrified and/or calcined, resulting in too many high-level waste packages to ship to and store in a waste repository. The Ex Situ Intermediate and Extensive Separations alternatives are difficult to choose between, because the efficiency of the sludge washing, ion exchange, and multiple complex chemical separations processes are not fully known for the various types of tank wastes. Hence, those two alternatives should be compared in a pilot plant using a Phased Implementation (possibly along with the In Situ Vitrification alternative applied selectively, particularly for MUSTs, and SSTs that have not leaked).

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Technical evaluation, categorization of tank waste, and application of appropriate technology would be conducted during Phase 1 (demonstration phase) of Phased Implementation and during the detailed design phase of any alternative analyzed in the EIS. Volume One, Section 3.4 includes descriptions of the processes, cost, and Implementability for each tank waste alternative. Volume One, Section 5.14 provides a summary of the environmental impacts for each tank waste alternative. The EIS provides the basis for comparison among the alternatives identified. DOE and Ecology believe sufficient differentiation exists between the alternatives to support a decision on the alternative to be implemented; therefore, a demonstration phase comparison of the two alternatives would postpone remediation.

Comment Number 0072.10

CTUIR

Comment The Tri-Party Agreement mandates full retrieval as the goal; only if this is not practicable on a tank-by-tank basis can lower retrieval goals be negotiated. Therefore, the in situ alternatives are not allowed and did not have to be evaluated.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

As required by the CEQ, the TWRS Draft EIS identifies and analyzes a range of reasonable alternatives for the proposed action, including those that are "not within the jurisdiction" of the agency (40 CFR 1502.14). DOE guidance on NEPA requires that EIS alternatives be addressed even if there is "conflict with lawfully established requirements" (DOE 1993d). However, the Agency is required to identify the laws and regulations that apply to each alternative and indicate if the alternative, if selected for implementation, would comply with applicable laws and regulations. This information must be provided to the public and the decision makers. Therefore, the failure to comply with the Tri-Party Agreement is not sufficient basis for excluding an alternative from detailed analysis in the EIS (40 CFR 1502.2d). A discussion of the methods used to develop the alternatives in compliance with NEPA requirements is presented in the response to Comment number 0072.05. Please refer to the response to Comment numbers 0072.80 and 0072.52.

Comment Number 0072.16

CTUIR

Comment In situ alternatives were not necessary since they are not allowed under the Tri-Party Agreement.

Response Please refer to the response to Comment numbers 0072.10 , 0072.52, and 0072.80.

Comment Number 0076.03

Blazek, Mary Lou

Comment The preferred alternative relies on using proven technology, and using a phased approach. We think a learn as you go approach makes sense, given the history of Hanford. And that should identify problems earlier, and at smaller economic and environmental cost.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Preferred Alternative would allow DOE to proceed with tank waste remediation. System modifications would be evaluated as waste inventory, removal method, separations, and disposal data are collected and analyzed during the Phase 1 demonstration. This continuous improvement is the cornerstone of the "learn and improve while doing" approach cited in the comment. Please refer to the response to Comment numbers 0060.04, 0060.02, and 0009.19 for more information on the preferred alternative.

Comment Number 0077.02

ODOE

Comment Leaving wastes in the tanks poses huge risks. The tanks are corroding and failing. As they fail, the radioactive waste is released to the soil and ultimately to the groundwater and to the Columbia River. Vitrifying the tank waste makes it far more stable and greatly reduces the threat to the public and the environment. While the cost of the preferred alternative is substantial, it is the only alternative which satisfactorily deals with the dangers presented by these wastes as quickly as practical. The phased approach allows USDOE to get on with cleanup while allowing for possible development of better approaches which remove all tank wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0076.03 and 0060.04. The response to Comment number 0091.01 addresses protection of the Columbia River in relation to the preferred alternative.

Comment Number 0078.02

ODOE

Comment Unacceptable Alternatives

The EIS evaluates the alternatives USDOE believes are available for the tank waste. Four alternatives are unacceptable because they could allow exposures to the environment and the public at levels higher than allowed. These include:

1. Two alternatives manage the waste as is; in failing tanks,
2. Two alternatives leave all or most of the tank waste in the tanks covered with sand and a complex barrier to keep rain water out,
3. One alternative proposed vitrifying all of the waste in the tanks in place.

A sixth alternative was added as the EIS went to print. This alternative is included in the cover letter for the EIS and is not analyzed in depth in the EIS. It would leave most of the waste in the SSTs, fill the tanks with sand and cover them with a barrier.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. NEPA requires an EIS address a comprehensive range of reasonable alternatives. The TWRS EIS fully addresses 10 alternatives for tank waste, which includes no action, long-term management, in situ, ex situ, and combination alternatives. NEPA also requires that these alternatives be analyzed regardless of regulatory compliance to allow an even-handed analysis of all factors, as discussed in the response to Comment number 0072.80. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0078.03

ODOE

Comment

Unacceptable Alternatives

The EIS includes four alternatives which meet legal requirements. These are:

1. Retrieve all of the waste, glassify it and sent it to a national high-level nuclear waste repository,
2. Retrieve all of the waste, use extensive chemical processes to separate the nonradioactive portions from the radioactive portions, glassify them and send the glass to a national high-level nuclear waste repository,
3. Retrieve all of the waste, use less extensive separations of the waste into high-activity and low-activity fractions, glassify, both, bury the low-activity fraction at Hanford and send the high-activity fraction to a national high-level waste repository (Government owned and contractor operated),

4. Do the same as three, but do it in phases using private companies to build and operate the plants. (This is the preferred alternatives in the EIS).

If privatization fails, the Tri-Party Agreement requires USDOE to revert to government owned and operated vitrification plants.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment number 0072.80 for a discussion of the NEPA requirements to analyze a full range of alternatives in an EIS regardless of regulatory compliance.

Comment Number 0079.01

Knight, Paige

Comment Hanford Watch supports the phased implementation plan, not because it's so great, but because it gets the waste out of the tanks. It is our conviction that waste must be removed from the tanks and put in a stable form. If this new preferred alternative reaches a point of failure, you must be prepared to turn back immediately to the path outlined in the Tri-Party Agreement, and follow the advice given by the Tank Waste Task Force, in the summer and fall of 1993. That advice can be summed up in the words get on with cleanup. The public has stated time and time again that the DOE must get on with it. Hear us. Do not change paths again.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0076.03. Please also refer to the response to Comment numbers 0009.19 and 0060.02 for more information on the reasons Phased Implementation was identified as the preferred alternative.

Comment Number 0079.03

Knight, Paige

Comment The alternative of long-term management also is unacceptable because according to the TWRS EIS that document will end in, that management will end in 100 years. This possibility the amount of time previous to the waste plumes becoming a severe health risk to the public and the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment number 0040.02 and 0101.01 for a discussion of the 100-year administrative control period.

Comment Number 0079.04

Knight, Paige

Comment The in situ alternative is also unreasonable, because again no protection of the groundwater is offered, and security and external control will end in 100 years. And that's when the contamination, theoretically, is going to become a real problem for the health and environment, health of people and environment. Further, the use of riprap basalt is suggested. And we fear that this material will be taken from sites at Hanford, that are sacred to the Indian tribes.

In short, any plan to leave this deadly brew of wastes in the tanks is totally unacceptable, and will meet with the resounding opposition from the citizens of the region. Water is sacred, and must be protected at all costs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment numbers 0091.01 and 0012.01 for discussions of groundwater issues related to current and planned monitoring programs and protection of the Columbia River.

Volume One, Section 5.7 describes the land-use impacts of the various alternatives, including impacts to potential borrow sites. Volume One, Section 5.5 describes the cultural resources impacts, including prehistoric and historic sites, and issues of potential concern to Native Americans. DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River and impacts to groundwater and the Columbia River are addressed in Volume One, Section 5.2 and Volume Four, Appendix F. Please see the response to Comment number 0019.03 for a discussion of borrow site issues. Please refer to the response to Comment number 0040.02 and 0101.01 for a discussion of the 100-year administrative control period. Response to Comment numbers 0091.01 and 0012.01 discuss groundwater issues related to current and planned monitoring programs and protection of the Columbia River.

Comment Number 0085.01

Klein, Robin

Comment Except to say that the no action alternatives, including long-term management are unacceptable options. They are not within the range of reasonable alternatives as the Draft EIS states. But are imprudent, hazardous, and in violation of the Tri-Party Agreement.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0072.52, 0072.05, 0078.02 and 0072.80.

Comment Number 0087.04

Tewksbury, Ross

Comment And I think that they should do the extensive waste retrieval and vitrify all, or nearly all of it, and whether it's stored on the site, or off the site is not really the major thing. The major thing is to get it in a form where it's not able to leak out into the groundwater and soil and the river, and everything else, and to do that as fast and as safely as possible. And I think that you should not really be concentrating on this waste separation idea that you were going over tonight, except what's absolutely necessary for the technical, chemical, and safety purposes. Because all of it has to be taken care of for hundreds, if not thousands of years. Thank you.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0078.02. The phased approach to the alternative implementation is discussed in the response to Comment numbers 0060.04 and 0076.03. Groundwater protection issues are discussed in the response to Comment numbers 0091.01 and 0012.01.

Comment Number 0088.01

Porter, Lynn

Comment I guess I support the preferred alternative because it sounds better than the others.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0014.04, 0072.05, 0078.02, 0009.19, and 0060.02 for a discussion of the reasons Phase Implementation has been identified as the preferred alternative.

Comment Number 0089.01

Nez Perce Tribe ERWM

Comment The Nez Perce Tribe ERWM favors protection of the Columbia River and its ecosystem through removal and disposal of tank wastes from 200 Area tanks as supported by the EIS. ERWM believes groundwater and the Columbia River are at risk from potential radionuclide or toxic chemical releases from the tanks. We endorse the alternative calling for removal of tanks wastes through one of the Ex Situ Separations alternatives or Phased Implementation.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0014.04, 0072.05, and 0078.02.

DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River and its ecosystem. An analysis of impacts to groundwater and the Columbia River are provided in Volume One, Section 5.2 and Volume Four, Appendix F. Discussions related to groundwater and protection of the Columbia River are contained in the response to Comment numbers 0091.01 and 0012.01.

Comment Number 0093.02

Devoy, Tiffany

Comment I also would like to say that I do think the Tri-Party Agreement should be followed in this case and actually in most cases and it seems odd that there is always someone trying to get out of it. It was signed and I think it should be followed. I think that they need to vitrify as much waste as possible and to leave as little waste behind as possible and I do not think that is an unrealistic expectation. There are 177 tanks and I do not even remember what was quoted to me as to how many gallons each those tanks were but it is pretty amazing and to think of all that waste concentrated and to just leave it there, I know that is not your preferred alternative, but I think some of your alternatives are not that much better. So vitrify it as much as possible, leave as little behind as possible, and follow the Tri-Party Agreement. That is about it.

Response DOE and Ecology acknowledge the preference for extensive waste retrieval, treatment, and disposal within the context of the Tri-Party Agreement expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating TWRS waste. The inclusion of alternatives in the EIS that do not comply with the Tri-Party Agreement complies with the NEPA, which is the Federal law requiring the preparation of this EIS. Please refer to the response to Comment numbers 0072.10 and 0072.80 for a discussion on requirements for inclusion of alternatives in an EIS analysis.

L.3.4.2 Elements Common to Tank Waste Alternatives

Comment Number 0098.03

Pollet, Gerald

Comment The public deserves to know how much money is going to be taken out of the authorization for Hanford clean up for the so-called privatization reserve. This process is a sham so long as an undisclosed amount of your Hanford clean up dollars are being removed in the future. Let us face it, basically the President and Congress have said you are going to have less money for Hanford clean up, we know what the President's projection is, it is seriously less than it used to be, and out of that a future chunk is going to privatization in a liability reserve but you and I can not see what it is. At the same time, the Department of Energy has target budgets now through the year 1998 which fail to fully fund essential safety and Tri-Party Agreement activities such as characterizing the wastes in these tanks. As the General Accounting Office has said, If you fail to properly characterize, you can not expect the contractors to be able to vitrify and, in fact, anyone can see down the road that the contractors are liable to say, You did not characterize properly, therefore, you owe us the full cost we put out for building the plant and our anticipated profit, we will take that 1.4 whatever billion dollar reserve it is, put it in our corporate pockets, the government will be out that money, you will have a plant that will not work because wastes were not characterized. Currently, the Department of Energy is planning in its budgets to be at least 3 years behind the Tri-Party Agreement requirement for characterizing the wastes. This can not be allowed to go forward.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The privatization contracting strategy and the budgetary process for funding the alternative selected are outside the scope of this EIS. DOE Richland Operations office prepares a budget each year, which includes funds required for cleanup; however, only Congress has the authority to appropriate funds. Please refer to the response to Comment numbers 0012.14 and 0072.14 for discussions of issues related to the tank waste inventory and ongoing efforts to characterize the tank waste.

Comment Number 0101.01

Yakama Indian Nation

Comment Unrealistic Assumptions Regarding Institutional Controls Restricting Future Human Actions --Design basis assumptions associated with the disposal of waste at Hanford optimistically assume protective conditions will exist in the future in connection with the estimation of impacts to the public

health and safety and the environment. Specifically, we consider the assumption of institutional controls restricting intruder actions or inadvertent intruder actions beyond about 130 years hence is invalid.

Response DOE and Ecology concur that intruder or trespasser activities could not be monitored or restricted beyond 100 years. The 100-year administrative control period is a bounding assumption used during the analysis of the alternatives. For all alternatives analyzed in the EIS, post-remediation risks assume that institutional controls would not exist beyond 100 years. Please refer to the response to Comment numbers 0040.02 and 0040.03 for more information regarding administrative controls. Because the information contained in the text was correct, no change was made to the document.

Comment Number 0101.04

Yakama Indian Nation

Comment Consideration of Low-Impact Waste Management Alternatives--Alternatives which evaluate impacts associated with the minimization of the volume of waste retaining a long-lived hazard (hazardous for 130 years or more) and large cask storage of stabilized wastes was not accomplished. We believe such options which were addressed in preliminary impact analyses, should be presented in the impact statement to allow full assessment of options. We consider that DOE (OCRWM) actions in preparation of the EIS to require consideration of small casks with no apparent technical or economic basis is unwarranted and capricious.

For example, the use of 10 cubic meter capacity (m^3) (360-cubic foot [ft^3] casks for storage and/or disposal of stabilized high-level radioactive wastes should be evaluated. Furthermore, consistent with evaluating alternatives which minimize the volume of waste for disposal, the option of using waste processes that would purify sodium salts (making up about 85% of the solids in the tanks) to a specific activity and hazard equivalent to Class A low-level radioactive waste with the calcination of the remaining high-level radioactive waste stream should also be specifically compared with processing options that produce larger volumes of long-lived hazardous wastes.

We note that the an additional benefit of removing sodium is the added stability of potential high-level radioactive waste forms without significant sodium, making this processing option desirable for disposal performance assessments.

Response The Ex Situ No Separations Vitrification and Ex Situ No Separations Calcination alternatives have been revised for the Final EIS to use a 10-m^3 (360-ft^3) canister for HLW storage and disposal. The size assumptions are presented in Volume One, Section 3.4 and Volume Two, Appendix B. These canister sizes have been used for impact analysis presented in Volume One, Section 5.0, Volume Three, Appendix D, Volume Four, Appendices E and F, and Volume Five, Appendices G and H. Please refer to the response to Comment number 0081.02 for related information.

The use of crystallization to remove sodium salts from the waste stream is included in the Ex Situ Extensive Separations alternative as a technology that could potentially reduce the LAW volume. This technology was not included as a primary treatment technology because it was not sufficiently mature to allow detailed evaluation. The focus of the EIS was to evaluate alternatives, rather than specific technologies, to allow sufficient flexibility to evaluate and implement emerging technologies in the future. Please refer to the response to Comment number 0072.05 for information on NEPA alternatives analysis requirements.

DOE and Ecology agree that removal of the sodium from the waste stream prior to immobilization potentially would reduce the volume of HLW for the Ex Situ No Separations Vitrification alternative and LAW for the ex situ alternatives that include separating the HLW and LAW for treatment. It would be expected that removal of the sodium would result in increasing the waste loading such that either waste form would meet waste form performance criteria. Please refer to the response to Comment numbers 0027.11 and 0008.01 for more information related to waste loading and the response to Comment numbers 0008.01 and 0009.08 for more information regarding consideration of canister (cask) size in the Draft and Final EIS.

Comment Number 0101.07

Yakama Indian Nation

Comment On another scale the impacts associated with the disposal of waste streams generated by the actions being considered must also be considered in a integrated manner. The issue associated with waste minimization and waste package sizing greatly affects disposal costs and other impacts, particularly those associated with the high-level radioactive waste deep repository at Yucca Mountain. Integration of the disposal facilities under the office of Civilian Waste Management (OCRWM) and the TWRS in DOE's overall environmental management actions should be evaluated and assessed from a systems engineering approach to resolve this issue.

We consider large savings (several billion dollars) are possible if valid systems integrations are accomplished compared to the base-line alternatives currently being pursued by DOE. These estimates stem from cost evaluations accomplished by the authors of the subject EIS.

Response Large canisters have been addressed in the Final EIS.

Please refer to the response to the following comments for more information:

- Comment numbers 0004.01 and 0081.02 - coordination with Office of Civilian Radioactive Waste Management (OCRWM) and revisions to repository cost calculations
- Comment number 0008.01 - canister size re-evaluation decision
- Comment number 0027.02 - systems engineering approach to the alternatives evaluation
- Comment number 0037.04 - relationship of the TWRS EIS to other Sitewide NEPA and programmatic documents.

The cost estimates in the EIS include contingency and a range of uncertainty based on the conceptual nature of the alternatives and standard industry practice for large capital projects. DOE expects that as detail design progresses, progress in technology optimization will result in cost savings. Please refer to response to Comment numbers 0052.04 and 0081.03.

L.3.4.2.1 Issues Related to Disposal Costs Calculations and Repository

Comment Number 0004.01

Boldt, A.L.

Comment References:

1. DOE, 1996, *Draft Environmental Impact Statement for the Tank Waste Remediation System*, DOE/EIS-0189D, U.S. Department of Energy, Richland, Washington and Washington State Department of Ecology, Olympia, Washington, April, 1996.
2. DOE, 1995, *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program*, DOE/RW-0479, U.S. Department of Energy, Washington D.C., September, 1995.
3. *Nuclear Waste Policy Amendments Act of 1987*, Public Law 100-203, December 22, 1987, 42 USC 10101 et seq.
4. Federal Register Notice, *Civilian Radioactive Waste Management; Calculating Nuclear Waste Disposal Fees for Department of Energy Defense Program Waste*, pp. 31508-31524, Vol. 52, No 161, August 20, 1987.
5. TRW, 1995, *Assessment of Pre-Closure System Cost and Health and Safety Impacts of Hanford HLW Vitrification Options on the Civilian Radioactive Waste Management System*, A00000000-01717-5705-00003, Rev. 0, TRW Environmental Safety Systems, Inc., Vienna, Virginia, April 27, 1995.

The geologic disposal costs presented in section B.3.0.8 of the draft TWRS EIS (ref 1) are based on a linear extrapolation of the unit container disposal costs provided by reference 2 for a specific scenario. The linear extrapolation of the unit container disposal cost from reference 2 to all the TWRS alternatives does not meet the requirements of the Nuclear Waste Policy Amendments Act (ref 3) and Federal Register Notice 52-161 (ref 4).

Federal Register Notice 52-161 identifies, in detail, the method to be used in estimating the disposal fees for the Department of Energy defense program HLW (HLW) share of total Civilian Radioactive Waste Management System (CRWMS) costs. Federal Register Notice 52-161 cost allocation is based on the concept of full cost recovery with sharing formulas applied to all fixed and variable system cost components.

The assumption of linear extrapolation of unit container disposal costs in the draft TWRS EIS greatly underestimates the disposal costs of the extensive separations alternative and greatly overestimates the disposal costs of the no separations alternative. Example disposal cost variability for alternate HLW container sizes and HLW volumes resulting from no separations, intermediate separations, and extensive separations using the methodology specified in Federal Register Notice 52-161 are provided in reference 5.

I am requesting that the draft TWRS EIS be revised to incorporate HLW disposal costs calculated with the methodology specified by Federal Register Notice 52-161.

Response As stated in Volume One, Section 3.4, the repository fees are based on the 1995 Analysis of the Total System Life Cycle Cost (1995 TSLCC) of the Civilian Radioactive Waste Management Program. The Draft EIS also acknowledges that the 1995 TSLCC was based on a single scenario and one repository. It is acknowledged that there is uncertainty in identifying a disposal fee prior to the final licensing of a national repository. Additional uncertainty results from analyzing various options considered in the EIS as the number of canisters varies from the baseline. However, DOE will comply with the provisions of the Nuclear Waste Policy Act requiring full cost recovery. The purpose of the cost analysis is to provide a basis for comparison among the alternatives (TWRS Draft EIS, Volume Two, Appendix B, page B-40).

In response to public comment, for the Final EIS, DOE and Ecology have reevaluated the estimate of disposal costs presented in the Draft EIS, using the 1987 methodology to more accurately reflect possible costs associated with disposal for the various canister options presented. This effort was coordinated through the OCRWM. Please refer to the response to Comment numbers 0081.02 and 0008.01 for additional information.

Comment Number 0005.44

Swanson, John L.

Comment I do not get the point of the sentence on page 3-37 "The use of a standard-sized canister does not consider waste loading, which ranges from 113,000 curies per canister to about 300-."

Response The use of the term "waste loading" here certainly could be confusing as it also refers to the waste loading of the glass with respect to percent sodium or waste oxides. Individual chemical entities such as sodium were considered in the "waste loading" of the glass. The quantity of radioisotopes and curie content was not limited in the glass formulations because the maximum heat load per canister was below the limit of 1,500 watts set for the repository.

The Final EIS was revised to include larger HLW canisters, which eliminates the need for the subject discussion in Volume One, Section 3.4. Please refer to the response to Comment numbers 0008.01 and 0081.02 for more information.

Comment Number 0008.01

Evett, Donald E.

Comment First, Current planning also assumes that this waste could be contained in approximately 18,000 standard-sized canisters. Also, there is insufficient capacity in the first repository to accept all Hanford Site -high-level waste under almost every alternative. Your study states that an estimated $360,000 cost per canister disposed of at the repository. The report alludes to the feasibility of using much larger canisters whereby the repository fees could be substantially reduced. In my opinion, I would think that the Department of Energy would vigorously pursue the much larger canisters.

Response Larger HLW canisters result in fewer waste packages for disposal at the geologic repository and offer substantial cost savings over the use of standard-sized HLW canisters. DOE is pursuing the use of HLW canisters that are larger than the standard-sized canister currently defined in the repository Waste Acceptance Systems Requirements Document (DOE 1994g). Since the Draft EIS was published, DOE-RW has acknowledged the technical feasibility of a larger canister for HLW and an independent technical review team convened to review the waste loading and blending assumptions used in the Draft EIS. The recommendations of the independent technical review team, along with the larger HLW canister specifications, have been incorporated into the ex situ alternatives for the Final EIS. The use of larger canisters and revised estimates for HLW volumes have been incorporated into the repository fee estimates shown in the Summary, Volume One, Section 3.0, and Volume Two, Appendix B. Section 3.4 describes the common assumptions for canister size and waste loading and additional detail is provided in Appendix B. Please refer to the response to Comment number 0081.02.

Comment Number 0008.02

Evett, Donald E.

Comment What happens if the Yucca Mountain project is defeated? What happens next and where will the canisters be disposed? If the year 2015 is the earliest date for acceptance of the high-level waste in canisters, where will the canisters be stored until this time? It is assumed that the use of canisters can commence much earlier than the year 2015.

Response DOE fully intends to comply with the Nuclear Waste Policy Act of 1982 as amended, which requires development of sites suitable for long-term disposal of spent nuclear fuel and HLW, and with DOE Order 5820.2A, which requires that HLW be processed and disposed of in a geologic repository. Therefore, disposal of HLW in a geologic repository was assumed and used as the basis for all alternatives involving HLW retrieval. The in situ and combination alternatives would result in onsite HLW disposal and the EIS analyzes the impacts associated with those actions. See Volume One, Section 6.0 for a discussion of the regulatory requirements and Volume One, Section 3.4 for assumptions associated with the geologic repository included in the EIS. Onsite storage at the Hanford Site for the HLW under the ex situ alternatives for up to 50 years is analyzed in the EIS. If longer-term storage is required due to delays in opening the geologic repository for disposal, appropriate NEPA analyses will be conducted.

Comment Number 0012.06

ODOE

Comment A large part of the cost shown for the vitrification alternatives included charges to dispose of the waste to the national high-level waste repository. These charges should not be used to decide whether to put the waste in a stable and durable form.

Several alternatives call for removal of all wastes from the tanks and vitrification. They differ in the methods used, complexity, speed and cost. The repository charges should be used as one criteria in deciding among these alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The cost estimates developed for each ex situ alternative presented in Volume One, Section 3.4 list the treatment cost, the estimated repository fee, and a total alternative cost range that combines treatment cost and estimated repository fee. The estimated repository fees, as acknowledged in the Draft EIS, have a high degree of uncertainty. Please refer to the response to Comment numbers 0004.01, 0008.02, and 0081.02 for more information concerning repository costs, canister size, and related uncertainties.

Comment Number 0027.02

Roecker, John H.

Comment Technical Data Manipulation

In Chapter 3 (page 3-33) DOE discusses the wide range of HLW canisters that could be produced and it makes reference to a WHC document for the low end of the range and a DOE document for the high end. The WHC document is an engineering document containing factual technical data and the DOE document is a set of comments on the TWRS System Requirement Document, which are not supported by technical data. This is another example of DOE Headquarters continuing to manipulate the technical data to support and satisfy their agenda rather than letting facts tell the story openly and honestly. Incidentally, the TWRS System Requirements Document has not yet been approved, to my knowledge, but yet here we are reviewing EIS alternatives which are supposed to be based on systems engineering. More on that later. I would request that in the Final EIS such manipulations of the technical data be eliminated and that all data be presented in accordance with standard systems engineering techniques and principles.

Response Because the alternatives evaluated in the EIS are conceptual at this time, engineering feasibility is limited to an Implementability review for each alternative. This is consistent with CEQ guidance that NEPA analysis occur as early in the decision making process as possible and always before irreversible and irretrievable commitments of resources have been made (40 CFR 1500). Following the publication of the Final EIS and approval of the TWRS ROD, a systems engineering and safety analysis of the preferred alternative will continue during the detailed design phase of the demonstration facilities. DOE intends to continue using systems engineering as a method for evaluation and implementation of the TWRS mission. It is anticipated that the detailed design of the waste retrieval, transfer, treatment, and storage demonstration facilities will be conducted using the system engineering and safety requirements currently being developed for TWRS (and concurrently with the TWRS Draft EIS).

The EIS presents an unbiased evaluation of each of the alternatives using the best available information. More information on canister assumptions and revisions to the EIS in response to revised information on canister size can be found in the response to Comment number 0008.01

Comment Number 0027.05

Roecker, John H.

Comment Repository Cost

I am not a lawyer, but in my reading of the Nuclear Waste Policy Act (NWPA) of 1982 as amended in 1987 and the Federal Register Notice 52-161 I believe it is quite clear on how the repository fee for disposal of HLW should be calculated. The use of linear extrapolation of a unit container cost for a specific disposal scenario to calculate the repository fee for all alternatives is completely wrong, misleading and totally obscures the real cost of each alternative. The use of a linear extrapolation of unit container cost greatly understates the cost of disposal for the extensive separations alternative and greatly overstates the cost for the No Separations alternative. This is a blatant example of data manipulation to make a particular alternative look attractive and misleads both the public and decision makers.

Response Please refer to the response to Comment numbers 0004.01, 0008.01, and 0081.02.

Comment Number 0027.07

Roecker, John H.

Comment Use of 0.62 m^3 HLW Canister

Requiring Hanford to use the 0.62 m^3 canister is overly restrictive and ridiculous particularly in light of the fact that a larger canister will be required for spent nuclear fuel. A larger HLW canister is a significant advantage for Hanford waste disposal and should be utilized.

Response DOE and Ecology recognize the potential benefits of using a larger canister for HLW. The use of larger HLW canisters has been included in the Final EIS. The size assumptions are presented in Volume One, Section 3.4 and Volume Two, Appendix B. These canister sizes have been used for impact analysis presented in Volume One, Section 5.0 and Appendices D, E, F, G, and H. Please also refer to the response to Comment number 0008.01 for more information on canister size and related impact on repository costs.

Comment Number 0035.04

Martin, Todd

Comment A clear stakeholder value has been that Yucca Mountain should not drive decision. We have said that the best waste form should determine which waste form is used, not the site, nor size, nor cost of a speculated national repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Repository considerations associated with the size, location, and cost of the potential repository did not drive the EIS analysis of waste form. The waste forms analyzed in the EIS are discussed relative to their ability to comply with existing waste acceptance criteria at the proposed repository; however, the analysis shows that the only waste form acceptable at the proposed repository is the one presently identified in the Tri-Party Agreement. This waste form is a borosilicate glass. Further, the information regarding timing is presented to provide a base case plan for analysis of impacts as required under NEPA. Information regarding the size of the repository is presented to inform decision makers and the public of the potential impact of TWRS waste on planning for the repository and the potential need for a second repository. In all cases, the EIS assumes, for purposes of impact analysis, that the waste would be stored on an interim basis at the Hanford Site and ultimately shipped for disposal at a geologic repository. The Final EIS has been revised to provide for up to 50 years of interim storage onsite. Each ex situ alternative includes interim onsite storage large enough to hold all HLW produced. This allows the waste treatment program to move forward with out relying on the geologic repository. The interim storage method provides for shielded storage of the immobilized HLW, protective of human health and the environment.

This is consistent with the Tank Waste Task Force value that DOE "accept the fact that interim storage, at least, of the waste in an environmentally safe form will occur for some time at Hanford" (HWTF 1993). Later in the Tank Waste Task Force report when addressing waste storage, a discussion is included that advises DOE to "assume temporary storage will occur at Hanford but don't assume that all radionuclides should be here forever." Please refer to the response to Comment numbers 0008.02, 0004.01, 0038.10, 0052.01, 0035.04, 0012.11, and 0055.03 for all issues related to tank waste disposal and the TWTF.

Comment Number 0035.05

Martin, Todd

Comment I would like to address the cost estimates and how they effect the TWRS EIS, particularly in regards to Yucca Mountain.

If you look at some of the simple technical assumptions that are made in the EIS, such as waste loading, the amount of waste that gets into the glass, it dramatically affects cost.

The waste loading has been altered by a mere factor of a little bit more than 10 percent over the last couple of months. Some of the blending assumptions have been changed.

What does that do to cost? If you look at the preferred alternative, it changes the repository cost from four billion dollars all the way up to 12 billion dollars. That is a big impact for such a small change.

The no separations options, change the canister size. What does that do to the cost? It changes the repository cost from about 13 billion all the way up to over 250 billion dollars.

These overly conservative assumptions and the uncertainty with the repository are driving the costs that we see in this EIS. That is inappropriate, and the stakeholders have made that clear in the past.

Response The repository fees presented in the Draft EIS for the ex situ alternatives were overly conservative, but consistent with the published information DOE had at the time the Draft EIS was published. The Final EIS has been modified based on new guidance from the repository and an independent technical review of the Draft EIS. Please refer to the response to Comment numbers 0004.01 (repository fees and associated uncertainty), 0008.01 (canister size assumptions and associated changes in repository costs), 0027.11 (HLW waste loading), 0035.04 (comprehensive repository issues), and 0081.02 (separation of respository costs from alternative costs).

Comment Number 0036.01

HEAL

Comment Unfortunately, the repository plays an important role in the cost analysis of EIS alternatives. The EIS does include the speculated repository cost as a separate cost item, allowing the careful reader to see the role the repository plays in cost. This is an improvement. But many will not read beyond the Summary -- where the total cost is the only number available. The EIS itself makes a very good case for removing the repository cost numbers:

(The estimate of repository disposal costs)"... is an estimate based on numerous assumptions. Nor should the assumptions used in the analysis be interpreted as final DOE policy. The program is in the early stages of development and design concepts for items such as the repository surface facility, underground layouts, and waste packages are very preliminary. The techniques used to estimate the total system cost were appropriate to the limited level of design development and entail a corresponding level of uncertainty ... There is a high degree of uncertainty in using a fixed cost per canister for geologic disposal over the wide range in the number of canisters that would be produced for the TWRS alternatives." (p. 3-37)

In other words, there is almost no basis for the repository disposal costs and they should not be trusted.

The continued high-profile role of the speculated repository is unacceptable. It goes against past stakeholder values and common sense. Further, the EIS itself says that DOE will bring the program to a safely stored state at Hanford, regardless of the repository's existence. Each of the ex situ alternatives will include onsite storage sufficient for ALL the waste. According to the EIS, "This would allow each of the alternatives to operate independent of the acceptance schedule for the potential geologic repository" (p. 3-38). The Final EIS must be rewritten in such a way as to clearly put the repository in perspective and dramatically reduce the role the repository plays in the document.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. The Final EIS has been revised to discuss HLW disposal at the geologic repository

and the associated cost separately. See Volume One, Section 3.7 and Volume Two, Section B.9 for the revised discussion of HLW disposal at the geologic repository. Please refer to the response to Comment numbers 0004.01, 0008.02, 0035.04, and 0081.02.

Comment Number 0036.02

HEAL

Comment The EIS is biased to maximize the cost impact of the national repository.

Over the last few months, changes in waste loading, blending, and canister assumptions have maximized repository costs. The assumption changes are a radical departure from past TWRS assumptions and are not based on any evident engineering data.

Assuming waste loadings similar to those in Tri-Party Agreement studies results in the following repository fees:

- about $4 billion dollars for the "Phased Implementation" alternative.
- about $13 billion for the "no separations" alternative.

After the assumptions were changed, the "Phased Implementation" repository fee rose to about $12 billion and the "no separations" skyrocketed to over $250 billion. Meanwhile, the repository fee for extensive separations stayed relatively constant.

These assumptions may seem minor, but obviously have a large -- and inappropriate -- impact.

Response DOE and Ecology acknowledge that the repository fees presented in the Draft EIS for the ex situ alternatives were overly conservative. The data to support the TWRS EIS assumptions, analysis, and calculations were cited in the Draft EIS and engineering data packages, and calculations were provided for public review in DOE Reading Rooms and Information Repositories. The Final EIS has been modified based on new guidance from the repository and an independent review of the Draft EIS. Please refer to the response to Comment numbers 0004.01, 0008.02, 0035.04, and 0081.02.

Comment Number 0037.03

Eldredge, Maureen

Comment I am concerned about the cost estimates in the program, particularly including repository costs. It does not make any sense. It is ludicrous. We do not have a repository. DOE needs to wake up to that fact.

We are not going to get a repository any time soon, not by 2015. It is just not going to happen. We do not know what the repository, if we ever get one, will look like. We do not know what its loading requirements will be. We do not know what its technical capabilities will be. We do not know what its size will be.

Any predictions of cost for a repository are highly speculative. Even if Yucca Mountain by some chance happened to open in any kind of reasonable time frame, the first people in line are the commercial nuclear utilities.

And believe me, they are going to make sure they keep their place first in line. And they are going to make sure all of their waste gets into the facility before any defense waste gets a chance.

Even if defense waste gets in the door, only 10 percent of the repository is slated to be for defense high-level waste. And I am afraid that we are going to run out of space at Yucca Mountain at least very soon, if it opens at all.

Then we are looking at a really fun option of going for a second repository. It is just not going to happen. And it is time to start making plans and start looking at the future with more reasonable expectations.

Response The siting, design, and licensing of a geologic repository to isolate spent nuclear fuel and HLW for long-term protection of public health and safety of the environment is a highly technical and complex process. As stated in Volume One, Section 6.2, the current program planning assumption is that any DOE material qualified and selected for emplacement in the first repository would be disposed of beginning in the year 2015.

As stated in the EIS, current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository. The ex situ alternatives presented in the TWRS EIS were developed to be consistent with this policy. Current projections for commercial spent nuclear fuel and defense HLW exceed the statutory limit of 70,000 equivalent metric ton heavy metal (MTHM) in the first repository. The need for a second repository will not be addressed until between January 1, 2007 and January 1, 2010 when the Secretary of Energy is required to report to the President and Congress under the Nuclear Waste Policy Act. Please refer to the response to Comment numbers 0004.01, 0008.02, 0012.20, 0035.04, and 0069.04 for additional information.

Comment Number 0038.10

Reeves, Merilyn

Comment The cost of the national repository, which you have heard about tonight, it should be removed from the EIS. The hypothetical, national repository has been a driver for the tank waste treatment and disposal decisions. And this is not in the best interest of cleanup at Hanford.

The Tank Waste Task Force of 1993 was very clear, quote, let the ultimate best form for the waste drive decisions, not the size, nor the timing of the national repository.

The repository costs are not broken out in the summary, misleading the reader by not communicating the importance of repository costs for each option. And the speculated cost of repository should be removed from the EIS.

Response The presentation of the cost estimates has been revised for the Final EIS by separating the cost and discussion regarding HLW disposal. See Volume One, Section 3.7 and Volume Two, Section B.9 for HLW disposal costs. There are real costs associated with disposal of HLW at the geologic repository, and removal of these cost estimates from the EIS would not allow for an equitable comparison among the alternatives as required under the NEPA process. It is necessary to show these costs in the EIS to fully inform the public and the decision makers of the total cost of the alternatives. Please refer to the response to Comment numbers 0004.01, 0008.01, 0035.04, 0052.01, 0069.04 and 0081.02 for additional information on issues related to cost estimates, the geologic repository, waste loading and waste forms, and interim onsite storage.

Comment Number 0050.01

Boldt, A.L.

Comment I have a comment on the Draft EIS disposal cost. The geologic disposal cost presented in the Draft EIS are based on the linear extrapolation of the average container disposal cost provided by the document from DORW0479 referenced in the EIS, Analysis of Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program. This analysis cost in this document was for a specific scenario of waste in a number of canisters. The linear extrapolation of this average container cost - disposal cost from this previous reference to all the TWRS alternatives does not meet the requirements of the Nuclear Waste Policy Amendments Act of 1987 and the Federal Register Notice 52161, the Civilian Radioactive Waste Management Calculating Nuclear Waste Disposal Fees for the Department of Energy Defense Program Waste.

Federal Register Notice 52161 identifies, in detail, the method to be used in estimating the disposal fees for the Department of Energy Defense Program HLW share of the Civilian Radioactive Waste Management System costs. The Federal Register Notice 52161 cost allocation is based on the concept of full cost recovery with sharing formula supplied to all fixed and variable cost system or system cost components. The assumption of the linear extrapolation of average container disposal cost in the Draft EIS, greatly under estimates the disposal cost for the Extensive Separations alternative and greatly over estimates the disposal cost of the No Separations alternative. Example, disposal cost variability for alternate HLW container sizes and high-level waste volumes resulting from No Separations, intermediate separations, and extensive separations using the methodology of the Federal Register Notice 52161 are provided in a document by TRW for Environmental Safety Systems and it has long numbers on the copy I will give you but it is assessed on the pre-closure system cost health and safety in facts of Hanford high-level vitrification options on the civilian radioactive waste management system. This document is dated April 27, 1995.

I am requesting with the Draft TWRS EIS be revised to incorporate high-level waste disposal costs calculated with methodology specified in Federal Register Notice 52161.

Response Please refer to the response to Comment numbers 0004.01 (repository costs related to canisters) and 0081.02 (separation of repository, retrieval, and treatment costs).

Comment Number 0052.02

Pollet, Gerald

Comment What we need to remove from your total cost estimates is the entire set of repository fees. It is not sufficient to say that we broke out the repository fee in the details because you are still presenting a total range of cost estimates that the public and media and the decision makers are actually going to look at and they're going to say by gosh, that No Separations alternative costs a quarter trillion dollars. What kind of lunatic wanted No Separations? And what the decision makers, public, and media will not know is that, in fact, No Separation alternative actually has a rather reasonable price tag of below 30 billion dollars and that 211 billion dollars is a hypothetical repository fee for a hypothetical repository. A fee charged by the department to itself for repository which it admits in the EIS will never have the capacity for this. So it is a hypothetical fee for a hypothetical repository that the one certainty is does not have the capacity for it ever opened. There is something wrong with that picture and presenting it to decision makers, the public, and the media, it is apparent to the casual observer that someone is trying to skew the results.

Response DOE and Ecology have revised the Final EIS in response to public comment and put the costs of the repository into a separate presentation. The estimated costs for disposal of the HLW at the potential geologic repository are included in the Final EIS because there would be real costs associated with packaging, transport, and placement of HLW in a geologic repository. Eliminating the repository fees from the cost estimates presented in the EIS would not provide all of the costs associated with the alternatives and would bias presentation of the alternatives. Please refer to the response to Comment numbers 0038.10 and 0081.02 for discussion of repository costs as these issues relate to the alternatives analysis and the response to Comment numbers 0037.03 and 0008.02 for a discussion of the proposed geologic repository availability and statutory capacity.

Comment Number 0052.05

Pollet, Gerald

Comment One last closing thought for our comments tonight which is if you have a hypothetical repository fee for the hypothetical space at a hypothetical repository and the hypothetical land, then for the very real cost to the three tribes to the future generations of this region why isn't there assigned a cost for the permanent use of land in the leave it in place alternatives that are clearly being shown a preference through out all the cost estimates in this EIS. You need to consider internalizing the externalities and I would say that is less hypothetical and I think that the public could provide you and the tribes some very real cost estimates for creating a sacrifice found under the leave it there scenarios.

Response The cost estimates for the in situ or ex situ alternatives do not include cost associated with permanent land commitment, or land use restrictions associated with groundwater contamination. The amount of land committed to waste management and disposal was estimated for each of the alternatives, as was the extent of a groundwater contamination and associated human health impacts. The costs associated with long-term loss of land use or groundwater use can be understood within the overall context of the relative difference among various alternatives land use and groundwater use restrictions. The more land or groundwater is restricted the higher the cost. So while absolute dollar estimates are not provided the EIS does provide an appropriate level of analysis to support the comparison of alternatives. Land use issues related to Tribal Nation concerns are described in Volume One, Sections 5.5 and 5.19. Please also refer to the response to Comment numbers 0072.26, 0072.22, and 0036.18.

Comment Number 0055.04

Martin, Todd

Comment A third point would be that the repository should not be driving decision making at Hanford.

Response DOE and Ecology acknowledge the concern expressed in the comment. NEPA requires that all reasonable alternatives be evaluated. Consideration of geologic repository availability was included in the evaluation of the ex situ treatment alternatives in the EIS to the extent that availability was assumed; a limit would be placed on the accepted volume, type, and final waste form of Hanford materials, and the interim storage facilities would include a 50-year design life to provide sufficient time for availability. Data that support the impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and the public during the comment period. Please refer to the response to Comment numbers 0008.02, 0035.04, 0037.03, 0038.10, and 0052.01.

Comment Number 0055.05

Martin, Todd

Comment I want to address cost estimates in Yucca Mountain. I think people have heard that several times but I want to address some of the specifics. In looking at the numbers, you change a few assumptions here and there and it is amazing what it does to those cost numbers. For example in Phased Implementation when we look at the repository cost. You shift the waste loading, the amount of waste that goes into the glass by a mere 10 percent into essentially a percentage that is much lower than I have ever seen in any documents. What does that do to the repository cost for that option. Moves from 4 billion dollars to 12 billions dollars. Just a little assumption like that. Let us look at the no separation option. You take a fairly large canister, your repository cost is about 13 billion dollars. Shrink that canister down a bit and it jumps to 252 billion dollars. These are the kind of assumptions that I think that Mr. Pollet pointed out appeared to have been skewed to maximum the impact of the Yucca Mountain on the EIS. And I would agree with that assertion.

Response The changes in repository cost were a result of changes to the waste loading, HLW canister size, and use of a blending factor to account for uncertainties in the ability of the retrieval operations to deliver a uniformly blended waste feed stream to the treatment facilities. The variation in estimated repository cost based on waste loading and canister size is included in the cost ranges presented in the EIS. Please refer to the response to Comment numbers 0035.04. 0038.10, and 0081.02.

Comment Number 0057.04

Garfield, John

Comment The logic of the repository cost for example in the intermediate separations adding up to $12 billion dollars does not make sense from even the simplest technical that any member of the public can understand. The Hanford contribution to the repository in total is about 1 percent of the total radionuclides if all the high-level wastes goes to the repository and about 1 percent of the heat. Whether or not content into the small number of canisters or leave it in a large number of canisters will not significantly drive the repository costs. That is a fairly straight forward and simple approach or way of thinking about that problem that everyone can understand. Attributing $12 billion dollars to that repository or $211 billion dollars for the No Separations case does not stand up to the simplest scrutiny.

Response The amount of HLW that ultimately could be accepted at a national repository is a function of available subsurface area and emplacement constraints among HLW and spent nuclear fuel (SNF) within this area. In addition, there is a statutory limit on emplacement of HLW and SNF in a first repository (70,000 MTHM) until a second repository is in operations. As a planning basis, the Department has allocated 10 percent of that statutory capacity of the first repository for defense SNF and HLW.

The physical amount of available subsurface area for HLW and SNF disposal, and the associated number of packages of HLW and SNF, would be defined through repository design and performance assessment activities, based on information collected during repository scientific investigations. Neither of these activities are completed. However, for planning purposes, the repository Advanced Conceptual Design assumes that 12,900 canisters of defense HLW, each containing 0.5 MTHM, can be accommodated within the statutory limit.

A number of factors are important in estimating disposal costs including number and size of canisters handled, number of waste packages, operation and capital costs, and number of shipments to a repository. In addition, there are common costs that must be allocated among waste generators, such as development and evaluation costs, to ensure full cost recovery. Using radionuclide inventory of Hanford HLW relative to other wastes would not provide an equitable basis for cost estimating. For more information on this issue, refer to the response to Comment number 0005.08.

A number of factors go into the repository cost estimate including heat load, canister size, waste package design, and number of waste packages. Looking at Hanford contribution of the repository cost solely from the standpoint of radionuclide contribution to the repository would not provide a straightforward and understandable basis for cost estimating. Please refer to the response to Comment numbers 0004.01, 0008.01, and 0081.02 for additional information on repository cost estimates.

Comment Number 0062.05

Longmeyer, Richard

Comment One of the things that would need to be re-looked at is if the Yucca Mountain facility is not going to become a reality, how would that affect the prioritization of these different plans. And my guess is that the Yucca Mountain facility, or any national repository for nuclear wastes, will never receive any nuclear wastes from across state lines in my lifetime, and probably not in the lifetime of my children. And so that means that we need to re-look at this, and prioritize them again. Doing so would probably leave us with three options. The in situ vitrification, the ex situ vitrification with onsite storage, and the Phased Implementation, which you have now with onsite storage. And so, those would be the three that I would recommend we look at more closely.

Response Current national policy calls for disposal of spent nuclear fuel and HLW in a geologic repository. DOE and Ecology developed the ex situ alternatives in accordance with this policy. In response to concerns regarding the timing and availability of the geologic repository to accept HLW from the Hanford Site, the Final EIS has been revised in Volume One, Section 3.4 and Volume Two, Appendix B to include the impacts associated with onsite interim storage of treated HLW for 50 years. The environmental impacts associated with the in situ alternatives identified in the comment are provided in the EIS in Volume One, Section 5.0 and associated appendices. Volume One, Section 5.12, and Volume Three, Appendix D contain discussions of the transportation risk associated with offsite disposal. Please refer to the response to Comment numbers 0008.02 (repository availability and related uncertainties) and 0037.03 (statutory limits), and 0052.01 (interim HLW onsite storage) for more information.

Comment Number 0072.84

CTUIR

Comment P3-28: PP 5: Does this mean you are only going to use one multi-purpose canister? Please explain in more detail in order for the readers to grasp how many and how much.

Response One type of multi-purpose canister was assumed as an overpack used for handling and interim onsite storage. This multi-purpose canister is referred to as a Hanford Multi-Purpose Canister (HMPC) throughout the document. The text has been revised in Volume One, Section 3.4 to discuss the relationship between the primary HLW canisters and the HMPC.

Comment Number 0077.05

ODOE

Comment A large part of the cost shown for the vitrification alternatives included charges to dispose of the waste to the national high-level waste repository. These charges should not be used to decide whether to put the waste in a stable and durable form.

Several alternatives call for removal of all wastes from the tanks and vitrification. They differ in the methods used, complexity, speed, and cost. The repository charges should be used as one criteria in deciding among these alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0004.01, 0035.04, 0052.01, and 0081.02 for more information regarding disposal costs, assumptions, and presentation in the Final EIS.

Comment Number 0079.05

Knight, Paige

Comment Repository costs must not be included in the total cost of any plan implemented. Cleanup dollars must go first towards stabilizing waste in a quality form that is not water soluble. Repository room must be considered. If Yucca Mountain is ever a viable option, it will only hold a small portion of Hanford waste. So the form of the waste must be not only stable, but retrievable. My reasoning there is that more than likely the waste in any kind of form is going to be sitting at Hanford for at least 40 years, and I would suspect much more than that.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0008.01, 0038.10, and 0081.02.

Comment Number 0081.05

Pollet, Gerald

Comment More importantly is the next bullet in our advice. Accept the fact that interim storage at least, at least, of the waste in an environmentally safe form will occur for some time at Hanford. Select a waste form that will ensure safe interim storage of this waste. The message was, Hanford is going to be the home for the high-level nuclear waste. Select the best form, and don't even put into the mix the theoretical cost of the repository, which the Department will charge itself, nor the theoretical capacity of it, because it doesn't have the capacity to handle it anyway, under any scenario here. We request that this advice be addressed, and placed in the front of this EIS. And it be addressed in the summary and throughout. We request that the repository costs be relegated to an appendix, and the total cost summaries be redone to show the total cost without the theoretical hypothetical self-dealing charge for replacing waste in the repository. When that is done, we should examine carefully the no separation versus the extensive separation scenarios. And we should see how much we pay for unproven technology under extensive separation, versus no separation and intermediate separation.

Response The storage of the HLW at the Hanford Site for 50 years has been included in the ex situ alternatives. Please refer to the response to Comment number 0089.18. Current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository and the ex situ alternatives were developed to be consistent with this policy. DOE and Ecology have revised the presentation of the cost estimates for HLW disposal for the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B. This will allow the reader to readily compare the estimated cost for waste treatment among the alternatives. There are real costs associated with packaging, transport, and placement of canistered HLW into a geologic repository, and failure of the EIS to present these costs would provide an incomplete picture for the decision makers and public. Please refer to the response to Comment numbers 0004.01, 0035.04, 0038.10, and 0069.04.

The EIS presents in Volume One, Section 3.4 and Volume Two, Appendix B, alternatives that are based on 99 percent retrieval with no separations (the Ex Situ No Separations alternative), intermediate separations (the Ex Situ Intermediate Separations alternative), and extensive separations (the Ex Situ Extensive Separations alternative). A summary comparison of these alternatives is provided in the Summary and a summary of the environmental impacts of each alternative is presented in Volume One, Section 5.14.

Comment Number 0089.18

Nez Perce Tribe ERWM

Comment Since the possibility exists that Yucca Mountain repository may not open, the design life of the onsite facility storing the vitrified high-level waste must be sufficient for the permitting and construction of an alternate high-level waste repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume One, Section 3.4, the Summary, and Volume Two, Appendix B.3 have been revised to include reference to the 50-year design life for the interim HLW storage facilities, which is based on a conservative estimate for approval and availability of the geologic repository. Please refer to the response to Comment numbers 0008.02, 0035.04, and 0052.11.

L.3.4.2.2 Alternatives Costs

Comment Number 0005.12

Swanson, John L.

Comment I applaud you for giving cost RANGES in comparing the different alternatives, but I am very surprised that you did not include the (large) uncertainties in HLW repository disposal costs in many of these ranges. In recent years, there have been reports of attainable cost savings through the use of higher waste loadings in HLW glass and the use of larger canisters; such savings could give estimated repository disposal costs only one-fourth as large as the values you give.

Response DOE and Ecology considered HLW disposal fees in the total cost range (treatment cost + repository fee) for the ex situ alternatives presented in the EIS. For example, when comparing the treatment cost range to the total cost range, the total cost range is not the sum of the treatment cost range and the repository fee. This methodology addressed only TWRS-specific parameters, mainly waste loading and canister size, in the cost uncertainty analysis. Uncertainties in the repository program are not within the scope of the EIS. However, 50 years of storage of the HLW is included in the ex situ alternatives to account for the uncertainty of when a repository may be available to accept waste for disposal. Please refer to the response to Comment numbers 0081.02, 0072.80, and 0008.01 for further discussions of repository and canister issues.

Comment Number 0005.13

Swanson, John L.

Comment Because of the large uncertainty in HLW repository disposal costs, I feel that it would be a more fair comparison of the costs of the alternatives in the Summary if you split out those estimates-something like "The cost of this alternative, exclusive of the HLW repository fee, is estimated to be in the range of ___ to ___. Based on the assumptions adopted for this EIS, the HLW repository fee for this alternative is estimated to be __; the use of other assumptions regarding higher waste loading in glass and the use of larger canisters could lower this estimated fee to ___."

Response DOE and Ecology recognize the concern regarding the cost uncertainty associated with the repository. The Final EIS has been revised to discuss HLW disposal at the geologic repository, the associated cost separately, and potential impacts (e.g., accidents during transportation). The Summary, Section S.8, Volume One, Sections 3.7 and 6.0, and Volume Two, Section B.9 contain a discussion of HLW disposal at the geologic repository. Please also refer to the response to Comment numbers 0081.02, 0008.01 and 0005.12 for further information regarding repository availability, cost estimate methodology, and assumptions.

Comment Number 0005.14

Swanson, John L.

Comment The more I look into your cost ranges, the more confused I become. For example; a) Footnote (3) to Table S.7.6 says that the relatively large ranges in costs for three of the alternatives is primarily a result of assumptions made for repository fee, but two of the three alternatives identified in this footnote do not fit this situation. b) Tables 3.4.13 and 3.4.14 contain footnotes indicating that the cost ranges are dependent on the canister size used, but the tables themselves give only individual values for the repository fees. Why aren't the repository fee ranges used given in the tables? Also, if the cost ranges resulting from canister size increase are given for this/these alternative(s), why aren't they given for the other alternatives as well? The way you have it is a mixture of "apples and oranges." c) Section B.8.3 ("Cost Uncertainty") does not do anything to help me, either-except to emphasize that "assumptions drive conclusions."

Response The footnote in question (footnote number 3 of Table S.7.6) is intended to provide the reader a summary-level explanation of why the cost ranges vary widely for the ex situ alternatives. The difference between the high and low cost range for the Ex Situ No Separations (Vitrification) alternative is $184 billion, the range for the Ex Situ No Separations (Calcination) alternative is $47 billion, and the range for Ex Situ Intermediate Separations and Phased Implementation alternatives is approximately $10 billion. The ranges estimated for these alternatives are greater than the other alternatives mainly because of repository fee assumptions. Technical assumptions regarding the HLW canister sizing have been revised for the Final EIS, which reduce the large cost ranges associated with the ex situ alternatives that produce large volumes of HLW. Additional detail on how the cost uncertainty and ranges were estimated is provided in Volume Two, Appendix B. Please refer to the responses to Comment numbers 0081.02 and 0005.03 for more information on uncertainty.

The Volume Two, Appendix B discussion on cost uncertainty is intended to provide an overview of the methodology and the analysis results. The detail input output data are included in the technical backup data that is publicly available as part of the TWRS EIS Administrative Record.

As noted in the response to Comment number 0005.12, the uncertainty in HLW disposal fees that would result from a variation in the number of HLW packages is included in the total cost range for each ex situ alternative. This allows for an equitable comparison among alternatives.

Comment Number 0052.03

Pollet, Gerald

Comment The costs have some other strange anomalies. For instance, some of the cost estimates for vitrification alternatives today are basable upon some market considerations in terms of what vendors are saying they believe they will be able to bid.

Response None of the cost estimates for the alternatives presented in the Draft EIS were based on privatization of the tank waste treatment. Privatization is an implementation strategy and as such was not addressed in the EIS. For a discussion of this, see Volume One, Section 3.3. All of the cost estimates were developed using the same methodology to provide an equitable comparison among the alternatives. Privatization issues are discussed in the response to Comment number 0060.01.

Comment Number 0052.04

Pollet, Gerald

Comment But what is kind of incredible in this EIS is continuing the historic practice at this site of having a capital contingency built into all the cost estimates of not just 30 percent here but 30 to 50 percent. It is really hard to talk about how the TWRS program is reaming in its costs when its capital cost estimates have a contingency added in of 30 to 50 percent. It is very disturbing and from point of view of how this is then presented to Congress, what we have is a set of alternatives that may emerge that are the ones that are necessary to meet the legal requirements of removal, retrieval, and treatment which are inflated because of their capital considerations by 50 percent and which are inflated by up to $211 billion dollars by a hypothetical repository fee and then we wonder why Congress may not want to fund vitrification.

Response The use of contingencies in cost estimates is standard practice throughout the public and private sector. This is especially true of conceptual estimates for any large construction projects. The use of a contingency in the capital cost estimates is a means to quantify the uncertainty inherent with conceptual designs. The use of contingencies is appropriate for all construction projects, especially projects involving the complexity of the TWRS program. Cost estimates associated with the repository are provided in response to Comment numbers 0004.01 and 0081.02. Capital construction costs are discussed in the response to Comment numbers 0055.06 and 0081.03. DOE-Richland Operations Office (DOE-RL) prepares an annual budget, which would include the budget required for the TWRS cleanup for that year. However, only Congress has the authority to appropriate funds.

Comment Number 0055.06

Martin, Todd

Comment On the costs more generally, I trust the costs in this document about as far as I can throw this document which needless to say without doubt is not very far. Most of the people in this room remember the Hanford Waste Vitrification Plant. This was a 1-ton a day high-level waste vitrification facility. This was the cornerstone of Hanford cleanup that as I recall is supposed to be running in about 3 years but we canceled the program. That was projected to cost about 1.3 billion dollars. Pretty hefty. I look at this EIS and I see that a low-level waste facility (vitrification facility) it is 20 mt per day. Twenty times the throughput is going to be built for 248 million dollars. I do not get it. I do not see the basis for those costs and I simply do not buy it. Further, to compare more of an apples to apples, we look at the high-level waste vitrification facility that is in the EIS. This a 1 metric ton a day facility, it is essentially HWVP. The 1.3 billion dollar facility. What is it in this EIS? 232 million dollars. I can not imagine that it can be built for that. In other words, total for the Phased Implementation alternative, DOE is going to built two low-level waste vitrification facilities with an agent pre-treatment on both of those and one high-level waste facility for 1.4 billion dollars. Essentially the cost of HWVP. I say no way. If that is true, why are we doing privatization? We can take the budget authority that has been given about 2 years and we have got the full cost of one of these facilities. This does not assume any efficiencies from privatization. These are government-owned, contractor-operated facilities, built under a traditional contracting mechanism. Essentially, until a formal credible data package has been done to support the Phased Implementation, the preferred alternative in this EIS, this EIS should go forward no further. Should go no further.

Response DOE and Ecology acknowledge this concern regarding the cost estimates and have reviewed and revised the Phased Implementation cost estimate as appropriate for the Final EIS. These revised cost estimates are shown in Volume One, Section 3.4 and Volume Two, Appendix B and are reflected in the Summary. The Hanford Waste Vitrification Plant (HWVP) cost estimate is not directly comparable to the capital cost estimate for the Phase 1 HLW facility because it includes support facilities and infrastructure that are estimated as separate components for Phased Implementation.

The Phased Implementation alternative was developed by scaling appropriate components from the Ex Situ Intermediate and Extensive Separations alternative. The capital cost was estimated using the "six-tenths rule" and the relative plant capacities for Phased Implementation were estimated in the absence of more definitive data. DOE and Ecology acknowledge that there is uncertainty introduced into the cost estimates by scaling and this is captured in the cost uncertainty analysis. The cost uncertainty analysis results in a cost range within which the final cost would be expected to fall. Total capacity cost breakdowns for a combined separations LAW facility and a detached HLW treatment facility are generally 35 percent equipment, 20 percent material, and 45 percent labor (WHC 1995j).

The cost estimates input data, methodology, and calculations are available in the reference documents included in the EIS and available for public review in DOE Reading Rooms and Information Repositories.

Comment Number 0057.06

Garfield, John

Comment There are a few other less important comments that I will make. One is with regard to the cost estimates for the combination case and to some degree the Phased Implementation case. Parsons has used 6/10ths power rule to arrive at those costs for lack of any conceptual design basis to make those estimates. That rule is applicable in the commercial industry for chemical processes because those plants are largely equipment-driven. 50 to 85 percent of those plant costs are equipment and when you vary the capacity that the capital cost of the facility does, as a rule, from varied by the 6/10ths power rule. Nuclear facility equipment costs only amounts to 10 to 20 percent of the total capital cost. That same 6/10ths power rule can not be used for a shielded nuclear processing facility. It makes no sense to do that and the cost have been skewed for using that. That adjustment should be made and can be made fairly easily.

Response The Phased Implementation alternative and combination alternatives were developed by scaling appropriate components from the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives. The capital cost was estimated using the "six-tenths rule" and the relative plant capacities for the Phased Implementation alternative in the absence of more substantive data. Some uncertainty is introduced into the cost estimates by scaling and this is captured in the cost uncertainty analysis presented in Volume Two, Appendix B. The cost uncertainty analysis results in a cost range within which the final cost would be expected to fall. Total capital cost breakdowns for a combined separations LAW facility and a detached HLW treatment facility estimated for the Ex Situ Intermediate Separations alternative are 35 percent equipment, 20 percent material, and 45 percent labor (WHC 1995j).

The cost estimating methodology has been reviewed and revised cost estimates have been completed for the Phased Implementation and combination alternatives, and for other alternatives as appropriate. These revised costs are shown in Volume One, Section 3.4 and in Volume Two, Appendix B.

Comment Number 0069.04

Pollet, Gerald

Comment The TWRS EIS skews the costs of the alternatives as well. This, coupled with the risks, presents a very biased picture in the EIS of the alternatives. First off, you see this is how their rank ordered in the EIS, as it will be presented to decision makers, and is being presented to you, the public. Leaving waste behind has a cost range of 23 to 28 billion. Extensive separation comes in close behind it, 27 to 36 billion. This is the Tri-Party Agreement path, called Phased Implementation, 32 to 42 billion, building just one plant basically with multiple melters, and calling it all high-level waste, glassifying it all, this astonishingly high price tag. Anyone rational would throw it out.

The repository fee, once it's removed ... excuse me, what I was saying was, the Nuclear Waste Policy Act does, indeed say how you should calculate a repository fee if your going to use it here.

It is not the way it is calculated here. Secondly, it should not be used at all because this waste will never fit into the proposed hypothetical repository at Yucca Mountain. So what is the fee for? It's a hypothetical fee the Department charges itself for a hypothetical repository that will not have room.

So all of a sudden, we have a drastic change in the order of the alternatives. In fact, what we get is, let me just present the conclusion, the Ex Situ/In Situ Combination goes from being least cost by 4 to 8 billion, to only being 1 to 7 billion dollar lower cost then getting all the waste out of there. The Extensive Separations goes from number 2 to number 4 and number 5. It goes from having a cost advantage of 5 to 6 billion dollars over the Tri-Party Agreement, to having a

5.4 to 6.4 billion dollar disadvantage over the Tri-Party Agreement path. It is an effort to skew the data here, and present it in a skew manner to decision makers. And the No Separations alternative, which gets wastes out of tanks fastest, with least research and development, actually shows up as having potentially the lowest range costs. Thank you.

Response The Phased Implementation alternative involves building two separations and LAW treatment facilities and one HLW vitrification facility during Phase 1 to demonstrate the treatment technologies. Following Phase 1, Phase 2 would be implemented, which would involve building full-scale treatment plants to treat the remainder of the tank waste. For a description of the Phased Implementation alternative, please refer to Volume One, Section 3.4.

The purpose of the Nuclear Waste Policy Act is to: 1) establish a schedule for the siting, construction, and operation of repositories that will provide a reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level radioactive waste and such spent nuclear fuel as may be disposed of in a repository; 2) establish the Federal responsibility, and a definite Federal policy, for the disposal of such waste and spent fuel; 3) define the relationship between the Federal Government, State and affected Indian Tribal governments with respect to the disposal of such waste and spent fuel; and 4) establish a Nuclear Waste Fund, composed of payment made by the generators and owners of such waste and spent fuel, that will ensure that the costs of carrying out activities related to the disposal of such waste and spent fuel will be borne by the persons responsible for generating such waste and spent fuel. The Nuclear Waste Policy Act does not provide a methodology for calculating the repository fee for disposal of HLW in a geologic repository. For the Final EIS, repository fees were recalculated. For more information, please refer to the response to Comment numbers 0004.01 and 0036.01.

Current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository. The current inventory of commercial spent nuclear fuel and defense HLW exceeds the statutory limit for the first repository. The disposal of all commercial spent nuclear fuel and defense HLW will require increasing the limit of the first repository or constructing a second repository. DOE is currently characterizing one site, Yucca Mountain, Nevada, for a geologic repository. The law requires that the Secretary of Energy report to the President on or after January 1, 2007, but not later than, January 1, 2010, on the need for a second repository. Within this context, none of the alternatives addressed in the TWRS Draft EIS exceed the capacity for geologic disposal, even though many of the alternatives would generate more canisters of HLW than the repository program is currently using for planning purposes. Based on revised canister size and other recalculations completed for the Final EIS, the EIS has been revised in Volume One, Sections 3.4 and 6.0, and Volume Two, Appendix B, to address the repository capacity issue relative to TWRS alternatives.

Failure to recognize that each of the ex situ alternatives would have cost impacts associated with HLW disposal would provide unequal information for the reader. Please see the response to Comment numbers 0081.01, 0081.02, and 0035.04.

Comment Number 0072.92

CTUIR

Comment P 3-36: PP 4: S 2: By what factor? Or by a factor of what?

Response Capital cost contingencies were included in the alternative cost estimates as described in Volume One, Section 3.4 and Volume Two, Appendix B. These contingencies are included to account for the uncertainty associated with the conceptual-level designs developed for analysis in the TWRS EIS. The contingency factors used ranged from 25 to 50 percent with a typical value of 40 percent. The higher contingencies were applied to the more conceptual facilities and the lower contingencies were applied to the more defined facilities. This is consistent with industry standards and practice. Please refer to the response to Comment numbers 0052.04, 0055.06, and 0057.06 for related information on the use of contingencies in cost estimating.

Comment Number 0072.93

CTUIR

Comment P 3-36: PP 6: Please explain how the R&D cost is to be assumed for the phased alternative.

Response Because Phase 1 would be a demonstration process, the research and development cost for the treatment process was assumed to be an integral part of the Phase 1 operating cost. The research and development cost associated with the waste retrieval and transfer function was included at the same level as the other ex situ alternatives. There are development programs currently ongoing at the Hanford Site that are covered under the TWRS program or other programs.

Comment Number 0077.04

ODOE

Comment Also, the cost analyses do not include the lost value of the lands or the costs from harm to future generations or the environment. Ultimately, the costs of these alternatives would prove to be much greater than removing and cleaning up the wastes, as called for by the preferred alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Analyzing the harm to future generations from an economic standpoint is not included in the EIS; however, lost habitat, health risks, health consequences, and probabilities of accidents to future generations were among the impacts analyzed by DOE and Ecology. Land use commitments are addressed in Volume One, Section 5.7, anticipated health effects in Section 5.11, and comparison of potential consequences from accidents in Section 5.12. For the Final EIS, a Native American scenario was added to the analysis presented in Volume One, Section 5.11. Please refer to the response to Comment numbers 0036.18, 0052.05, 0072.22, 0072.55, 0072.198, 0072.225, and 0072.34 for related discussions..

The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0081.01

Pollet, Gerald

Comment We are concerned that the Department of Energy falsely inflated the costs of waste removal and glassification options to justify leaving waste in the tanks. We are also concerned that the rate the costs have been presented would erroneously lead policy makers to the conclusion, when combined with the use of erroneous assumptions as to risk, lead to the conclusion that in fact it would be cost affected to leave waste behind.

Response The cost estimates are an equal analysis of the total life-cycle costs of each alternative and reflect the best available cost information given that the engineering is still at a conceptual stage. The estimates are available for inspection by the public in the TWRS EIS Administrative Record. Please refer to the response to Comment number 0081.02 for a discussion of how the repository costs were recalculated for the Final EIS. For responses to specific comments regarding risk assumptions, please refer to the response to Comment numbers 0069.08, 0069.09, 0069.03, 0069.06, 0069.07, 0081.07, and 0069.11.

Comment Number 0081.03

Pollet, Gerald

Comment And what is interesting is it has the least technical question. And the EIS is based, in terms of these costs, costs include a 30 to 50 percent capital cost contingency. This is pretty bazaar. We're spending 10's of millions of dollars on research development design phased approach.

We are spending 10's of millions of dollars on design, which ought to drive down contingencies. 30 to 50 percent contingency is the way Hanford has done business with capital construction projects in the past. It is sinful. It is not going to be able to continue. If we eliminate, and we use different factors for contingency, take a look at the fact that a no separation alternative means you build one plant with the simplest technology, vitrification. You vitrify everything. You don't try to separate. You just vitrify. You do not have to build a multi-billion dollar separation plant. You do not have to build separate low activity and high activity vitrification plants. You could, and this EIS fails to consider the alternative which was eliminated earlier in this process, of having a very simple separation of low activity and high activity, in terms of which melter waste is directed too, at the front-end of such a plant. If we look at the cost issue alone, the no separation option actually drives down into the cost range, and perhaps will compare more favorably than the Ex Situ/In Situ Combination even.

The cost assumptions, as with all other assumptions, are critical. Building in 30 to 50 percent contingencies for one set of options is not acceptable for this type of policy decision making. And we can't afford to continue with 30 to 50 percent contingencies for capital costs at Hanford.

Response As noted in the response to Comment number 0052.04, the use of contingencies in capital cost estimates is standard practice throughout the public and private sector. All of the alternatives presented in the EIS include contingencies in the capital cost estimates. During design development for the alternative selected, the cost estimate would be refined and the contingency reduced. The cost estimate for a large facility would typically have some contingency remaining at the start of construction. The capital cost estimate as well as the contingency estimated for the Ex Situ No Separations alternative is smaller than the Ex Situ Intermediate and Extensive Separations alternatives because one treatment facility is constructed instead of two. The contingency factor for the Ex Situ No Separations alternatives provides an equal presentation to the public and the decision makers. Capital construction costs are also discussed in the response to Comment numbers 0055.06, 0057.06, and 0081.03.

A single facility designed to vitrify both HLW and LAW would not be precluded by the EIS for any of the alternatives that include separation of the HLW and LAW. The impacts associated with a single treatment facility would be bounded by the alternatives presented in the EIS. The separations processes included in the EIS cover a reasonable range of representative technologies. The separation of the waste into HLW and LAW streams is bounded with no separations on the low end, extensive separations on the high end, and intermediate separations in the middle.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please also refer to the response to Comment number 0072.05 for a discussion of the development of the alternatives for analysis in the EIS.

Comment Number 0089.04

Nez Perce Tribe ERWM

Comment Purification and removal of sodium nitrate and other major wastes from tanks prior to segregation of LAW and HLW should be considered for volume reduction and cost savings. Possible removal of sodium nitrate for industrial or certain agricultural use should be considered. Another option may be reacting the sodium nitrate with an organic reducing agent to produce sodium carbonate, nitrogen, ammonia and water, greatly facilitating waste reduction. Options such as these need to be considered to reduce vitrification volumes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume reduction measures for the waste have been considered, including calcination and the clean salt process. These measures are addressed in Volume Two, Appendix B, Section B.3. Removal of sodium nitrate, such that this compound would be safe and suitable for industrial or agricultural uses would be limited because complete radionuclide removal to form a purified waste would be extremely difficult.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment number 0072.05 for related discussion.

Comment Number 0090.01

Postcard

Comment Please listen to us say no:

to falsely inflating the cost of glassifying Hanford's High-Level Nuclear Wastes by $211 billion.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment numbers 0004.01, 0009.04, 0008.01, 0038.10, 0081.01, and 0081.02, for discussions regarding how repository costs were calculated and presented in the EIS..

Comment Number 0092.01

Hanson, Mary

Comment I certainly feel that as a lay person, I have every right to the most conservative principles being used in this situation and I certainly, personally and I think I stand for others here, do not consider cost to be important. Money can be made, the environment can not be remade. Now the total defense budget for this country is somewhere around 260 billion dollars per year. That is a lot of waste. In my opinion, that it is throwing money at defense. Most of it. Playing games, testing this and that and so forth. This is a real problem. This is a real security problem and if it were up to me I would put probably half the defense budget on it. So I do not consider money to be something that you can quote, "balance against health." I do not think money is something you balance against the environment. You can not balance a nonrenewable resource like the environment against a renewable resource like money. So I am very strongly in favor that this be done in the economic, in a conservative manner, economically speaking but I certainly feel that if the public really was as aware as everyone in this room is of what the issues are, they would vote very high amounts of money to deal with this threat to our security.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Cost estimates presented in the Draft EIS have been reviewed and revised, as appropriate in the Final EIS.

The alternatives and impact analysis presented in the EIS were based on conservative principles, consistent with the requirements of NEPA to bound the potential impacts and to address a range of reasonable alternatives. For more information on this topic, please refer to response to Comment number 0072.05 or in the EIS Volume One, Section 3.3. Please also refer to the response to Comment number 0081.01 for a discussion of issues related to the presentation of costs.

Comment Number 0098.01

Pollet, Gerald

Comment The Department of Energy's presentation tonight and at prior meetings and in these materials show ... say ... claim that this unproven technology of so-called in situ vitrification, sticking electrodes into the ground and melting the ground into glass. The presentation said that this would comply with Washington State law. Nothing could be further from the truth. Washington State first off has in the model toxic control act and our dangerous waste regulations a presumption that we will favor removal. That is the law. Leaving it in place when you have an alternative of removal and retrieval is never allowable under Washington State law. We have a set of priorities for dealing with waste. Hanford does not get to make an exception for itself although it sure does try most of the time.

Response The disposal of HLW by ISV would comply with Washington State law if the hazardous waste components are adequately treated to remove the hazardous characteristics or immobilize the hazardous components. The treatment and disposal would be subject to review and permitting by Ecology. Washington State law does not apply to disposal of the radioactive components of the HLW. For a discussion of regulations applicable to the HLW, see Volume One, Section 6.1. For related discussion regarding technical uncertainty, please refer to the response to Comment number 0012.04. Because the information contained in the Draft EIS is correct, no change to the text was made.

L.3.4.2.3 Assumptions

Comment Number 0005.39

Swanson, John L.

Comment The paragraph beginning at the bottom of page 3-31 is interesting. It starts out by saying that the residual contaminants would be insoluble, and then goes on to make the conservative assumption that 1 percent of the water-soluble contaminants would also be present. This conservative assumption drives conclusions, as discussed in (18) above [Comment number 0005.18].

Response DOE and Ecology recognize the concern expressed in the comment regarding conservative assumptions used in the impact analysis and the extent to which these assumptions affect the calculated risk values. The analysis performed for the Draft EIS assumed, for the ex situ alternatives, that 1 percent of the original inventory would remain in the tanks as residual waste that could not be retrieved. This assumption is bounding (e.g., provides a reasonable upper limit) with respect to the impact analysis, because it includes 1 percent of the water soluble contaminants. The Final EIS has been revised to include Volume Five, Appendix K, which will provide a nominal case analysis using best estimate assumptions. The nominal case analysis was based on 1 percent residual volume that was modified to reduce the inventory of soluble constituents. Using this assumption will result in a risk range and will enable the reader to see the variation in the long-term risk as a function of nominal and bounding assumptions. Please refer to the response to Comment numbers 0072.59, 0072.51, and 0072.05.

Comment Number 0005.40

Swanson, John L.

Comment On page 3-34 it is said that the assumption of cullet in a matrix material as the waste form for onsite LAW disposal "--provides a conservative analysis of the long-term impacts--." This statement is true only if conservative assumptions were made regarding the performance of the matrix materials. Were those assumptions conservative? Are they spelled out somewhere? (Page 3-66 contains a statement in opposition to the one on page 3-34; "The potential benefits of a matrix material and glass cullet combination as a disposal form are reduced contaminant release rates and--." Thus, the assumption of cullet in a matrix material does NOT provide a conservative analysis of the long term impacts, as is stated on 3-34).

Response In order to bound the impacts associated with the LAW disposal vaults, the releases from the LAW vaults were calculated under the assumption that the matrix material provided no reduction in the release rates from the LAW disposal vaults. DOE and Ecology believe that using a matrix material with glass cullet would reduce the release rates from the LAW disposal system. The two statements do not conflict with each other. Cullet, as opposed to monolithic pours, would be more easily leached; therefore, cullet is considered the more bounding (higher) approach in the environmental impacts analysis. Assumptions associated with release rates and associated impacts to groundwater are discussed in Volume Four, Appendix F.

Comment Number 0005.42

Swanson, John L.

Comment The last sentence on page 3-35 says that it has been determined that a bleed stream would be required to avoid a continuous buildup of Tc-99 in the vitrification off-gas stream. I do not believe that is necessarily true, and wonder who made that determination (and on what basis). The data I have seen indicate that some melters can retain a significant fraction of the Tc in the glass; thus, Tc in the off-gas from such melters would stop building up when that in the feed plus recycle equals that in the glass.

Response DOE and Ecology acknowledge the concern regarding the constituents that would require the use of a bleed stream for the off-gas recycle system. The EIS discussion includes technetium-99 and mercury as representative examples of the type of volatile constituents that could build up in the off-gas recycle streams. The LAW vitrification processes addressed in the EIS are based on a combustion fired melter. This melter type raised the concern regarding retention of volatiles and semivolatiles in the glass during technical review of the Preliminary Draft EIS. The requirements for a bleed stream were noted and included in the EIS.

As indicated in the comment, a bleed stream may not be necessary to avoid a continuous buildup of technetium-99 in the off-gas recycle stream, but based on available information, it appears probable that a bleed stream would be required. The functional requirements and sizing of the off-gas recycle system would be developed during the detailed design phase following selection of an alternative.

Comment Number 0012.20

ODOE

Comment Vitrification of the wastes greatly reduces the risk to the public and the environment. Even the least capable glass waste forms represent a dramatic improvement over the current conditions. Wise selection of pretreatment and segregation options and glass specifications may greatly reduce the long-term costs and risks to the public. These should not however delay decisions to proceed with cleanup and vitrification of Hanford's tank wastes.

There is no assurance that any of the vitrified waste will leave Hanford. As a consequence, it is essential that the vitrified waste contain all of the radioactive wastes for so long as they remain hazardous.

The vitrification alternatives do not specify the physical or chemical properties or requirements for the glass products. There is no specification for how durable the glass waste form must be, or for how long the glass must contain the radioactive wastes. Specifications must require the product glass be durable enough to contain the radioactive components for as long as they remain hazardous. This requirement is relatively easy to meet for short half-life isotopes such as strontium-90 and cesium-137. It is more difficult for long half-life isotopes which easily migrate in water, such as cesium-135, iodine-129, technetium-99, and neptunium-237. These isotopes are volatile and are difficult to incorporate into glass. Additionally, the long lived actinides also must be retained until they are no longer hazardous.

The common glasses used for the immobilization of high-level nuclear waste are not durable enough to contain these materials for the times needed. The borate content of these glasses is often controlled at high levels to reduce the melt temperature of the glass and to lower its viscosity. As the borate content is increased, the durability of the glass decreases. Glasses are attacked by organic acids such as humic and fulvic acids from the decay of vegetation which are often found in surface waters. Because the repository is expected to be deep underground, the water which may reach the repository is unlikely to contain large amounts of organic acids. Accordingly, the performance and durability studies of waste glasses for disposal to a national high-level nuclear waste repository have not analyzed the impact of organic acid corrosion on glass wastes, however this is particularly important if the glass waste remains at Hanford and may be subject to corrosion by surface waters.

If the durability of the glass cannot be assured and other barriers provide inadequate protection for the glassified wastes which may remain at Hanford, the radioactive isotopes with half-lives over one thousand years should be removed from the water soluble fraction of the wastes. These should be incorporated into better waste forms, or blended and glassified with the waste which will be sent to the national high-level nuclear waste repository. These isotopes include cesium-135, iodine-129, technetium-99, neptunium-237, and all long half-life actinides.

The durability requirements for glassified wastes to be sent to the proposed national high-level nuclear waste repository are not sufficient to assure protection of human health and the environment at Hanford. The physical conditions onsite are vastly different, and the geologic isolation provided by a deep repository is not available. The EIS must consider changing climate conditions. Hanford cannot be assumed to remain an arid area for as long as these wastes remain hazardous.

As the geologic barrier is not present at Hanford, and the glass wastes may exhibit more rapid corrosion from surface water, additional barriers to contain the waste should be included. The containers for the glass should be of sufficient chemical resistance and durability to protect the glass from the environment for as long as the wastes remain hazardous. The containers should be resistant to corrosive attack and embrittlement from exposure to the glassified wastes. Welding or other sealing of the containers should be done in such a manner as to avoid creating brittle areas in the container. Embrittled containers are likely to fail far more quickly.

Type 309 and 304L stainless steels have been proposed for use at Savannah River and West Valley, New York for containing glassified waste. High-carbon 309 stainless steel is easily embrittled by chloride ions. It should not be used. Low-carbon 304L stainless steel has insufficient molybdenum content to allow long term corrosion protection from the waste. If corrosion resistant stainless steel is used, it should contain at least three weight percent molybdenum to minimize corrosion from chloride and fluoride. It should also be very low carbon steel. Other high resistance alloys should be considered.

Response The alternatives presented in the Draft EIS provide a range of treatment, including disposal of HLW onsite as part of the in situ and combination alternatives. To be consistent with current national policy, all ex situ alternatives that include retrieval and treatment of the tank wastes are based on the assumption that the HLW would be disposed of in a geologic repository. The EIS does analyze permanent near-surface disposal of LAW under the ex situ and combination alternatives and disposal of HLW in place under various in situ and combination alternatives. To address public concerns with the availability of the geologic repository, all ex situ alternatives have been revised in Volume One, Section 3.4 to include interim onsite storage of the immobilized HLW for 50 years.

The ex situ alternatives that produce borosilicate HLW glass comply with the DOE OCRWM Waste Acceptance Systems Requirements document, which requires that the waste form meet performance criteria. The alternatives that do not produce a borosilicate HLW glass are identified as non-conforming to the geologic repository and are potentially not as acceptable and require resolution to make them acceptable which would make them subject to delayed acceptance.

Alloy specification for the HLW canisters would be accomplished during final design of the waste package. Embrittlement, corrosion, and material incompatibility are issues that will be evaluated during canister design and material selection. However, please note that the HLW canister presently has no long-term disposal function. This function is allocated primarily to the waste package disposal container.

DOE and Ecology acknowledge that technical issues requiring evaluation remain before the long-term impacts associated with permanent near-surface disposal of canistered HLW can be assessed. Please refer to the response to Comment numbers 0008.01 and 0008.02.

Comment Number 0019.04

WDFW

Comment The author states that "for the analysis performed in this EIS, a Hanford barrier was used to bound impacts." At this point in time, a cursory effort to bound impacts (resources) of a Hanford barrier should only require volume of soil needed and/or potential acreage impacted. A supplemental EIS can discuss borrow sites and alternatives.

Response DOE and Ecology acknowledge the concern expressed in the comment. However, the Hanford Barrier is the most extensive system for a surface barrier proposed for use on the Hanford Site. The assumption to apply this multi-layered barrier technology serves as the basis for comparison of the impact of changes within an alternatives, as well as between alternatives. The selection of borrow sites is an issue that would be addressed for tank farm closure which will be the subject of a future NEPA analysis. Please refer to the response to Comment number 0019.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0027.11

Roecker, John H.

Comment Waste Oxide Loading

The use of a 20 percent waste oxide loading is overly conservative and biases the alternatives analysis. A waste oxide loading of 25 percent has normally been used for design and analysis purposes. Studies are also underway for loadings in the 30-35 percent range.

Response The TWRS EIS uses bounding assumptions for HLW oxide loadings for all ex situ alternatives to provide a comparable and bounding analysis in the absence of definitive information. DOE and Ecology are aware that higher HLW oxide loadings have been used for process design and acknowledge, in Volume One, Section 3.4 of the EIS, that current development work may result in higher waste loading factors. Given the uncertainty associated with the characterization data and assumptions made for separations efficiencies, DOE and Ecology believe that a 20 weight percent waste oxide loading is a reasonable assumption for the purpose of calculating impacts. Waste loading is also discussed in the response to Comment numbers 0035.04 and 0027.11. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0040.02

Rogers, Gordon J.

Comment The 100-year limit for retaining administrative control is ridiculous, and is not applied to any other human activity.

Response Federal regulations (40 CFR 191) state that to provide the confidence needed for long-term compliance with the requirements for the disposal of HLW, active institutional controls over disposal sites should be maintained for as long as is practical. However, institutional controls are limited to 100 years when considering the isolation of the wastes from the accessible environment. As is stated in Volume One, Sections 3.4.2 and 3.4.3, the 100-year period is an assumption that has been applied to all alternatives analyzed in EIS to provide an equitable basis for comparison of impacts among alternatives. As required by the regulations, the administrative controls would be maintained by DOE and Ecology as agencies of the Federal and state governments. For related discussions, please refer to the response to Comment numbers 0101.01 and 0040.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0052.01

Pollet, Gerald

Comment Going to start tonight by asking that a little more attention be paid in the materials and the Final EIS through the advice of the Tank Waste Remediation System Task Force. The Task Force urged the three agencies from our putting together this EIS to explicitly not utilize a hypothetical repository in assessing costs and it is nice to go right after someone else whose commented on the same issue.

The TWRS Task Force said we have to assume canisters stay at Hanford. That is not only a reasonable alternative, unfortunately it is the realistic alternative, and it is not appropriately considered in the EIS. So what we need to see is - what are the long-terms costs and impacts from having canister storage here at Hanford.

Response The Tank Waste Task Force report recommended that DOE "accept the fact that interim storage, at least, of the waste in an environmental safe form will occur for some time at Hanford." The report also directed DOE to "assume temporary storage will occur at Hanford but did not assume that all radionuclides should be here forever" (HWTF 1993). The EIS, for all ex situ alternatives, assumes interim storage at the Hanford Site in an environmentally safe manner for up to 50 years and ultimate disposal of HLW offsite at the potential repository. If HLW storage extended beyond 50 years, appropriate NEPA review would be required. Please also refer to the response to Comment numbers 0035.04, 0081.02, 0038.10, 0008.02, and 0004.01 for related information.

Comment Number 0062.03

Longmeyer, Richard

Comment We've talked a little bit about the new tanks that are being filled with wastes from current tanks that are leaking. That also raises a safety concern in that, as was stated, this sludge that remains behind in the single-shell tanks that did leak, actually becomes more dangerous than when there was water in the tank. Dangerous in terms of the material itself, and danger of actual exposure to the outside from explosions, and so forth. So that is a concern.

Response A description of the saltwell pumping program, which is a required action under the Tri-Party Agreement, is provided in Volume One, Section 3.4 and Volume Two, Appendix B. An analysis of safety issues is performed prior to removing liquids to ensure that removal can be performed safely. The SSTs in question that have been pumped have been included in the accident and consequence analysis presented in Volume One, Section 5.12 and Volume Four, Appendix E. The unit liter doses from these tanks were compared with the unit liter doses from the rest of the SSTs and all of the DSTs. The bounding unit liter doses were used to calculate the consequences to bound the analysis.

Comment Number 0064.01

Roecker, John H.

Comment The second point I'd like to bring out is what I call data manipulation. There are examples throughout the EIS where data has been, what I call, manipulated to present a specific case, or to present certain agendas. I can give you some examples, in fact I will give you written comments on the ones that I have found. But as an example, where you talk about the high-end and the low-end of the number of canisters for the two different processes. The low-end you reference a Westinghouse document, and for the high-end you reference a DOE document. Being a little suspicious, and having a little experience with what was going on, I went back to look at those specific documents. The Westinghouse document is an engineering document, which has some pretty good estimates in it. The DOE document is a review of a systems requirements document of DOE that had a high number in it to make some very specific points. To use those numbers in the EIS, I think, is misleading. Because they do not accurately represent the engineering and technical data that is available.

Response The EIS presents an unbiased assessment of the potential impacts associated with each alternative. Please refer to the response to Comment number 0027.02 for a discussion of this same issue and Comment numbers 0081.02, 0008.01, 0069.04, 0035.04, and 0038.10 for a discussion of cost estimates.

Comment Number 0072.85

CTUIR

Comment P3-31: PP1: It should be assumed that there will be leaks and more leaks from the SSTs and DSTs during the administrative control.

Response DOE and Ecology realize that it is difficult to accurately predict the number or severity of tank leaks that will occur in the future. There are factors that will increase the number of leaking tanks, primary of which is the age of the tanks. As the tanks get older, the probability of a leak increases. There also are factors that will decrease the number of leaking tanks. The primary factor in decreasing leaks is the interim stabilization of the tanks by removal of the free liquid from the pore space and other voids in the tank solids; sealing the entrances to the tanks to prevent fresh liquid from accidentally entering the tanks; and placing covers over the tanks to inhibit the infiltration of precipitation. Once these measures are in place, leaks from the tanks would be very small. Because there was no inherently accurate method of determining future leaks, the assumption was made that at some predetermined time in the future (after the loss of administrative control), all the tanks of a given type would leak. This assumption allows an equitable comparison of the long-term environmental impacts of the various proposed alternatives. Please refer to the response to Comment numbers 0005.37, 0029.01, and 0072.70 for related information.

Comment Number 0072.86

CTUIR

Comment P 3-31: PP: Is the required depth to ground water, in the case of leaking tanks, at the minimum to the bottom of the leakage? Or is the required depth from the bottom of the tank? Please explain this with a description of the reasoning involved.

Response Releases for the tanks, whether from in situ or ex situ alternatives, are assumed to be from the bottom of the tank. This is a bounding assumption that results in the highest predicted contaminant concentration in groundwater.

Comment Number 0072.88

CTUIR

Comment P 3-31: PP 6: The efficiency goal should state no more than 1 percent of the solid-dry tank inventory would remain as a residual and no more than .1 percent liquid tank inventory remain as a residual following waste retrieval activities.

Response The Tri-Party Agreement (Ecology et al. 1994) includes a milestone that directly impacts the TWRS program. Milestone M-45-00 requires tank residues not exceeding 10.2 m^3 (360 ft^3) in each 100 series tank, and tank residues not exceeding 0.85 m^3 (30 ft^3) in each 200 series tank. This milestone provides the basis for the TWRS EIS assumption of 99 percent removal for ex situ alternatives. An overview of retrieval and transfer from the tanks is provided in Volume Two, Section B.3.5.3. Further evaluation of the residual inventory would be performed in a future NEPA analysis on closure of the tank farms. Please refer to the response to Comment number 0089.03, 0089.07, and 0005.18 for related residual waste information. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.89

CTUIR

Comment P 3-34: PP 7: Assuming that a LAW activity waste cullet provides the basis of conservatism is wrong. The technical staff of the SSRP suggests that all LAW waste be vitrified into glass and poured into canisters for the lowest risk levels.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The referenced language in Volume One, Section 3.4 is a discussion of waste composition for the various alternatives. A disadvantage of cullet is its high surface to volume ratio, which results in lower long-term performance. Therefore, the calculations of leach rates are higher (more bounding from an impact assessment standpoint) for cullet than for other glass forms. In the area of long-term environmental impacts, this lower long-term performance manifests itself as greater amounts of contaminants leaching from the cullet. Changing to another waste form that would have potentially better long-term performance may be achieved during the final design of the alternative selected. Because the information contained in the Draft EIS is correct, no change to the text was made. Please refer to the response to Comment number 0005.40.

Comment Number 0072.90

CTUIR

Comment P3-3: PP 8: The public has stated numerous times that grout for use as a way of stabilizing tank waste in any form is unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Grouting liquid waste streams is included in Volume Two, Appendix B as a reasonable immobilization technology in the EIS; however, it is not a technology included in the preferred alternative. For a discussion of NEPA requirements to analyze reasonable technologies, please refer to the response to Comment number 0072.05. Grout is discussed in the response to Comment numbers 0005.18, 0009.03, and 0072.179.

Comment Number 0072.178

CTUIR

Comment P B-37: Sect.B.3.0.6: Please explain how soda lime glass can be upgraded to the standards of the only standard HLW form, borosilicate glass in terms of leachability, thermal-breakdown, expansion, and ability to capture and isolate radionuclides.

Response Soda-lime glass would have different characteristics than borosilicate glass in terms of leachability, thermal expansion, and physical processing parameters. As stated in Volume Two, Section B.3, borosilicate glass currently is identified as the only standard HLW form to be accepted at the potential geologic repository. Other types of glass could be selected for the vitrification of HLW or LAW; however, they would have to meet the NRC waste form requirements and support the repositories ability to meet long-term performance requirements.

Under the Ex Situ No Separations alternative, all of the sodium present in the tank waste would be included in the vitrified waste stream. Because of this, the glass more closely approximates a soda-lime glass. The repository Waste Acceptance Systems Requirements Document currently includes only borosilicate glass as an acceptable glass composition; however, it identifies that other waste forms may be addressed in the future. The acceptability of alternative glass compositions would be based on waste form performance testing. Please refer to response to Comment numbers 0012.20, 0012.11, and 0035.04 for a related discussion.

Comment Number 0072.179

CTUIR

Comment P B-38: The use of grout is unacceptable and has been thoroughly denounced by the public. The grouting of LAW which will contain discrete particles of hi-activity radionuclides is unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.90, which addresses the consideration of grout as a waste form in the EIS.

Comment Number 0072.194

CTUIR

Comment P B-157: Sect. B.5.0: The information on how closure activities would affect remediating the tank waste should include carrying all of the listed closure options through the alternatives process in order to adequately present the information. Simply choosing a single representative approach to tank closure (closure as a landfill) is insufficient and in the light of the importance of this retrieval EIS. The closure options presented must indicate whether they do or do not preclude one or more of the alternatives. Additionally the closure options must necessarily conform to the law ALARA conditions for the purposes of reducing risks to future generations. This information is simply not here and raises doubt that the representative approach is truly representative.

Response Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives cannot be assessed at this time and 0072.50 for information on alternatives that would preclude closure options. Closure of the tank farms will be addressed in a future NEPA analysis when sufficient information is available on past practice releases, releases during retrieval, and tank

residuals. Please refer to the response to Comment number 0101.06 for a discussion of issues related to analysis that would be required to support closure alternatives analysis. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.195

CTUIR

Comment P B-158: Sect. B.6.0: The inclusion of the Hanford Barrier and the exclusion of all other closure activities may preclude adequate justification of the alternative section due to the fact that providing one option is not providing a choice of options. Please insert the other closure activities options or remove section B.5.0 tank closure because it is not within the scope of this EIS.

Response Closure is not included in the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. However, Volume One, Section 3.3 and Volume Two, Section B.5 address how tank waste remediation and closure are interrelated because some of the decisions made regarding how to treat and dispose of tank waste may impact future decisions on closure. To provide information on how closure activities would be affected by remediating the tank waste, a representative approach to tank closure (closure as a landfill) has been included in each of the TWRS alternatives to allow an equitable comparison of the alternatives. The Hanford Barrier described in Volume Two, Section B.6 is included as a representative approach to tank closure. Please refer to the response to Comment numbers 0101.06, 0019.03, 0019.04, 0052.01, 0072.50, and 0101.05 for related discussions. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0081.04

Pollet, Gerald

Comment The Tank Waste Task Force, convened by the Department of Energy, U.S. EPA, and Washington Department of Ecology, urged that the Department of Energy abandon making decision making on the basis of high-level nuclear waste canisters, and their theoretical costs for being placed into a repository. Our advice was, now I need to turn to the appropriate page, on page 11 of the Task Force Report under Values, under Waste Form and Storage. Let the ultimate best form for the waste drive decisions, not the size or timing of the national repository. This EIS has failed to consider that advice.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0081.02, 0008.02, 0035.04, 0038.10, and 0052.01 for a discussion regarding task force advice.

Comment Number 0089.03

Nez Perce Tribe ERWM

Comment Listed below are our general statements regarding the EIS.

Some necessary topics are not properly considered in the EIS. An example is the proposal to leave 1 percent of the waste in the tanks. We believe that with the technology currently proposed, if 99 percent of the waste can be removed, then it is also possible to remove much of the remaining 1 percent of the tanks wastes. This question will definitely be pursued by ERWM during soil and groundwater remediation, which are not part of the EIS. For proper soil remediation, beneath the tanks following closure or tank removal, it is imperative that no waste be left in the tanks.

Response The amount of residual waste that ultimately remains after retrieval will depend on the effectiveness of the retrieval technology. For the purposes of NEPA analysis, the assumption that 1 percent of the waste would remain in the tanks was assumed in the EIS analysis. For a discussion of this issue, please see the response to Comment numbers 0005.18 and 0089.07. Further experience with waste retrieval will be required before the issue of the extent of retrieval can be fully resolved. Please refer to the response to Comment numbers 0101.06, 0072.08, and 0072.88 for related information concerning tank waste residuals, soil and groundwater contamination, and closure.

L.3.4.2.4 Miscellaneous Issues

Comment Number 0005.41

Swanson, John L.

Comment The word "grouting" at the start of the last paragraph on page 3-34 appears to be out of place, and appears to belong instead at the start of the first paragraph on the next page.

Response "Grouting" does belong with the paragraph at top of page 3-35 of the Draft EIS. The two sentences following the word "grouting" are out of place. The text of the Final EIS has been corrected.

Comment Number 0005.43

Swanson, John L.

Comment On page 3-36 is discussed the use of sodium from the FFTF to make sodium hydroxide for use during enhanced sludge washing. Is this really worthy of mention? Was the cost of conversion of sodium to sodium hydroxide (which has some safety problems) included in the cost estimates?

Response Fast-Flux Test Facility (FFTF) sodium disposal is worthy of mention because of the potential amount of material that may require disposal considerations in the near future. A cost analysis of the conversion facility and the process safety issues were not performed and would need to be addressed before a decision was made to use FFTF sodium as a source of material for separations chemicals. The use of sodium from FFTF was included in the EIS as an example of Sitewide waste minimization activities that could be considered.

Comment Number 0008.04

Evett, Donald E.

Comment On the subject of groundwater, I believe the method of retrieval using the articulated arm to reach into the tanks and recover waste would be an excellent method and it would reduce the amount of leakage, which is of paramount importance.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. As indicated in Volume One, Section 3.4, the articulated arm retrieval method would be used in situations where conventional technology is not effective or inefficient for the particular tank waste type or form. Using the articulated arm technique and others is also key to removing as much of the tank waste as possible to minimize or eliminate any materials that could be released to the environment. DOE and Ecology will analyze the data collected during the demonstration phase to select the most effective removal method for the tank and tank waste type.

Comment Number 0068.03

Martin, Todd

Comment The last point I want to make is that a clear lesson that we've learned from Hanford and from the nuclear weapons complex is that postponements and delays lead to greatly increased obligations in the future. We've learned that in spades, at least I hope we've learned that. And I'm not sure that the Federal government has learned that. The American people are certain of that. That means we need to get on with it now, otherwise it's going to cost that much more in the future.

Response DOE and Ecology share the desire to proceed with remediation at the earliest possible date. Delays can be costly. DOE intends to allow sufficient time to design adequate actions that are supported by factual information, that incur a reasonably acceptable level of technical risk (i.e., high probability that the action will work and accomplish the desired result), and that are implemented in a managed and cost-effective way. Please refer to the response to Comment numbers 0009.19, 0060.02, 0098.02 and 0078.07.

Comment Number 0072.82

CTUIR

Comment P 3-27: Sect. 3.4.1.1: First bullet: What exactly is "managing operations" and are these the operations included in the 1997 RDS for fail-safe management?

Response Managing operations, as listed in the first bullet in Volume One, Section 3.4, includes the activities listed in the bullets that follow as well as tank farms and associated facilities management (as a program), and the relationship of the TWRS program to the Hanford Site Operations system. Consequently, the management issues relevant to each activity (e.g., personnel, safety, quality, and milestone status) are relevant on a programmatic level across Tank Farm Operations. Tank farms management is one operation described in the 1997 Risk Data Sheet (RDS) for fail-safe management. The 1997 RDS was prepared for the Hanford Site as a single operation.

Comment Number 0072.83

CTUIR

Comment P 3-28: PP 4: how much exactly will these controls increase the cost of maintenance and monitoring activities.

Response The operating cost and schedule impacts associated with placing all 177 tanks under flammable gas controls (if this were to occur) is not fully known at this time. One of the factors that will influence the cost and schedule impacts would be resolution of the flammable gas safety issue for the tanks.

Comment Number 0072.87

CTUIR

Comment P 3-31: PP 4: How can you fill a tank full of liquid with rocks and not have liquid overflow?

Response As discussed in the description of the alternatives in Volume One, Section 3.4 and Volume Two, Appendix B, for the In Situ Fill and Cap alternative, as much water as possible would be removed from the liquid waste streams through evaporation at the 242-A Evaporator. The amount of water that can be removed from a liquid waste stream at the evaporator is limited by the saturation concentration of the evaporated waste stream. Following transfer of the evaporated liquids back to the tank, salt-cake formation would begin in the DSTs similar to what has already happened with the DSTs. This would allow for additional evaporation of the liquids. If the In Situ Fill and Cap alternative were selected for implementation, further analysis may indicate a need for additional evaporation using in-tank technologies for selected tanks.

Comment Number 0072.91

CTUIR

Comment P 3-36: PP 1: Exactly what is "some low temperature process"? How much will this process cost? Is this process figured in the privatization process, and what are the risks associated with this? How much extra waste is going to be generated with this process? What will this waste be classified as?

Response Calculations performed for the Ex Situ Intermediate Separations alternative off-gas recycle bleed stream resulted in an estimate of 3,500 m^3 (930,000 gallons) of liquid waste. This waste stream would be dilute and the volume could be reduced by evaporation. The stabilization of this waste stream would require a low-temperature stabilization and treatment technology such as encapsulation, hydraulic cements, or organic polymers to immobilize the waste and limit further volatilization. The development and selection of this process would occur during the detailed design phase. An individual cost estimate for this process was not included in the alternative cost estimates developed for the EIS. The cost would be minor compared to the total alternative cost and would be well within the estimated cost range.

Each of the alternatives that involve high temperature waste treatment technologies, such as vitrification, would have to deal with the volatile chemical and radionuclide emissions in the off-gas system. The risks during remediation are included in the analysis performed for each of the alternatives in Volume One, Section 5.11 for health impacts during remediation. The post-remediation risks that would result from disposal of the stabilized off-gas recycle bleed stream is assessed in the Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds.

An estimate for the total volume of immobilized waste that would be generated has not been made for the alternatives. A volume estimate would be made during the detail design phase when the characteristics of the bleed stream were developed and the immobilization technologies were evaluated.

Following stabilization, this waste stream would be classified as LAW. The classification and handling of this waste stream would be consistent with established Hanford Site solid waste disposal practices.

Comment Number 0072.180

CTUIR

Comment P B-39: S 2: Please explain how the amount of tertiary waste generated would be primarily a function of the number of operating personnel.

Response The primary component of tertiary waste is personal protective equipment. Therefore, because the number of operating personnel required to wear personal protective equipment when the potential exists for contact with hazardous or radioactive substances is higher for the alternatives that include the more complex remediation activities, the amount of tertiary waste generated also would be higher.

Comment Number 0089.05

Nez Perce Tribe ERWM

Comment Offsite disposal of LAW should be considered in the EIS.

Response DOE and Ecology acknowledge the recommendation expressed in the comment. Offsite disposal of all waste at the potential geologic repository is addressed in the EIS under the Ex Situ No Separations alternative. Offsite disposal of the LAW was not considered to be a reasonable alternative because of the cost and human health impacts of transporting the waste and because there would be no compensating benefits to offsite disposal. Please refer to the response to Comment number 0005.03 for a discussion of the assumptions used in the alternative analyses.

Comment Number 0089.11

Nez Perce Tribe ERWM

Comment Page B-72, Paragraph 1

We have some questions about the plan for the cross-site transfer line. Apparently this line will be sloped to at least 0.25 percent grade to preclude accumulation of solids. ERWM questions the thought behind those plans, the elevations at 200 West and 200 East are nearly the same but 5 miles apart. How will the line be constructed and this slope engineered?

Response Specifications for the cross-site transfer line are not included in the scope of this EIS; however, the SIS Final EIS addresses the cross-site transfer line in detail (DOE 1995i). The SIS EIS was referenced during preparation of the TWRS EIS. According to the SIS EIS, the line would slope up from the 200 West Area to a midpoint, and then down to the 200 East Area to ensure that the line will drain.

L.3.4.3 No Action Alternative (Tank Waste)

Comment Number 0072.94

CTUIR

Comment P 3-40: Sect 3.4.2: No Action Alternative: Technical staff of the CTUIR do not agree that this alternative is a responsible action, given that the contents have half lives that number in the thousands.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, compliance to existing regulations, potential risk, or any other factor used in the analysis of alternatives. Furthermore, the CEQ requires that the TWRS Draft EIS identify and analyze a range of reasonable alternatives for the proposed action, as well as for the No Action alternative. All data that support the cost and impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and the public during the comment period. Please refer to the response to Comment numbers 0072.80 and 0072.10 for more information concerning the No Action alternative and NEPA requirements for reasonable alternative analysis.

Comment Number 0072.181

CTUIR

Comment P B-41: Sect. B.3.1: A one hundred year administrative control period does little to protect human health and environmental impacts from long lived (>10,000 year 1/2 life radionuclides).

Response Although DOE has no plans to abandon the Site after 100 years, it is not reasonable to assume that administrative controls will extend to 10,000 years. In order to show potential impacts that could occur if administrative controls were lost, a 100-year administrative control period was assumed. This assumption is consistent with standard impact assessment methods for hazardous and radioactive waste sites. Please refer to the response to Comment numbers 0072.80, 0040.02, and 0101.01 for discussions related to DOE assumptions associated with the 100-year administrative control period and the analysis of long-term impacts resulting from the loss of institutional controls.

Comment Number 0072.182

CTUIR

Comment P B-43: Sect. B.3.1.4: Please insert the statement 'some tanks may not last fifty years'.

Response Volume Two, Appendix B addresses actions that would be taken in the event that a tank leaks within the estimated design life of 50 years, as well as the integrity testing to be conducted within any applicable 50-year design life. "Continued management would include maintaining spare DST space to accommodate leak recovery in the event of a DST leak. Tank conditions would be continually monitored, and those tanks determined to be leaking would require recovery of the leakage from the tank annulus." Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.4 Long-Term Management Alternative

Comment Number 0038.01

Reeves, Merilyn

Comment I would like to point out that one of the things that the Hanford Advisory Board did was to commission a special report, a report to look at whether or not we should build six new massive tanks, double-shelled to hold waste because we were not looking at any other end point.

A report was prepared by Dr. Glen Paulsen, Dr Frank Parker, and Dr. Michael Cavanaugh, noted experts in the field.

And from this report it became clear that they recommended that no new monies be spent for the construction of new tanks to store the tank waste at Hanford.

The Board adopted this. This is a savings of approximately 300 to 400 million depending on which report you look at.

I think that this also puts in place the Long-Term Management alternative in the EIS that would have required replacement of all the double-shelled tanks in the year 2035, and again in the year 2085.

And so I believe that our consensus advice, which was listed as consensus advice number 22 in which we endorsed the recommendations of this report should put to rest whether or not we should embark on any scheme to just continue to build double-shell tank for storage of these wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. The range of alternatives must include a No Action alternative and then may include other reasonable alternatives to allow an analysis of a full range of alternatives. Within the range of considered alternatives is the Long-Term Management alternative, which contains the provision for building two sets of DSTs at 50 and 100 years in the future. Including this alternative in the EIS serves a useful purpose, because while it does not contain provisions for immobilizing the tank waste, it does contain provisions for maintaining the SSTs in a relatively dry condition and for retanking the wetter DST wastes on a periodic basis. Please refer to the response to Comment number 0072.05 for a discussion of how the alternatives were developed to comply with NEPA requirements to analyze a range of reasonable alternatives.

Comment Number 0072.95

CTUIR

Comment P 3-43: PP: The argument for long term management seems poor given that a large amount of SST waste has already leaked to the ground, and that the transfer of tank waste simply for maintenance reasons has inherent risks that are unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, compliance to existing regulations, potential risk, or any other factor used in the alternatives evaluation process, which would include the Long-Term Management alternative evaluated in the EIS. Please refer to the response to Comment numbers 0072.05 and 0038.01 for related discussions. All data that support the cost and impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and by the public during the comment period. DOE and Ecology are aware that the vadose zone has been contaminated beneath the tanks. Existing contamination is presented in Volume One, Section 4.2, and cumulative impacts of existing contamination, TWRS alternatives and other Hanford Site actions are presented in Volume One, Section 5.13. The potential risks associated with moving waste from one tank to another one are analyzed in the EIS in Volume One, Section 5.11 and Volume Three, Appendix D for routine operations during remediation and Volume One, Section 5.12 and Volume Four, Appendix E for accident risks.

Comment Number 0072.96

CTUIR

Comment P 3-45: Sect. 3.4.3.5: Post Remediation: this section needs to have an account of the remediation of the extra ground used.

Response This comment refers to the post remediation section for the Long-Term Management alternative. The extra ground would be the surface area overlaying the 26 new DSTs that would be constructed as part of this alternative. As explained in Volume One, Section 3.4.3.1, this alternative is similar to the No Action alternative in that administrative controls over the Hanford Site are assumed to be maintained for 100 years. No remediation activities would be performed. The consequence is stated in Section 3.4.3.5 that there would be no post-remediation activities associated with the Long-Term Management alternative. Because there is no remediation of the extra ground, no account of this activity has been provided in the EIS.

Comment Number 0072.183

CTUIR

Comment P B-44: Is there a sludge well pumping operation ongoing?

Response DOE and Ecology believe that the comment is referring to saltwell pumping. Saltwell pumping of the SSTs to remove interstitial liquids is an ongoing operation that is scheduled to be completed in the year 2000. Saltwell pumping is an activity that would be a part of continued operations under all alternatives as indicated throughout Volume One, Section 3.4.

L.3.4.5 In Situ Fill and Cap Alternative

Comment Number 0072.184

CTUIR

Comment P B-48: Sect. B.3.3: This alternative is unacceptable as are all in situ alternatives. Language clearly defining that in situ alternatives are against the law must be inserted here.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Summary, Section S.7, discusses regulatory compliance for each alternative and indicates which alternatives would fail to comply with applicable laws and regulations. Regulatory compliance also is addressed in Volume One, Sections 3.4 and 6.2 and Volume Two, Appendix B. In each of the sections cited, it is clearly stated that this alternative would not comply with certain laws and regulations. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.6 In Situ Vitrification Alternative

Comment Number 0014.01

Bullington, Darryl C.

Comment It is impossible to take seriously any document that includes a proposal to spend 16 to 23.8 billion dollars and use one-quarter of the available electricity of the Washington Public Power Supply System to vitrify 73 million curies of hazardous radioactive solids and surrounding soils contaminated with thousands of gallons of cesium-137 containing liquid (a volume of over 20,180 cubic yards per tank) to a depth of sixty feet by inserting electrodes and heating to 2,600 to 2,900 F. Before I would even waste the paper to evaluate such a scheme I would have to see some demonstration using noncontaminated materials at a place and in a way that would not be a hazard to the public and people involved. To design any system that could contain all of the gases that would be suddenly released from such an event or a heat shield needed to protect the operating deck above the tanks, and enclosed, should melting such a mass even be possible, is beyond all imagination. To perform such a full-scale demonstration for $70 million is also highly suspect.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. ISV is a commercially available technology that has been successfully demonstrated on a smaller scale and is a reasonable alternative for analysis in the TWRS EIS. The EIS does discuss the technical uncertainties associated with implementing this alternative in the Summary, Section S.7, Volume One, Section 3.4, and Volume Two, Appendix B. Please refer to the response to Comment numbers 0072.80 and 0072.05 for discussion of NEPA requirements for reasonable alternatives analysis.

Comment Number 0023.01

Geosafe

Comment The ISV alternative should provide an objective evaluation for selecting the size of the tank farm containment facility. The confinement facility as shown in Figure 3.4.5, which encloses an entire tank farm, may have some distinct advantages but it poses significant design and construction difficulties. A smaller containment facility could be more easily constructed that encloses only one tank at a time. The smaller facility could be moved into position using a crawler system similar in design to that proposed for the decommissioning of the 100 Area Reactors (WHC MLW-SVV-037106). Two sets of crawlers could be used to move multiple containment facilities. Although not stated in the EIS, it is presumed the need to enclose an entire tank farm was based on the premise that a structural load could not be supported by the dome structure of the tanks and would result in their collapse. For the ISV alternative, the void spaces in the tanks will be filled with sand or other material and can be made suitable for load bearing. The smaller confinement facility would be significantly easier to construct, maintain and decontaminate after project completion. In addition, the smaller facility should significantly reduce the degree of technical difficulty in implementing the ISV alternative and potentially lower its cost as well.

Response Alternative configurations for the tank farm confinement facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the TWRS EIS. This proposed size reduction ultimately could result in a confinement facility that would be mobile, and could be moved from tank to tank within a tank farm. A large facility would not impose a bearing load on the individual tanks because its perimeter would lie outside of the tank farm. Because a smaller confinement facility potentially would impose a bearing load on adjacent tanks, a design solution to this problem would have to be formulated before the smaller confinement facility could be considered practicable. Filling the adjacent tanks with sand would be among those considered.

One potential problem area not discussed in the comment is the off-gas collection and treatment equipment and facilities. With a large confinement facility, the off-gas would be ducted to stationary treatment facilities. With the smaller, mobile confinement facility, the solution might be to move the off-gas treatment facility when the confinement facility is moved, or alternately, to re-route the off-gas ducting when the confinement facility is moved. This is one of a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion in the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers.

The Draft EIS addressed the full range of reasonable alternatives. The alternative is bounded by the alternatives addressed in the Draft EIS, and DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. For a discussion of the approach used in the EIS to develop and analyze alternatives, please see Volume One, Section 3.3 and refer to the response to Comment number 0072.05.

Comment Number 0023.02

Geosafe

Comment An objective evaluation should be provided for selecting the size of the ISV equipment. The evaluation should discuss the advantages and disadvantages of using a large ISV system versus using a smaller system more closely resembling commercially available equipment.

The concept of treating a tank with extremely large melts significantly increases the difficulty and the technical Implementability of the ISV alternative. The ISV system proposed in the EIS is 40 times larger (4 Mw vs. 160 Mw) than existing equipment and is capable of treating a tank in one setting. Geosafe believes treating tanks in large settings may pose significant operational problems. We believe a more workable approach is to treat tanks with smaller multiple ISV settings so as to have better control on the release of vapors from in and around the tank.

Another factor to consider with a large-scale ISV systems is power level fluctuations caused by startup or shut down. It is envisioned that power line fluctuations caused by a 160 Mw system may be unacceptable for the regional power grid unless special arrangements are provided.

In summary, smaller ISV units that treat tanks in multiple settings would greatly increase the technical Implementability of the ISV alternative and potentially reduce costs. Schedule requirements could be maintained by using multiple ISV systems operating simultaneously at various tank farms. In addition, the research and development time required for the smaller ISV unit would be significantly shorter than the 160 MW unit.

Response Alternative configurations for the power supply facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the EIS. A large facility potentially could impose load fluctuations on the regional power grid, although with proper planning these fluctuations could be effectively managed. Because a smaller power supply facility potentially would melt only a portion of a tank and its contents, a solution to this problem would need to be formulated before the smaller power supply facility could be considered practicable. Using multiple power supply units would be one solution among those considered. That multiple smaller power supply units potentially would reduce costs may be premature. For the majority of process equipment, purchasing a single large unit rather than multiple smaller units is generally more economical. To state that the research and development time required for the smaller power supply facility would be significantly shorter than for the larger unit also may be premature. Using multiple ISV settings would allow better control on the release of vapors from in and around the tank also would be considered premature until further studies have been completed. These are a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment numbers 0023.01 and 0072.05.

Comment Number 0023.03

Geosafe

Comment Two techniques should be evaluated for reducing the processing depth of ISV which is specified in this document as 60 ft. Implementation of one or both of these techniques will decrease the technical difficulty of implementing the ISV alternative.

The first option would involve the removal of overburden to expose the dome structure of the tank. The overburden could be subsequently added to the tanks to eliminate internal void spaces. This would decrease the required processing depth of ISV to approximately 45 ft for the largest volume tanks.

The second option would involve the intentional lowering of the tank dome structure into the tank to reduce the effective processing depth from 45 ft to 33 ft for the largest tanks. This would be accomplished by first covering the contents of the tanks with an adequate depth of soil to provide radiation shielding. Next the center portion of the tank would be cut into pieces and lowered into the tank on to the soil. Following the removal of the dome structure, additional soil would be placed in the tank to provide a level surface to begin ISV operations. It is recognized that cutting into a tank will present some added risk that will need to be evaluated.

Response Further research and investigation associated with ISV is possible. This particular comment deals with potential solutions to the problem of having ISV operate at depths of approximately 60 feet. The suggestions for using the tank overburden to reduce tank voids; and subsequently lowering the tank dome into the tank before vitrification are examples of areas where further investigation may prove to be of value; however, substantial safety considerations would need to be overcome. Added risk from exposing and cutting into the tanks has not been evaluated. These are several areas where further detailed study could potentially result in an improved process. To address this issue, the cost estimate includes additional costs for technology development for this alternative. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers. Please refer to the response to Comment number 0023.01.

Comment Number 0023.04

Geosafe

Comment Following treatment of the tanks with ISV, there is no need for the tanks to be capped with the Hanford barrier. A simpler and less expensive cover to minimize the downward percolation of water could be used. The Hanford barrier is designed to provide plant, animal and human intrusion into a waste zone using a thick zone of crushed rock and to prevent the downward percolation of water. Since the ISV monolith is already a rock "cap" of considerable structural strength the need for a biointrusion zone is unnecessary.

Response ISV will leave the tank contents in a form unique to that alternative. However, the remaining waste form is still radioactive and some means must be employed to prevent access by humans, animals, and plants. The Hanford Barrier was used for this purpose as a potential form of closure, which is applicable to all the alternatives. Closure or dispositioning of the tanks is further discussed in Volume One, Section 3.3 and in Volume Two, Section B.5.0 of the EIS. Tank waste remediation and tank farm closure issues cannot be separated; therefore, an assumption common to all alternatives was included in the alternatives evaluation, but not evaluated as a single, specific action. Because the information contained in the Draft EIS is correct, no change to the text was made. Please also refer to the response to Comment number 0019.04 for a discussion of the Hanford Barrier.

Comment Number 0023.05

Geosafe

Comment The ISV cost estimate should discuss the following costing assumptions: (a) are individual tank depths being taken into consideration for estimating treatment volumes, e.g. the 500,000 gal tanks are 18 ft deep and the million gal tanks are 32.5 ft deep, (b) is the area between tanks being vitrified and (c) is soil beneath the tanks being treated.

Response DOE and Ecology have presented life-cycle cost estimates for each alternative. These estimates are based on conceptual designs for the alternatives. Because of the conceptual nature of the alternatives, there is a level of uncertainty associated with the life-cycle cost estimates. To account for the variations cited in the comment, such as variations in tank sizes and variability of the volume of treated material, an uncertainty analysis has been completed for the tank waste alternatives. The resultant cost range for each alternative is shown in Volume Two, Section B.8.0 of the EIS. Other information on the cost estimates is contained in Volume One, Section 3.4.1.7 and Volume Two, Section B.3.0.8 of the EIS. Only the contaminated soil between the tanks and immediately around and below the tanks is assumed to be vitrified. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.06

Geosafe

Comment Page 3-52, 4th par. "Each vitrification system ... consuming 160 Mw of power." Power consumption rates should be discussed for all alternatives and not be specifically limited to the ISV alternative. ISV is an extremely efficient vitrification technology. On average ISV consumes 800 Kw-hrs of electricity to vitrify a ton of material which is considerably lower than other vitrification technologies. The power consumption rates as listed in Table B.11.0.3 for the ISV alternative is 7,690 Gwh, which is less than the "ex situ no separation" alternative (8,800 Gwh) and the "ex situ extensive separation" alternative (41,600 Gwh).

Response The preliminary calculations used in the EIS show that ISV has a power consumption lower than other alternatives. To provide a side-by-side comparison of the resource consumption of the alternatives, DOE and Ecology have presented the material in summary form in Volume Two, Table B.11.0.3. To provide a complete narrative description in Volume One, Section 3.0, the EIS presents the information for each alternative under six headings: Process Description; Construction; Operation; Post Remediation; Schedule, Sequence and Costs; and Implementability. The Process Description for each alternative describes the major pieces of equipment for each process, giving a description of some of the major equipment used in the process. The section to which the comment refers is the Process Description for ISV, and the power supply was described as one of the major equipment items of this process. For other alternatives, the major equipment items will be different because the process is different. Because this section is a process description, it should not be interpreted as attempting to portray ISV as having obvious advantages or disadvantages. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.07

Geosafe

Comment Implementability: 1st bullet, The degree of uncertainty of the ISV alternative will be significantly reduced by using smaller ISV units as discussed above.

Response The concept of treating tank waste with large-volume melts may have more technical issues associated with the implementability of the ISV alternative. The configuration proposed in Comment number 0023.01 is smaller in size than the facility depicted in the EIS. This is one of a number of areas where further detailed study potentially could result in an improved process with fewer issues regarding technical implementability. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding.

Comment Number 0023.08

Geosafe

Comment Implementability: 2nd bullet, We agree that substantial research and development activities would be required to implement the 160 MW ISV system and for this reason have recommended using smaller ISV units closer to the scale of our commercial 4 MW system. Geosafe has already proposed a concept to DOE for treating the single shell and double shell storage tanks using our 4 MW ISV system (see attached white paper dated December 1995). The 60 ft depth limitation for processing the large volume tanks can be reduced by implementing the techniques discussed in comment A 3. [Comment number 0023.03]

Response Alternative configurations for the power supply facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the EIS. It should not be inferred that the use of a smaller power supply is a feature of any particular vendor or that the use of a smaller power supply constitutes an endorsement by DOE or Ecology. Because a smaller power supply facility would potentially melt only a portion of a tank and its contents, a solution to this problem would have to be formulated before the smaller power supply facility could be considered to be practicable, and substantial research, development, and demonstration activities still would be required. There are a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts presented to the decision makers as bounding. The EIS analysis bounds the information suggested by the commentor. For a discussion of the technique of reducing the depths of the tanks, please refer to Comment number 0023.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.09

Geosafe

Comment Implementability: 3rd, bullet, The possibility of an uncontrolled reaction occurring in a tank is mainly limited to 38 tanks containing organics or ferrocyanide material. The DOE Radioactive Tank Waste Remediation Focus Area is currently evaluating the explosive issue concern. Potentially, ISV treatability testing will be required to fully address this concern.

Response Further treatability testing will be required to fully address the concern of uncontrolled reactions in the tanks if the contents were vitrified. There may be answers to the situation that are inherent with ISV, which is that extensive mixing of contents of different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been limited, and it may be premature to state that the problem is mainly limited to 38 tanks containing organics or ferrocyanide material. Until further investigations have been completed, DOE and Ecology believe that the statement in the EIS that further analysis is required remains correct. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.10

Geosafe

Comment Implementability: 4th bullet, We agree that the tank farm containment facility is highly conceptual and recommend that it be scaled down in size from the proposed 500 ft wide by 600 ft long facility to an approximately 120 ft square facility which covers only one tank. The technical difficulties of constructing the smaller facility are minimal.

Response The large tank farm confinement facility is highly conceptual in nature. The area discussed at this point is that further development would be required before any confinement facility, regardless of size, would be expected to comply with current DOE facility design requirements. A confinement facility that is 120 feet on a side is still sufficiently large that additional design study would be required. The technical difficulties that may be expected in designing and constructing the smaller confinement facility would be less than those expected in designing and constructing a much larger confinement facility. It may be optimistic to state that these technical difficulties would be minimal. This is one of a number of areas where further study potentially could result in a process with fewer issues regarding technical implementability. In these areas, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers. The EIS bounds the information suggested in the comment. Please refer to the response to Comment number 0023.01 regarding the use of smaller ISV units.

Comment Number 0023.11

Geosafe

Comment Implementability: 5th bullet, The use of a smaller tank containment facility will eliminate most of the construction difficulties. Using a smaller mobile containment facility will allow construction activities to take place in a clean area, thereby eliminating the risks and added expense of working in or around a tank farm exclusion zone.

Response The large tank farm confinement facility may be more difficult to construct. The area being discussed in the EIS at this point is the atypical nature of the design of the large confinement facility and restrictions associated with working in and around the tank farms. While a smaller confinement facility could be constructed adjacent to the tank farms and then moved into position to assume that this will eliminate the risks and added expense of working around the tank farms would be considered premature. This is one of several areas where additional design study potentially could result in process improvements and potentially could result in a process with fewer issues regarding technical implementability. In these areas, the configuration used in the EIS represented a bounding condition, resulting in environmental impacts that also were bounding. Please refer to the response to Comment number 0023.01 regarding the use of smaller ISV units.

Comment Number 0023.12

Geosafe

Comment Implementability: 6th bullet, Inspection of the final waste form can be done by core drilling through the vitrified monolith after a period of cooling. Core drilling is routinely performed on commercial ISV projects to verify waste treatment for project closure. In the past, core drilling has been used to sample untreated tank wastes and should be easily adaptable to sampling a vitrified waste form which is easier to handle. Secondary wastes generated from the drilling can be recycled to future melts. If a core sample fails to meet waste acceptance testing, the area from which it was taken can be retreated by ISV.

Response Methods exist for the sampling of the in situ vitrified product. Many cores would likely be necessary for each tank and the cuttings from the core would require special handling and disposal. While the secondary wastes generated can be returned to the untreated tanks, other problems may be encountered during the development and operating phases of the core drilling system. The core drilling of vitrified HLW is an area that would require additional research and development to investigate further and determine its workability. If core drilling becomes an accepted technique for determining the acceptability of the waste form, the design of the confinement facility would include provision for equipment to accomplish the core drilling. Inspection and potential pretreatment of the final waste form are implementability problems that remain to be solved.

Comment Number 0023.13

Geosafe

Comment Implementability: 7th bullet, Use of the proposed smaller tank confinement facilities will be significantly reduce decontamination and decommissioning problems.

Response The large tank farm confinement facility may be difficult to decontaminate and decommission and these difficulties should be fewer for a smaller facility. Further study could result in an improved process. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.14

Geosafe

Comment B-53, 3rd par., last sent., A reference should be provided for the current research which is addressing depth-enhancement techniques.

Response A reference has been added to the last sentence of the referenced paragraph in Volume Two, Appendix B.

Comment Number 0023.15

Geosafe

Comment B-53, 4th par., Elimination of interstitial spaces between soil particles is not the only mechanism for volume reduction. During ISV treatment a significant volume of tank wastes will be vaporized due to the decomposition of nitrates, nitrites, carbonates and sulfates. This will result in a volume reduction that is expected to exceed 50 percent by volume. In addition, the ISV process will not produce significant quantities of No_x that require special off-gas treatment. The high operating temperature of the ISV melt and its reducing environment will decompose nitrate and nitrite into N_2 and O_2 gas.

Response Elimination of interstitial spaces between soil particles is not the only mechanism for volume reduction. A reduction in volume due to decomposition of the tank wastes will occur. However, at this time, no ISV facilities have been designed for use at the Hanford Site. Until design and testing have been completed, to consider that the ISV process will not produce significant quantities of nitrogen oxides requiring special off-gas treatment is premature. ISV most closely resembles a batch process, where the nature of the reacting materials and the reaction products change as a function of time. Temperature also changes with time during ISV, starting with the cool tank wastes and glass formers and ending with molten glass at a very high temperature. Therefore, while extremely high temperatures will enhance the dissociation of nitrate and nitrate, nitrogen oxides will be produced until those temperatures are reached, and the off-gas treatment system must be able to treat all of the vapors evolved. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.16

Geosafe

Comment B-56, Figure B3.4.3., The NO_2 burner is configured as a lime spray dryer.

Response The essential function of the nitrogen oxide burner is correctly depicted on the flow diagram in Volume Two, Appendix B. The streams entering and leaving the unit are shown correctly. Because the essential function of the unit has been depicted, no changes to the EIS have been made.

Comment Number 0023.17

Geosafe

Comment B-57, 1st par., Treating the area between the tanks unfairly increases the cost of the ISV alternative and should not be included unless other alternatives address this concern. Potentially, an ISV option could be included which addresses the treatment of contamination below and around the tanks.

Response The inclusion of extra material in the zone of vitrified material is unique to the ISV alternative. Treating the area between the tanks would occur as a consequence of the nature of the ISV process, and doing so would not unfairly increase the cost of the ISV alternative. Because of the in situ nature of the process, ISV must have a vitrified zone that extends beyond the tank dimensions to ensure that the tank and its contents have been vitrified. This zone would not exist for the ex situ alternatives, for which retrieval activities will be performed that would be bounded by the tank walls. Because of the technical uncertainty in determining the dimensions of the zone of vitrified material during the melting operation, the preparers of the engineering data package (WHC 1995f) made the assumption to extend the dimensions of the vitrified zone beyond the tank dimensions to include the extent of the tank farms. Using this assumption ensured that the preconceptual costs, energy consumptions, and glass former usages were reasonable. For use in the EIS, these conservative assumptions and resulting calculations form a bounding condition. The use of this bounding condition will result in environmental impacts that are likewise bounding. NEPA requires that bounding conditions be equally compared for the environmental impacts that potentially may result from all alternatives evaluated. Please refer to the response to Comment numbers 0023.01 and 0001.01 for other discussions of subsurface barriers.

Comment Number 0023.18

Geosafe

Comment B-63, last par., The ISV flow diagram (Figure B.3.4.3) does not show a water quench system, venturi scrubber, solids separator, chiller or mist eliminator, which are the standard ISV off-gas treatment system components.

Response Figure B.3.4.3 depicts the major features of the ISV process. At the point when further engineering design potentially would be done, an expanded set of process flow diagrams would be developed. Because the description of the process in Section 3.4.3 of Appendix B refers to the water quench, scrubber, solids separator, chiller, and mist eliminator, no changes to the EIS have been made. These treatment systems were included in the design for the process, but were considered too much detail for presentation in the EIS. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.19

Geosafe

Comment B-64, 3rd par., The degree to which organics and ferrocyanides present an explosive issue in the tanks is presently unknown and is currently being researched by DOE. At most an estimated 38 tanks potentially contain high enough concentrations of these contaminants to be of concern (PNL 10773).

Response The degree to which organics and ferrocyanides present an explosive issue currently is under investigation. There may be answers to the situation that are inherent with ISV, which is that extensive mixing of the contents of different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been limited, and it may be premature to state that the problem mainly is limited to 38 tanks of organics or ferrocyanide material. Until further investigations have been completed, the statement in the EIS that safely treating reactive materials requires further analysis is correct. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.20

Geosafe

Comment 1st bullet, Geosafe agrees that the proposed ISV alternative is more conceptual in design than the ex situ vitrification alternative but has made the following recommendations to significantly decrease the degree of uncertainty associated with cost, schedule and resource requirements.

- Use smaller ISV equipment and multiple melts to treat tanks
- Use a smaller moveable tank containment building
- Reduce tank effective height to lower treatment depth and volume.

Response Additional areas for further research and investigation associated with ISV are possible. Using smaller ISV equipment and multiple melts, smaller, moveable confinement facility, and tank overburden to fill voids and lowering the tank dome into the tank are areas where further investigation may be valuable. The configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that also were bounding. These bounding impacts were presented to the decision makers. Please refer to the response to Comment numbers 0023.01, 0023.03, and 0023.11. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.21

Geosafe

Comment 2nd bullet, The degree of uncertainty for the ISV alternative can be reduced by using smaller equipment which is considered highly feasible given the current understanding of the technology.

Response Alternative configurations for the tank farm confinement facility for ISV are possible. The configuration proposed in Comment number 0023.01 includes a confinement facility that is 120 feet on a side. The area under discussion in the EIS is the higher degree of uncertainty for the exact equipment required for ISV versus ex situ alternatives. The 120-foot confinement facility is still several times larger than that used in current development work for ISV. To state that this configuration is highly feasible could be considered premature. Comment number 0023.01 discusses concerns related to the movement of a smaller confinement facility and its off-gas facilities. Because these concerns remain as issues and problems to be resolved, the EIS is correct in referring to the degree of uncertainty involved. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.22

Geosafe

Comment 3rd bullet, Implementing the recommendation to use a smaller containment facility will eliminate all these concerns except for the need to characterize the tanks. Tank waste characterization is a generic concern that is applicable to all treatment alternatives and is not limited to the ISV alternative.

Response Vitrifying one tank at a time will not require the characterization of an entire tank farm if a smaller, mobile confinement facility were to be used. ISV by its very nature does not retrieve the tank contents. Consequently, there is no opportunity to advantageously blend the tank contents, as would be the case if several tanks were retrieved at the same time as in the ex situ alternatives. To consider the smaller confinement facility will eliminate all these concerns except the need to characterize the tanks would be premature. Still, ISV is basically a batch process (or potentially a semi-continuous process). One characteristic of a batch process is the changing nature of the reactants and products as a function of time. The system must be able to process the expected products, and this requirement does not change with the size of the confinement facility. Further detailed study would result in an improved process; however, no changes to the information presented in the EIS are required. Please refer to the response to Comment number 0023.01.

Comment Number 0023.23

Geosafe

Comment 4th bullet, An estimated 20 tanks potentially contain organics at concentrations that may represent an explosive concern. Research on treating these problem tanks could be conducted while other non-effected tanks are being processed.

Response The degree to which organics present an explosive issue is currently under investigation. Extensive mixing of waste from different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been very limited, and it may be premature to state that the problem mainly is limited to 20 tanks containing organics. Concurrent research and testing on treating these problem tanks could be conducted while other non-affected tanks are being processed. This research must be successfully completed before this method could be used to remediate tanks that may present an explosive concern. Until further investigations have been completed, the statement in the EIS that the safety of drying some waste types is uncertain remains correct, and as a result, no changes to the EIS have been made. The potential for fires and explosions in the tanks is addressed in Volume One, Section 5.12 and Volume Four, Appendix E. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.24

Geosafe

Comment 5th bullet, Geosafe recommends using smaller ISV units which should significantly reduce the uncertainties associated with off-gas treatment. The high operating temperature of ISV has been demonstrated to effectively decompose nitrogen compounds without the formation of NO_xS and greatly reduces off-gas treatment concerns. The calcium sulfate waste stream should not be recycled because the sulfates will be reintroduced back into the off-gas.

Response There is the potential for the production of a secondary waste stream of potentially contaminated calcium sulfate from ISV. This waste stream should not be recycled because the sulfates may not be incorporated into the melt and may be reintroduced into the off-gas. However, at this time, no ISV facilities have been designed for use at the Hanford Site and none have been designed of the size needed to vitrify the tank waste anywhere in the world. Numerous ISV facilities have had problems with off-gas treatment and fires. Until development work has been completed, to state that the high operating temperature of the ISV process would effectively decompose nitrogen compounds without the formation of nitrogen oxides and greatly reduce off-gas treatment concerns would be considered premature. ISV most closely resembles a batch process, where the nature of the reacting materials and the reaction products change as a function of time. Temperature changes also occur with time during ISV, starting with the cool tank wastes and glass formers and ending with molten glass at a very high temperature. So while extremely high temperatures will enhance the dissociation of nitrate and nitrate, nitrogen oxides will be produced until those temperatures are reached. The off-gas treatment system must be able to treat all of the vapors that are evolved. Because these uncertainties will remain regardless of the size of the ISV units, no changes to the EIS have been made. Please also refer to the response to Comment number 0023.01 for a discussion of smaller ISV units.

Comment Number 0023.25

Geosafe

Comment 6th bullet, The 60 ft depth limitation is overly conservative and can be reduced by removing overburden from the tanks and lowering the effective height of the tank as discussed in comment A 3. [Comment number 0023.03]

Response Please refer to the response to Comment numbers 0023.03 and 0023.08.

Comment Number 0023.26

Geosafe

Comment 7th bullet, The use of the proposed smaller tank containment facility (120 ft by 120 ft) will eliminate structural design and costing uncertainties.

Response The EIS addresses only the uncertainty that remains in the design of the large (i.e., 500- by 600-foot) confinement facility. At this time, no ISV facilities have been designed for use at the Hanford Site. Until additional technology development has been completed, it would be considered premature to state that the use of the smaller confinement facility will eliminate structural design and costing uncertainties. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.27

Geosafe

Comment 8th bullet, Verification of the ISV monolith can be performed by core sampling which is a well demonstrated technology. Allowances will have to be made for coring of a radioactive glass monolith but it is feasible given an enclosed system and sufficient concern for safety issues. Secondary wastes generated from coring can be directly recycled to future melts thus eliminating waste disposal concerns.

Response DOE and Ecology agree with the comment that methods exist for the sampling of the in situ vitrified product. The core drilling of vitrified HLW is an area that would require additional research and development to determine its workability. If core drilling becomes an accepted technique for determining the acceptability of the waste form, the design of the confinement facility would include provision for equipment to accomplish the core drilling. While the comment is correct in stating that the secondary wastes generated can be returned to the untreated tanks, it is possible that other problems will be encountered during the development and operating phases of the core drilling system. The text referred to in the comment discusses the fact that inspection and potential pretreatment of the final waste form are problems of implementability that remain to be solved. Despite the fact that methods are available for sampling the vitrified waste form, the technical problems associated with this issue remain to be solved. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.28

Geosafe

Comment 9th bullet, The use of the smaller ISV system will eliminate concerns regarding movement of the off-gas system.

Response The EIS addresses the uncertainty that remains in the design of the off-gas treatment facilities. Until additional technology development has been completed, to state that the use of the smaller ISV system will eliminate concerns regarding movement of the off-gas system would be considered premature. Please refer to the response to Comment number 0023.24. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.29

Geosafe

Comment 10th bullet, The use of a smaller ISV system will greatly reduce the time needed to retreat a specific area in a tank if it fails to meet the treatment criteria.

Response The EIS addresses the uncertainty that would occur in the operations schedule if an area as large as a complete tank has to be retreated as a result of unsuccessful ISV. Until additional technology development has been completed, to state that the use of the smaller ISV system will greatly reduce the time needed to retreat a specific area in a tank if it fails to meet the treatment criteria would be considered premature. The time required to retreat a tank is not a function of the size of the confinement facility. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.30

Geosafe

Comment 11th bullet, The concern of mixing fluxants into deep zones of the tank can be reduced by implementing the treatment depth reduction techniques recommended in comment A 3 (See Comment number 0023.03). Geosafe has already demonstrated the mixing of fluxants at full scale with excellent results.

Response Thermal mixing is well known in conventional electric furnaces and should work well for ISV. Because thermal mixing in electric furnaces is a natural phenomena, its presence does not constitute an endorsement of the application of a particular technique or equipment. The statement in the EIS refers to further development work that may be required. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.97

CTUIR

Comment P 3-48: Sect. 3.4.5: In Situ Vitrification Alternative: this section does not adequately discuss how all of the vitrified ground and waste is to be verified for vitrification, and how this verification process will include leakage, migration, below the area of impact. This process has not been adequately explained for the purposes of this EIS.

Response Further technology development regarding the implementation of the ISV alternative may be required. Volume One, Section 3.4.5.7 and Volume Two, Section B.3.4.4 discuss the issues applicable to the implementability of this alternative including inspection of the final waste form to confirm that all of the waste is stabilized and the waste form is acceptable. One possible method of verification would be drilling through the vitrified mass to ensure that vitrification was complete, but these drill holes would not necessarily confirm any potential migration that may exist below the vitrified mass. Migration in the vicinity of the vitrified mass could be verified by drilling additional boreholes near each tank farm when ISV had been completed. Please refer to a related discussion on verification in the response to Comment number 0023.12.

Comment Number 0072.98

CTUIR

Comment P 3-54: Sect. 3.4.5.7: Implementability: How is excess melting going to be addressed, Please describe the fractionation process of the melt? What are the anticipated cooling times, and how have these times been calculated, are they based on the fractionation process? If the times are not based on the fractionation process what exactly are they based on? What is the verification process for the vitrification, the fractionation, the cooling, the immobilization?

Response Many crucial questions must be answered before the ISV alternative can be implemented. Volume One, Section 3.4.5.7 contains discussions of the substantial research, development, and demonstration activities that would be required. Inspection of the final waste form to confirm stabilization of the waste is one area requiring more information. The implementability of this alternative is not known at this time. To account for these uncertainties, additional technology development time and costs were incorporated into the analysis of these alternatives. The information requested is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives. Implementability was one factor analyzed for the technologies included in the alternatives analysis.

Comment Number 0072.99

CTUIR

Comment P 3-54: The technical uncertainties associated with this process are just as great for the MUSTs because the contents of the MUSTs have been inadequately described within this EIS.

Response As is explained in Volume Two, Section A.2.3, definitive characterization data do not currently exist for the inactive MUSTs. Because they received the same waste products that are contained in the tanks, the concentration of constituents is expected to be approximately the same. Volume Two Table A.2.3.1 lists the current estimated waste volumes for the MUSTs and briefly comments on the use of each tank. ISV of the small MUSTs may present less of a technical challenge because the size of the melt more closely conforms with previously demonstrated vitrification processes. Please refer to the response to Comment numbers 0012.14, 0072.169, 0029.01, and 0060.02 for a discussion related to MUST contents.

Comment Number 0072.185

CTUIR

Comment P B-53: Sect. B.3.4: Same comment as above. [Please refer to the response to Comment number 0072.195.]

Response Please refer to the response to Comment number 0072.195.

Comment Number 0102.01

Eister, Warren

Comment The Draft Environmental Impact Statement for the Hanford Site Tank Waste Remediation System -

Summary (DOE/EIS-0189D) seems to suggest the choice system would be In Situ Vitrification (Figure S.6.2 along with Tables S.7.2 and S.7.3).

It is very reassuring that decisions made more than twenty years ago continue to be re-evaluated. Unfortunately those decisions have been extremely difficult to implement.

However, in spite of the continuing unresolved difficulties, this EIS Summary reports that DOE has already adopted the Phased Implementation System which is dependent on potential geologic repositories and involves extensive process and transportation activities.

Is the In Situ Vitrification technology being developed with the same level of effort as the Phased Implementation?

Would this In Situ Vitrification System be applicable to the:

- Savannah River site?
- Spent fuel from the nuclear power reactor program?
- TRU waste?
- Low-level wastes?

Are there other technologies being sought that would allow the spent fuel from the nuclear power program to remain in the vicinities of the current power plant sites?

Response The preferred alternative for tank waste identified in the Draft EIS and Final EIS is Phased Implementation not ISV. DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.05 regarding NEPA requirements for the analysis of alternatives and Comment numbers 0055.03 and 0005.07 for a discussion of the role of the EIS in the decision making process. Repository costs and uncertainties analysis results for each alternative have been included in Volume Two, Appendix B and Volume Five, Appendix K, respectively, in the Final EIS.

The TWRS EIS focused on tank waste remediation alternatives. Technology evaluation was limited to those technologies currently available or for which sufficient development information was available. DOE is not currently developing any remedial technologies. Potentially-applicable ISV technologies are under commercial development. Technologies development and/or evaluation would be conducted during the detailed design and demonstration phases of the preferred alternative. Issues related to ISV technology applicability at other DOE sites, for commercial nuclear power programs, or to other radioactive waste types beyond those required for the alternatives evaluation were not considered because they are beyond the scope of the EIS.

Please refer to the response to Comment number 0037.03 for more information concerning interim onsite storage of HLW and compliance issues related to the Nuclear Waste Policy Act.

L.3.4.7 Ex Situ Intermediate Separations Alternative

Comment Number 0005.45

Swanson, John L.

Comment Page 3-59 contains a sentence regarding the Tri-Party Agreement requiring the retrieval function to remove waste to an extent based on volume or as much as is technically possible, WHICHEVER IS LESS. I believe you mean to say remove the MOST, leaving the LEAST - but that is not what the sentence says.

Response The cited text has been revised as follows, "The Tri-Party Agreement (i.e., Milestone M- 45-00) requires that the removal function remove waste to the extent that SST waste residuals meet specific volume requirements based on tank type, or that as much waste is removed as technically possible, whichever action results in the least residual waste volume" (Ecology et al. 1994).

Comment Number 0005.46

Swanson, John L.

Comment Page 3-67 defines an off-gas stream from a vitrifier as a "gaseous air stream containing combustion gases." This is true for a combustion-fired melter, but how about a joule-heated melter?

Response Volume One, Section 3.4.6.2 states that fuel-fixed melters have been included for analysis in the EIS. It is further stated that future evolution may result in another melter configuration. With either the joule-heated or fuel-fixed melter, a large quantity of off-gas with contaminants such as SO_x and NO_x must be treated. The total volume of gas with a fuel-fixed melter would be greater with the use of kerosene and oxygen for the fuel, but the total amounts of SO_x and NO_x would not differ greatly. The fuel-fired melters considered provide a more conservative analysis in the design and treatment of the off-gas for discharge to the environment. Please refer to the response to Comment numbers 0005.42, 0072.91, 0023.01, 0023.15, 0023.24, 0023.28, and 0072.101 for discussions of issues related to off-gassing. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0005.47

Swanson, John L.

Comment Page 3-67, last paragraph of 3.4.6.2 ("Driving heavy equipment--") seems to be out of place. This same paragraph appears in similar locations for other alternatives too; the same comment applies in those sections as well.

Response Because this is an issue common to many of the alternatives, a better location for a one-time entry to the section has been determined. This discussion on mitigating a potential accident has been moved to a discussion of elements common to the alternatives in Volume One, Section 3.4 and Volume Two, Appendix B. This statement of concern appears on several pages within Volume One, Section 3.0 and Volume Two, Appendix B.

Comment Number 0027.10

Roecker, John H.

Comment Technical Uncertainty

To state that the technical uncertainty of the intermediate and extensive separations alternatives are both moderate is erroneous and misleading to those who are not familiar with the technologies involved. Intermediate separations requires three technologies, all of which have been demonstrated, while extensive separations requires at least ten, most of which have not been demonstrated. This misleading information needs to be corrected.

Response The degree of technical uncertainty provided in the Summary assigns a high, medium, or low ranking for the entire remediation alternative. DOE and Ecology acknowledge that there is a higher level of technical uncertainty with extensive separations than with intermediate separations. However, overall, both alternatives fall into the moderate category. Additional discussion regarding technical uncertainty is provided in Volume One, Section 3.4 and Volume Two, Appendix B and the response to Comment number 0005.03.

Comment Number 0036.16

HEAL

Comment The EIS states that intermediate separations would reduce the waste going to the repository. It adds, "The other goal of separations would be to limit the generation of additional waste during the separations processes" (p. 3-65). What does this passage mean?

Response Limiting the generation of additional waste during the separations process means that design and implementation of the HLW/LAW separations processes would consider the volume of LAW along with the volume of

HLW that would be generated. One means of accomplishing this would be to limit the introduction of sodium hydroxide during the enhanced sludge washing process, which would limit the overall amount of sodium in the resulting LAW form.

Comment Number 0057.03

Garfield, John

Comment With respect to primarily the cost, the EIS references the document from '94 Boomer et al. That document compares two alternatives that are nearly identical to intermediate separations, then extensive separations is called clean and enhanced sludge washing in that document. It shows a cost penalty for using clean of $7 billion dollars compared to enhanced sludge washing. Those same alternatives show a $3 billion dollar advantage in the Environmental Impact Statement Draft. That is a $10 billion dollar swing. That deserves investigation. The repository comments convey part of that. The rest relates back to my earlier remarks about the headquarters influence.

Response The cost estimates were reviewed and revised for the Final EIS. The waste loading and blending assumptions that impact the volume of HLW have been revised to reflect the recommendations of an independent technical review team. The size of the HLW canisters has been revised to reflect recent DOE-RW findings that a longer canister for Hanford HLW is technically feasible. These changes, as well as the resulting cost impacts, were revised and are included in Volume One, Section 3.4 and Volume Two, Appendix B. For more information on issues relating to HLW canisters and repository costs, please refer to the response to Comment numbers 0081.02 and 0008.01.

Comment Number 0057.05

Garfield, John

Comment The next comment I would like to make is that the chosen case built around the extensive sep..or excuse me the intermediate separations data of without repository cost shows it $30 billion dollars. That estimate assumes a stand-alone high-level waste treatment facility which would cost in the vicinity of $1 to $2 billion dollars and add another equivalent amount in operating costs. There is some recent data developed using a single facility but which can be - its mission can be modified both in terms of scope and capacity to accommodate both low-level treatment at a smaller scale through the 200-ton per day capacity 1 to 200-ton per day capacity for the full scale low-level treatment and then can be converted for high-level treatment. That is the only sane approach to this problem. Building three demonstration plants and two full-scale plants is a lunacy that will cost us $30 billion dollars. A simpler facility approach that I just described would cut those costs in approximately half and, in fact, the studies release from the DOE reading room suggests that cost is about $16 to $18 billion dollars. That should be the basis for the EIS intermediate separations case.

Response DOE and Ecology recognize that there are opportunities for optimizing the costs estimated for each of the alternatives addressed in the EIS. As discussed in the EIS, the alternatives were developed to bound the impacts associated with remediating the tank waste. Process and facility design optimization would not be precluded with the selection of any of the alternatives presented in the EIS. For more information on the topic, please refer to response to the Comment number 0072.05.

The Draft EIS addressed the full range of reasonable alternatives. The alternative identified is bounded by the alternatives addressed in the Draft EIS, and DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers.

Comment Number 0072.100

CTUIR

Comment P 3-56: Sect. 3.4.6: Ex Situ Intermediate Separations Alternative: The separation of the Waste streams into HLW and low activity waste seems confusing. Low activity waste is waste that is a subset of HLW? What are the legal requirements for classifying waste as LAW? Have the Affected Tribes been consulted regarding this?

Response LAW is the waste remaining after removal of as much of the radioactivity from HLW as practicable. The definition of LAW is provided in Volume One, Section 1.0. DOE and the NRC have had formal discussions on tank waste classification and LAW regulation; however, DOE would need to formally solicit an opinion from the NRC regarding the classification of LAW. Volume One, Section 6.2 provides additional information on tank waste classification and the results of the discussions between DOE and the NRC. Criteria must be formalized as to the extent to which the HLW in the tanks must be separated for the residual waste to meet requirements for incidental waste, LAW, as well as the DOE and Washington State definitions of LLW and hazardous waste requirements of the State of Washington. Design specifications for HLW and LAW treatment will require that waste forms meet applicable criteria for disposal in the potential geologic repository or as LAW for onsite disposal, respectively.

DOE plans for onsite near-surface disposal of LAW date back to the 1988 Hanford Defense Waste EIS ROD (DOE 1987). That NEPA process, as well as subsequent consideration of onsite disposal of LAW during the 1989 and 1994 Tri-Party Agreement negotiations, and the Tank Waste Task Force process (HWTF 1993), provided interested parties as well as Tribal Nations with the opportunity to comment on the planned onsite disposal of LAW. The TWRS EIS and the public involvement process for Tri-Party Agreement amendments associated with the privatization initiative provided additional opportunities for Tribal Nation input into the decision-making process related to this issue. The Tribal Nation consultation process is discussed in the response to Comment number 0072.149.

Comment Number 0072.101

CTUIR

Comment P 3-56: PP 3: The LAW is to be quenched into a 'cullet', this indicates that there is going to be an additional secondary waste stream generated from the reaction of molten silicates, nitrates, hydroxides, oxides, metals and water. What will be done with this waste stream. Will this waste stream be classified as High level liquid waste? The off gasses that are produced are supposedly going to be treated in some fashion, please explain how this is to be accomplished including feed rates, volume of off gas produced, filter failure rates, retrievable useable material, and indicate where this process has been proven including references.

Response The technical data that served as a basis for developing the Ex Situ Intermediate Separations alternative are referenced in the EIS (WHC 1995 n, j, i and Jacobs 1996) and are available for review as part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories.

Quench water is a secondary waste stream that would contain contaminants as a result of quenching the molten LAW glass in order to produce the cullet. This quench water would be recycled extensively either as quench water or back to the front of the process to be added to the LAW stream for vitrification. This liquid waste stream would not be expected to be classified as HLW.

The amount of secondary waste generated during operations of the Ex Situ Intermediate Separations alternative would consist primarily of off-gas and liquid effluent emissions identified in Volume Two, Table B.11.05. The off-gas and liquid effluents would be treated to remove contaminants to the maximum extent possible before being discharged. The HLW vitrification process would result in gas flows out the stack of approximately 3,500,000 metric tons (mt) over the life of the facility. The radiological and chemical concentrations to be released from the stack were calculated and used in the routine risk assessment. The liquid effluent from the HLW vitrification facility was estimated to be 1,200,000 mt (before recycle) based on material balance calculations. Volume Two, Section B.3 describes the liquid effluent processing of secondary radioactive waste streams for all alternatives. In addition to these emissions, secondary waste consisting of contaminated filters and spent ion exchange resins would be generated during treatment operations.

The generation of off-gas during the vitrification process would result from the evaporation of water, thermal destruction of chemical compounds, evolution of volatile compounds, and the entrainment of particulates in the off-gas stream. A detailed description of the off-gas system is provided in Volume Two, Section B.3. Control technologies that would be employed to reduce emissions include: quench towers, venturi scrubbers, chillers, demisters, high-efficiency particulate air (HEPA) filtration, sulfur recovery, and NO_x destruction. The off-gas emissions from the vitrification plants are included in the risk assessment. The off-gas treatment processes that would be used are the same technologies that have been successfully used in commercial and defense nuclear industry as well as the chemical processing industry.

Comment Number 0072.102

CTUIR

Comment P 3-56: PP 5: What is the amount of secondary waste generated from this process? Will there be material that can be recycled? Will the secondary waste stream have to be reprocessed for additional radionuclide removal?

Response Secondary waste streams will include treatment for removal of radionuclide and chemical contaminants to the maximum extent possible before discharge. Off-gas streams will include various technologies to treat chemical and radionuclide emissions during operations. Liquid effluents would be collected and sent to the onsite Liquid Effluent Treatment Facility for treatment. Please refer to the response to Comment numbers 0072.101 and 0072.109.

Comment Number 0072.103

CTUIR

Comment P 3-59: top of the page: Where does the strontium end up with this process, in the liquid or the solids phase?

Response The strontium will be mainly in the HLW solid phase during the enhanced sludge washing process used for the Ex Situ Intermediate Separations alternative. A small amount, approximately 6 percent of the strontium and decay product activity, would end up in the LAW.

Comment Number 0072.104

CTUIR

Comment P 3-59: Sect. 3.4.6.2: What was the process for determining the average feed stream, and what are the expected ranges for this feed stock in relation to the glass content and characteristics? What will be the process for determining what to do, in the case of 'out of operating' mode? Will this process entail stocking waste from the other tanks in order to blend the feed mixture? If this is the case, has this information been costed out to show how many and how large these out of ground tanks will be?

Response The technical data that served as a basis for developing the Ex Situ Intermediate Separations alternative is referenced in the EIS (WHC 1995i, j, n and Jacobs 1996) and available for review as part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. Additional details regarding the facility layout, including the melter feed system and associated tankage, are provided in Volume Two, Section B.3.

The average feedstream was developed by taking the average overall chemical and radiological inventory including dilution water that would be added during waste retrieval operations. The material balance calculations assumed that the tank waste would be adjusted to 5 molar soluble sodium during retrieval and transfer. It is expected that there will be some variation in the feed stream composition during the waste treatment process. Compositional limits for waste feed would be established during the detail design phase and would take into consideration the affect of variability in the waste feed on the vitrification process, the acceptability of the glass, as well as safety concerns. Blending of the waste during retrieval and the ability to sample and blend waste in the lag storage area would minimize the variance in the waste feed. The lag storage and melter feed system would provide further opportunity for waste feed conditioning. The engineering data developed include the necessary equipment and processes to blend the waste feed and no additional out of ground tanks are required.

Comment Number 0072.105

CTUIR

Comment P 3-61: Sect. 3.4.6.2:. PP 3: S 1: The figure 3.4.9, depicts a sluicing module at the end of the end effector. If sluicing has to be discontinued because of tank leakage, please describe this sluicing module, and why it is depicted.

Response The sluicing module referred to in the comment would minimize the amount of water introduced to the tank during retrieval as compared to articulated arm method of sluicing. The articulated arm would be deployed when there was concern about the integrity of the tank or a potential for tank leakage. Other types of engineered modules, such as mechanical end effectors, could be used for selected retrieval operations with the articulated arm. Please refer to the response to Comment number 0029.01 for additional information concerning sluicing.

Comment Number 0072.106

CTUIR

Comment P 3-66: PP 1: S 7: Within this sentence there is a reference that silica is sand. Silica is not sand. Sand can consist of many things, including silicon dioxide.

Response Sand is commonly defined as loose, fine particles of disintegrated rock. The sentence that is referred to in the comment is describing glass formers, some of which may be either silica or sand (depending on the desired composition of the glass).

Comment Number 0072.107

CTUIR

Comment P 3-66 PP 2: S 1: Quenching molten glass will not necessarily make gravel sized pieces, in addition the pieces formed will have a high percentage of fractures, and necessarily a very large surface area, please explain how these cullets are better at resisting aging, and weathering, and where are the references for this process?

Response The treatment facilities that would produce glass cullet as a waste form would have equipment in place to produce uniform-sized cullet. Glass fines would be screened and recycled back to the melter and oversized cullet would pass through a roll crusher to produce cullet of acceptable size for handling. Glass cullet would have a larger surface area-to-volume ratio as compared to monolithic pours of glass (e.g., glass logs) in canisters. This discussion is included in Volume Two, Section B.3 of the EIS. Glass cullet would have higher leach rates than monolithic pours of glass due to the higher surface area-to-volume ratio. The acceptability of HLW glass cullet produced under the Ex Situ No Separations alternative is identified in Volume One, Sections 3.4 and 6.2 and Volume Two,

Appendix B. The increased leaching for cullet was taken into account when the impacts associated with the immobilized LAW were analyzed in the EIS in Volume One, Section 5.2 and Volume Four, Appendix F. Please refer to the response to Comment numbers 0035.04, 0012.11, and 0052.11 for a discussion of waste form and storage issues.

Comment Number 0072.108

CTUIR

Comment P 3-67: PP 2: What does partial recycle of off gas mean? Does this mean that there is going to be a substantial amount of off gas released to the environment? Has this been incorporated into the risk section? Have the impacts of this off gas been assessed as to their affects to Native Americans?

Response Each tank waste alternative that uses high-temperature processing (vitrification or calcination) would make extensive use of recycle streams to recycle back into the treatment process volatile radionuclide and chemical constituents captured in the off-gas system. These recycle streams would minimize the generation of secondary waste. It has been determined that a bleed stream would be required for each alternative to avoid a continuous buildup of certain volatile radionuclides and chemical constituents, namely technetium and mercury, in these recycle streams.

Complete recycle of the more volatile constituents is not possible. The off-gas emissions estimates used for risk assessment were developed considering volatility and the ability of the off-gas treatment system to capture and recycle individual constituents.

Please refer to the response to Comment numbers 0072.207 and 0072.91 for discussions on assessment of Native American risk resulting from routine air emissions during remediation. The Tribal consultation process is discussed in Comment number 0072.149.

Comment Number 0072.109

CTUIR

Comment P 3-68: PP 4: Bottom of the Page: One 22 metric ton per day HLW does not seem like enough, especially since there is going to be down times for change outs, plugging, melt inconsistencies, spills, and other process related problems. Wouldnt it be more prudent to plan for additional melt capacity above and beyond the 20 mt as allowances for capacity needs? Additionally, what is the total amount of secondary waste generated with his process? How will this compare to the global vitrification process already in use in France, and the United Kingdom? What are the expected off gases, and what are the treatment process being proposed? Are these gasses being addressed in the risk portion of this document?

Response The 20 mt (22 ton) melter capacity for HLW vitrification under the Ex Situ Intermediate Separations alternative was calculated using a 60 percent overall operating efficiency along with a 13-year operating duration. The 60 percent overall operating efficiency takes into account down time due to process-related problems.

The amount of secondary waste generated during operations of the Ex Situ Intermediate Separations alternative would consist primarily of off-gas and liquid effluent emissions identified in Volume Two, Section B.11, Tables B.11.05 (radiological) and B.11.06 (nonradiological) The off-gas and liquid effluents would be treated to remove contaminants to the maximum extent possible before being discharged. The HLW vitrification process would result in gas flows out the stack of approximately 230,000 mt over the life of the facility. The radiological and chemical concentrations that would be released from the stack were calculated and used in the routine risk assessment. The liquid effluent from the HLW vitrification facility was estimated to be 72,000 mt based on material balance calculations. Volume Two, Section B.3 describes the liquid effluent processing of secondary radioactive waste streams for all of the alternatives. In addition to these emissions, secondary waste consisting of contaminated filters and spent ion exchange resins would be generated during treatment operations.

A discussion of foreign vitrification technologies can be found in Volume Two, Section B.9. A comparison of secondary waste generation at foreign vitrification facilities was not made; however, the generation of gaseous and liquid effluent streams would be expected to be the same for similar waste types and processing rates. Regulatory requirements for gaseous and liquid discharges would control the number and type of treatment technologies employed to reduce the risks to human health and environment. These requirements would be different in foreign countries. The Hanford Waste Vitrification Plant Foreign Alternatives Feasibility Study indicated that plants operating in foreign countries would require additional process equipment for treating melter off-gas and other effluents to meet United States environmental requirements.

The generation of off-gas during the vitrification process would result from the evaporation of water, thermal destruction of chemical compounds, evolution of volatile compounds, and entrainment of particulates in the off-gas stream. A detailed description of the off-gas system is provided in Volume Two, Section B.3. Control technologies that would be employed to reduce emissions include: quench towers, venturi scrubbers, chillers, demisters, HEPA filtration, sulfur removal, and NO_x destruction. The off-gas emissions from the vitrification plants are included in the risk assessment.

Comment Number 0072.110

CTUIR

Comment P 3-70: Sect. 3.4.6.5: Post Remediation: this section has to be, either removed or changed to reflect the clean closure option. Additionally during closure, the tanks are not supposed to have residual equal to 1 percent but should be less than 1 percent. The MUSTs, pump pits, valve boxes, and diversion boxes, final disposition has not been firmly established within this EIS. If these ancillary equipment are to be dealt with under clean closure conditions then they need further definement in terms of their contents, their extent of contamination and their disposal.

Response Closure is not included in the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. However, Volume One, Section 3.3 addresses how tank waste remediation and closure are interrelated because some of the decisions made regarding how to treat and dispose of tank waste may impact future decisions on closure. There are three representative types of closure addressed. These include clean closure, modified closure, and closure as a landfill. The referenced paragraphs are included in Volume One, Section 3.4 to illustrate the type of activities following remediation rather than specifying the type of closure. The value of, "... a residual equal to no more than 1 percent ...," was used to bound the impacts from the tank residuals. Closure of ancillary equipment also is not included in the scope of this EIS. Issues related to tank farm closure are discussed in Comment number 0072.08. Please refer to the response to Comment numbers 0012.14, 0072.50, and 0101.06 for MUST characterization and issues related to closure. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.111

CTUIR

Comment P3-72: Sect. 3.4.6.7: Implementability: bullets 3,6: If Low Activity Waste has not been thoroughly described, and permitted, how does this EIS propose to deal with the enormous amount of uncertainty involved throughout all the process stages? This is not the easiest way of dealing with the waste. Because the Nuclear Regulatory Commission has not finished with the negotiations, why in Section 3.4.6.5., does it mention that this LAW be buried under the Hanford Barrier? Burying this waste in a cullet form under the Hanford Barrier is the same as saying DOE made the waste, used their contractors to partially treat it, buried it and then walked away leaving the Affected Tribes to deal with the consequences. This is not acceptable. The ex situ intermediate separations alternative therefore is not acceptable. Changes made to this alternative, such as determining the LAW disposal criteria will necessarily need CTUIR input.

Response DOE and Ecology acknowledge the concerns regarding uncertainty expressed in the comment. To develop engineering data required to perform impact analyses for each of the alternatives, assumptions were made regarding the technologies that have been configured to create a remediation alternative, including process stages and waste form. Also, for the purposes of comparing alternatives, a single and consistent method of closure was assumed for all of the alternatives. Closure as a landfill covered by a Hanford Barrier was chosen as the representative closure method for analysis. This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. Please refer to the response to Comment number 0072.08 for more information regarding closure. Although these assumptions were based on best information available, applications of a similar technology, or engineering judgement, there are uncertainties associated with each of the alternatives. Major assumptions and uncertainties are addressed in Volume One, Section 3.4. Additional uncertainty analyses were completed for the Final EIS, and are included in Volume Five, Appendix K.

DOE and Ecology acknowledge the concerns regarding LAW expressed in the comment. LAW is the waste remaining after removal of as much of the radioactivity from HLW as practicable. DOE and the NRC had formal discussions on the way tank waste is classified and how the LAW portion might be regulated in the context of the previously planned grouted LAW. 58 FR 12344, March 1993, states that disposal of residual waste from the DST waste would only be a small fraction of the reprocessing wastes originally generated at the Site; residual waste material should be classified as incidental waste, since they are wastes incidental to the process of recovering HLW; the residual activity of these incidental wastes would be below the concentration limits for Class C wastes under the criteria of 10 CFR part 61; and the disposal of the residual would not be subject to NRC licensing. Section 6.2 provides additional information on tank waste classification, and the results of the discussions between DOE and the NRC. However, criteria must be formalized as to the extent to which the HLW in the tanks must be separated for the residual waste to meet requirements for incidental waste (LAW) as well as the DOE definition of LLW and State of Washington definition of hazardous waste. Design specifications for HLW and LAW treatment will require that waste forms meet applicable criteria for disposal in the potential geologic repository, or as LAW for onsite disposal.

LAW disposal in onsite near-surface vaults was incorporated into the Ex Situ Intermediate Separations alternative, as well as all other ex situ alternatives except Ex Situ No Separations, because that is the current planning basis for the TWRS program as represented in the Tri-Party Agreement. The planning basis assumes that LAW will be vitrified and disposed of onsite in near-surface vaults. Further, it assumes that LAW will meet NRC criteria for incidental waste based on the extent of separations of LAW from HLW during the pretreatment process.

The disposal criteria for incidental waste is determined by the NRC and is well-established criteria. For the TWRS program, the issue at hand is whether the LAW waste stream, when vitrified, will be classified as incidental waste on the waste specifications. In the requests for proposals for Phase 1 of the privatization initiative, DOE defined the waste specifications for LAW that contractors would be required to meet. The waste specification was prepared to produce a waste that would be classified as incidental waste. DOE will consult with NRC to ensure that the waste meets applicable standards for incidental waste.

DOE and Ecology acknowledge the concerns regarding burial of vitrified cullet expressed in the comment. Cullet has a high surface area-to-volume ratio which results in lower long-term performance, including susceptibility to leaching. However, assuming vitrified LAW in cullet form for all of the ex situ alternatives provides a conservative analysis of the long-term impacts resulting from onsite retrievable disposal of LAW in near-surface vaults. Risks associated with retrievable disposal of LAW in vaults have been analyzed and these are presented in Appendix D.5. In addition, a Native American Scenario has been added to the Final EIS in Volume One, Section 5.11 and Appendix D. DOE and Ecology acknowledge the recommendation regarding consultation with Tribal Nations in determining LAW disposal criteria. Please refer to the response to Comment numbers 0035.04, 0012.11, and 0052.11 for related information.

Comment Number 0072.186

CTUIR

Comment P B-66: Sect. B.3.5: LLW is not the same as LAW, yet it appears that these terms are being used interchangeably. Because of this short time period for the review of this particular EIS. Please check for additional similar situations and correct them as is appropriate.

Response LLW is not the same as LAW. LAW is the waste remaining after removing as much radioactivity as practicable from HLW. The definition of LAW is provided in Volume One, Section 1.0, and addressed in more detail in Section 6.2. The term LAW used in Volume Two, Appendix B on page B-66 describes the waste stream after removal of the HLW components. The term is used correctly so no change to the EIS is warranted. Please refer to the response to Comment numbers 0005.25, 0072.118, 0072.117, and 0072.100 for issues related to regulatory definitions of Hanford tank wastes.

Comment Number 0072.187

CTUIR

Comment P B-95: PP 2: How will the insoluble sludges be suspended in the solution of soluble waste? How much volume of additional chemicals must be added? Will this be done in tank or in a receiving tank?

Response Following retrieval, where the sludges will be mobilized and suspended, the insoluble sludge particles will remain in suspension in the aqueous solution as long as the sludge particles have sufficient velocity. This velocity can be produced by such mechanical devices as pumps and mixers. The additional volume of chemicals to be added and the location of the addition point will be determined during the testing phase for this alternative.

Comment Number 0072.188

CTUIR

Comment P B-95: PP3: Why is it assumed that Cs is the only soluble radionuclide to be removed?

Response The engineering data package used in developing this alternative (WHC 1995j) assumed that only well-documented technologies would be used in developing the Ex Situ Intermediate Separations alternative. Cesium recovery by ion exchange is at present the sole technology that is well-documented for the recovery of soluble radionuclides. This assumption was then carried forward into the EIS. Removal of additional soluble radionuclides was included in the Phased Implementation and Ex Situ Extensive Separations alternatives.

Comment Number 0072.189

CTUIR

Comment P B-107: Sect. B.3.6: Calcining tank waste will result in a form not acceptable at the permanent waste repository.

Response The calcined HLW form would not meet the standard waste form (i.e., borosilicate glass) specified in the current waste acceptance requirements for the potential geologic repository. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not be in compliance with laws and regulations. Please refer to the response to Comment number 0072.80 for a discussion of the NEPA requirement to consider reasonable alternatives regardless of their ability to comply with regulations. Volume One, Sections 3.4 and 6.2 and Volume Two, Section B.3 address regulatory compliance issues related to each of the alternatives. Please refer to the response to Comment number 0012.20 for a discussion of glass types and regulatory licensing issues.

Comment Number 0089.09

Nez Perce Tribe ERWM

Comment Page 3-66, Paragraph 2

It states that, with ex situ vitrification, LAW will be melted and flow into a water bath to break the glass formed into cullets, later the cullets will be bonded in a matrix material before onsite disposal. The EIS does not indicate what matrix material will be used to hold the cullets together. It is a concern that the matrix may not be as resistant to degradation as the vitrified glass allowing breakdown and waste surface area to increase. Whatever the matrix material is it will than also become LAW along with the glassformers used to create the product. Why not leave the LAW as a full size molded product rather than increasing the surface area for chemical breakdown by forming cullets. Surely a suitable configuration can be found for the molded LAW, that will not require forming cullets.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Matrix material composition and final waste form would be evaluated during the detailed design phase that would follow selection of this specific remedy, if this selection occurs. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified low-activity cullet form. Cullet would provide processing and material handling advantages for high-capacity processing facilities; however, cullet has a high surface area-to-volume ratio, which results in lower long-term performance. Please see the response to Comment numbers 0005.40 and 0072.89 for a discussion of how the cullet waste form provides a bounding impact analysis. The response to Comment numbers 0035.04, 0052.11, and 0012.11 contain discussions concerning waste form.

L.3.4.8 Ex Situ No Separations Alternative

Comment Number 0005.48

Swanson, John L.

Comment The second paragraph under "Vitrification Process" on page 3-74 appears to be garbled. On balance, it appears to be addressing LAW vitrification, but it specifically says HLW glass.

Response The second paragraph under Vitrification Process on the referenced page may appear to discuss LAW vitrification, but the section heading is Ex Situ No Separations alternative, meaning that all of the glass waste produced is HLW. The first paragraph under Vitrification Process states that the HLW facility capacity is provided by two melters operating in parallel. The paragraph identifies HLW glass because this paragraph discusses only the HLW process as the only applicable process for discussion under this alternative. The text has been revised to clarify the discussion regarding vitrification under the Ex Situ No Separations alternative in Volume One, Section 3.4.

Comment Number 0057.07

Garfield, John

Comment Other things like the calcination case mentioned two calciners at a processing rate of 200 tons per day. You may be able to accomplish a solidified moltent sodium process at those rates but drying the waste to a calcine form would require something on the order of 20 to 40 calciners. The physics are not there to do it at a 100 tons per calciner. That is a technical error that should also be fixed.

Response A more detailed description of the conceptual calciner is discussed in Volume Two, Section B.3. The discussion in Volume One, Section 3.4 is a summary level discussion. The calciner design is modeled after available laboratory data. Additional details including mass and energy balances for the calcining process are available for review in the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.112

CTUIR

Comment P 3-73: Sect.3.4.7: PP 4: Because this is a retrieval EIS not a closure EIS, this paragraph should be removed, or the language strengthened to indicate that there are several closure options.

Response Cost estimates for the removal and treatment alternatives included several Site closure assumptions (e.g., the Hanford Barrier), which are discussed in Volume One, Section 3.4.1.4, Major Assumptions and Uncertainties to provide an equal basis of comparison among alternatives. The text is considered appropriate within the context of the section and therefore no revisions to the text are required. For an extensive discussion of all issues related to closure, please refer to the response to Comment numbers 0072.08, 0019.03, 0019.04, and 0101.06.

Comment Number 0072.113

CTUIR

Comment P 3-74: Calcination Process: This process results in an unacceptable waste form for the permanent repository and thus this section should be removed or edited to clearly state the consequences of producing an unstable waste form that will spread to the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The information requested in the comment is in the EIS. The Summary, Section S.7.1, Volume One, Section 3.4.7.7, and Volume Two, Section B.3.6.4 discuss the fact that the calcined waste form would not meet the current waste acceptance criteria for the potential geologic repository. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not be in compliance with laws and regulations. For a discussion of this requirement, see the response to Comment number 0072.80. Volume One, Section 6.2 and Volume Two, Appendix B.3 also address regulatory compliance issues related to each of the alternatives. The radiological impacts of transporting the calcined HLW are analyzed in Volume Four, Section E.7.4.1.1.

Comment Number 0072.114

CTUIR

Comment P 3-76: PP 2: This paragraph relates to a process that produces a product that is unacceptable for the permanent waste facility, this paragraph should be removed or edited to clearly state the consequences.

Response Please refer to the response to Comment number 0072.113.

Comment Number 0072.115

CTUIR

Comment P 3-76: PP 3: S 2: This sentence refers to the closure process which is not within the scope of this EIS and should be removed or edited to clearly state the reasoning and the consequences and additional closure alternatives associated with this action.

Response Please refer to the response to Comment numbers 0072.112 and 0072.08.

Comment Number 0072.116

CTUIR

Comment P 3-77: Sect. 3.4.7.5: This section refers to the closure process and should either be removed or edited to reflect additional closure options such as the clean closure option of removing the tanks and the contaminated underlying soils as not to preclude all closure options.

Response Please refer to the response to Comment numbers 0072.112 and 0072.08.

L.3.4.9 Ex Situ Extensive Separations Alternative

Comment Number 0005.49

Swanson, John L.

Comment The first paragraph on page 3-80 refers to "--multiple complex chemical separations--." It appears to me that the use of the word "complex" is editorializing, and that word should be deleted. The last sentence of that paragraph says "--fewer radioactive contaminants--"; a more accurate statement would be "--lower concentrations of radioactive contaminants--"

Response It is true that the term "fewer radioactive contaminants" would mean less radioactive isotopes in the LAW and "lower concentrations of the radioactive contaminants in the LAW." The text in Volume One, Section 3.4 has been revised to reflect lower concentrations of radioactive contaminants in the LAW.

The term "complex" is intended to give the reader a feeling for the number, complexity, and level of development for the multiple separations processes used for the Ex Situ Extensive Separations alternative; therefore, the term conveys accurate and useful information.

Comment Number 0005.50

Swanson, John L.

Comment The second paragraph on page 3-80 includes Jacobs Engineering as a Site M&O contractor, which is incorrect.

Response The cited statement references information obtained from the Site Management and Operations contractor documents, one of which was prepared by Jacobs Engineering Group Inc. (i.e., Jacobs 1996), and does not state, nor is meant to imply, that Jacobs is the Site Management and Operations contractor. Therefore, the statement has not been revised.

Comment Number 0036.13

HEAL

Comment The EIS is inaccurate in addressing technical risk.

As noted above, DOE has conducted many analyses of the alternatives for treating and disposing Hanford tank wastes. Compared with many of these analyses, the EIS is relatively useless in communicating varying degrees of technical risk.

For example, following is a quote from the EIS on the technical risk involved with the intermediate separations technology: "Performance of key processes (e.g., solid liquid separation) has been assumed in the absence of substantive data" (p. 3-72). Next is a quote addressing the technical risk involved with extensive separations: "The key implementability issue associated with this alternative is that the performance of key separations processes has been assumed in the absence of substantive data" (p. 3-85).

The two above quotes say exactly the same thing: There is no qualitative difference between the technical risk involved in intermediate separations and the technical risk involved in extensive separations. Extensive separations is a complex, essentially science fiction technology that has little chance of becoming practical for use on tank waste. It has not been utilized except on a laboratory scale. Intermediate separations, on the other hand, has been used in several places and is relatively simple. The key concern is whether intermediate separations will work on the scale that it must to be useful to the tank program. The list of concerns with extensive separations is almost as long as the TWRS EIS. The approach in the EIS is tantamount to saying that building a car that can go 250 miles per hour involves the same amount of technical risk as building one that can go 2,500 miles per hour.

The position of the Northwest's stakeholders on this issue is clear: The TWRS Task Force stated:

The high cost and uncertainty of high-tech pretreatment and R&D threatens funding for higher performance low-level waste form, vitrification, and cleanup. Use the most practicable, timely, available technology, while leaving room for future innovation. Keep a folio of technological options and make strategic investments over time to support a limited number of promising options. Give up further research on unlikely options.

The lack of honest, frank text concerning technical risk seriously misleads the public and decision makers and unfairly prejudices judgement on the separations issue.

Response In response to the issue of assessment of technical risk; the EIS discusses the ability to implement the alternatives to provide additional information to decision makers. The implementability of a remedial alternative is a function of its history of demonstrated performance and its ability to be constructed and operated. In the case of both the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives, there is no history of demonstrated performance on the Hanford tank wastes. Bench-scale testing is currently underway for the Ex Situ Intermediate Separations alternative. No testing is underway for the Ex Situ Extensive Separations alternative at the Hanford Site; however, a process that is similar to the Intermediate Separations alternative is being used on the tank wastes at the Savannah River Site. It would be premature to state that intermediate separations has been used in several places and is relatively simple, especially with the operation problems that have occurred at the Savannah River Site. To provide the engineering information required for the EIS, the engineering data packages for both alternatives (WHC 1995e and WHC 1995j) assumed the performance of key processes in the absence of substantive data, leading to the same essential statement in the EIS. The inclusion of both the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives is the result of providing a range of reasonable alternatives to the decision makers, and no change has been made to the EIS. DOE and Ecology believes that the uncertainties are expressed in an unbiased and accurate manner.

Regarding the issue of alternatives that should or should not be considered in the EIS, NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. This range of alternatives must include a No Action alternative, and may then include other reasonable alternatives to allow an analysis of a full range of alternatives. Among the four major categories of alternatives examined in the EIS was a category involving extensive retrieval of the wastes from the tanks. Following retrieval, the HLW is separated from the LAW. The degrees of separation of these two types of wastes may range from no separations, to intermediate separations, to extensive separations. For more information on how the EIS developed alternatives consistent with the recommendation of the Tank Waste Task Force, see the response to Comment numbers 0072.05 and 0038.05. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0055.09

Martin, Todd

Comment The EIS is somewhat inaccurate in addressing technical risk for pretreatment. If you look at the language addressing the intermediate separations essentially sludge washing which we have a pretty good idea of how to do and the extensive separations which I have often characterized as science-fiction technology, the language is almost identical. It basically says there is uncertainty here because these are first of the time processes. I agree with that but one is much more technically uncertain the extensive separations than the other and I think the EIS should reflect that.

Response Please refer to the response to Comment number 0036.13.

Comment Number 0072.117

CTUIR

Comment P 3-81: PP 2-5: the LAW form as described here, is not an acceptable form because it does not meet the regulatory criteria, and the process results in a waste form that is very susceptible to leaching of high activity components. This section also needs to be redone to assume a glass form as the final waste product.

Response The Ex Situ Extensive Separations alternative would meet the requirements for disposal of HLW and LLW. However, residuals left in tanks would not meet the water protection standards if additional closure is not performed. Closure is not included in the scope of this EIS; however, closure for the tanks and residuals would be addressed in a future closure plan. The EPA is considering a rule to further regulate LLW disposal facilities; and the final design of the onsite LAW disposal facility may be impacted by EPA rule 40 CFR 193. A discussion of the ability of each tank waste alternative to enable DOE to comply with Federal and State regulations is included in Volume One, Section 6.2. Specifics of the matrix material and waste form would be final design issues. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified LAW cullet form.

Please refer to the response to Comment numbers 0005.40, 0072.89, and 0072.107 for discussions of the cullet waste form and how cullet provides a basis for a conservative analysis of long-term impacts. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.118

CTUIR

Comment P 3-83: Sect. 3.4.8.4: Operation: The LAW description needs to be edited, removing the last two bullets.

Response Specifics of the matrix material and waste form would be final design issues; however, for the purposes of analyzing the ex situ alternatives in this EIS, LAW was assumed to be produced in vitrified cullet form. The referenced text correctly describes the operations involved in producing this type of waste form. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified LAW cullet form. Cullet would provide processing and material handling advantages for high-capacity processing facilities; however, cullet has a high surface area-to-volume ratio, which results in lower long-term performance. Assuming vitrified LAW in cullet form for all of the ex situ alternatives provides a conservative analysis of the long-term impacts resulting from onsite disposal of LAW. No change to Volume One, Section 3.4 is required.

For a discussion of regulatory requirements for onsite disposal of LAW please refer to the response to Comment number 0072.111.

Risks associated with retrievable disposal of LAW in vaults have been analyzed and these are presented in Volume Three, Appendix D.5. In addition, a Native American Scenario has been added to the Final EIS in Volume One, Section 5.11 and Appendix D.

Please refer to the response to Comment numbers 0005.40, 0012.11, 0072.11, 0035.04, 0052.01, 0072.89, 0072.107, and 0072.117 for related information. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.119

CTUIR

Comment P 3-84: Sect 3.4.8.5: Post Remediation: second and third paragraphs: these two paragraphs need to be removed because this EIS is a retrieval EIS and closure options are not within the scope. If closure options were within the scope of this EIS then the option would necessarily be clean closure and removal of the tanks, underlying soil contamination, ancillary equipment, and MUSTs as not to prejudice future options for closure.

Response Please refer to the response to Comment numbers 0072.08 and 0072.112.

Comment Number 0072.190

CTUIR

Comment P B-115: Sect. B.3.7: The definition of LAW indicates that there will be a HLW component. This is unacceptable in terms of long term risk.

Response Volume Two, Section B.3.7.1 describes the extent to which the treatment processes are used to separate HLW from the tanks waste. LAW is the waste remaining after removing as much of the radioactivity as practicable. The definition of LAW is provided in Volume One, Section 1.0, and tank waste classification (e.g., Class A, B, C) is addressed in more detail in Section 6.2. NRC Class A waste contains the least amount of radioactivity. Long-term risk has been analyzed for each of the alternatives and waste forms, and this is presented in Volume One, Section 5.11, and addressed in more detail in Volume Three, Appendix D.4.7. Because the information contained in the Draft EIS is correct, no change to the text was made.

For more information on LAW, LLW, and HLW definitions, please refer to the discussions contained in the response to Comment numbers 0072.100, 0072.111, 0072.117, and 0072.118.

Comment Number 0072.191

CTUIR

Comment P B-119: Fig. B.3.7.2: This figure, to be acceptable, should have LLW exchanged for LAW and interim on site storage exchanged for on site disposal.

Response Figure B.3.7.2 accurately depicts the process flow of the Ex Situ Extensive Separations alternative described in Volume Two, Appendix B, Section B.3.7. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.10 Ex Situ/In Situ Combination 1 Alternative

Comment Number 0005.09

Swanson, John L.

Comment The two combined ex situ/in situ alternatives discussed in the EIS speak of remediating a large fraction of the risk while remediating only a small fraction of the tanks. Such statements imply a knowledge of tank-by-tank inventory data that is much better than that given in the EIS. What data (or assumptions) were used for these alternatives? What accuracy do they have? Without evaluation of these factors, it is not possible to evaluate whether these combined alternatives are worth considering. Thus I feel that the current presentation of these combined alternatives is very biased in their favor.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The TWRS EIS addresses many potential criteria that could be used to develop a selection process and acknowledges that additional waste characterization and analysis would be required to implement this alternative (Volume Two, Appendix B, page B-127). Please also refer to the response to Comment number 0072.192. The data used for tank-by-tank analysis were based on SST and DST inventory data presented in summary form in Volume Two, Appendix A. DOE and Ecology believe that the existing historical data, laboratory data, and characterization reports, which provide the basis for the tank waste inventory used in the EIS, are adequate for detailed evaluation of impacts. The EIS acknowledges the uncertainties associated with the tank waste inventory, and accordingly uses a bounding approach to impacts assessment based on the available data.

The ex situ/in situ alternatives were developed to assess the impacts of combining two or more of the tank waste alternatives. Recognizing that tank waste differs greatly in the physical, chemical, and radiological characteristics, it may be appropriate to implement different alternatives for different tanks. These alternatives were developed to bound the impacts that could result from a combination of alternatives and are intended to represent a variety of potential alternative combinations that could be developed to remediate the tank waste. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the response to Comment number 0005.03 for a discussion of assumptions and uncertainty ranges used in the alternatives analyses.

Comment Number 0072.120

CTUIR

Comment P 3-86: Ex Situ/In Situ Combination Alternative: Technical staff agree that it may be necessary to implement an alternative treatment process for Tank wastes due to their varied contents, but the alternative of in situ treatment is unacceptable. The people of the CTUIR have been made involuntarily responsible for the waste DOE produced on CTUIR ceded land, and do not and should not, have to bear the responsibility of the enormous excess risk from in situ process. Therefore this alternative is unacceptable both in idea and in implementation.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. The Ex Situ/In Situ Combination alternative was developed to assess the impacts that would result if a combination of two or more of the tank waste alternatives were selected for implementation. Because the tank waste differs greatly in its characteristics, it may be appropriate to implement different alternatives for different tanks. The Ex Situ/In Situ Combination alternative represents a combination of the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives, and as such can be considered as one of the reasonable alternatives for evaluation. It is intended to represent a variety of potential alternative combinations that could be developed to remediate tank waste. Because this alternative is one of the full range of alternatives developed in the EIS, the document has not been changed. For the Final EIS, a second combination alternative that was presented in the Draft EIS, has been fully described and impacts have been analyzed. This alternative is described in Volume One, Section 3.4 and impacts of the alternative are described in Volume One, Section 5.0 and associated appendices.

Comment Number 0072.192

CTUIR

Comment P B-126: Sect. B.3.8: This alternative is unacceptable in that there is an illegal in situ component. Additionally the characterization process has not adequately justified that they know where 90 percent of the contaminants that contribute to long term risk are located, or how to get at them for treatment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The Ex Situ/In Situ Combination alternative was developed to represent a variety of potential alternative combinations that could be developed to remediate the tank waste. Existing uncertainty associated with the tank waste inventory data must be resolved and additional tank characterization is required before final design of any alternative. Please refer to the response to Comment number 0005.09. Several activities that involve collecting and analyzing data on tank contents are ongoing, including the Tank Characterization program. Data obtained from this program would be used for refining remediation process design. Please refer to the response to Comment numbers 0012.14 and 0072.07 for discussions on characterization of tank inventory. Volume Two, Appendix A,

Section A.3 and Volume Two, Appendix B, Section B.1 address tank inventory data and ongoing waste characterization programs, and Volume Three, Appendices D and Volume Four, Appendix E address anticipated risk and accidents. Volume Five, Appendix K addresses the uncertainties associated with human health risks associated with this and other alternatives.

L.3.4.11 Phased Implementation Alternative

Comment Number 0005.51

Swanson, John L.

Comment Page 3-94 says "Separations prior to LAW processing--." I believe that the word IMMOBILIZATION or VITRIFICATION should be substituted for the word PROCESSING.

Response The Phased Implementation alternative description has been revised as follows, "Separations prior to LAW immobilization would be performed to remove the cesium, strontium, technetium, TRU elements, and entrained sludge particles from the waste stream to the extent required to meet LAW product specifications."

Comment Number 0005.52

Swanson, John L.

Comment The first two paragraphs on page 3-99 appear to be "lifted" from a privatization write-up, in that they talk of what functions are to be performed by DOE. This EIS assumes that all the functions will be performed by DOE.

Response Volume One, Section 3.4 has been revised as follows for the Phased Implementation alternative, "The waste (mainly DST liquid waste) would be retrieved and transferred to receiver tanks for LAW treatment." The cited text in Volume One has been revised as follows, "Separated cesium and technetium radionuclides would be stored at the treatment facilities or packaged for interim onsite storage at the Canister Storage Building."

Comment Number 0005.53

Swanson, John L.

Comment On page 3-99 it is stated that Phase 2 sludge washing will be performed in-tank. Is that really the intent?

Response The text regarding sludge washing has been revised in Volume One, Section 3.4 to remove the reference to in-tank sludge washing.

Comment Number 0005.54

Swanson, John L.

Comment I do not understand how the Phased Implementation approach can have R&D costs of only $190,000,000 (page 3-100) when those costs are $820,000,000 (page 3-71) for the intermediate separations alternative, which involves fewer pretreatment steps. Can you explain this?

Response Because Phase 1 of the Phased Implementation alternative would be a demonstration process, the research and development cost for the treatment process was assumed to be part of the Phase 1 cost. Research and development cost associated with the waste retrieval and transfer function was included at the same level as the other ex situ alternatives. Development programs currently are ongoing at the Site that are covered under the TWRS program or under other programs.

Comment Number 0032.05

Heacock, Harold

Comment In regard to the Department's currently planned method of implementing this program which is based upon the privatization of the work performance, we are not addressing that issue at this time. However, we have previously supported the privatization concept in other statements.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Comment numbers 0032.06, 0043.04, and 0060.01 contain information concerning privatization and associated issues related to privatization.

Comment Number 0032.06

Heacock, Harold

Comment Funding of the privatization program through the proposed budgeting set-aside at the expense of other Hanford Site cleanup programs and the concurrent failure to meet all Tri-Party Agreement commitments is not acceptable.

Response Changes to the TWRS program were incorporated into the Phased Implementation alternative, as required by the proposed 1996 Tri-Party Agreement amendments; therefore, Phased Implementation would not deviate from the Tri-Party Agreement or any other applicable regulation. DOE and Ecology intend to comply with all Federal, State, and local regulations and ordinances applicable to tank waste remediation. Funding for privatization is outside the scope of the TWRS EIS. The response to Comment number 0043.04 contains a discussion of privatization issues.

Comment Number 0035.06

Martin, Todd

Comment More specifically, I do not trust the costs just in general in the EIS. For example, the EIS assumes that for about 250 million dollars, the DOE can build a 20-ton a day low-level vitrification facility.

Everybody who has been in Hanford circles for years remembers that the Hanford waste vitrification plant, a one to three metric ton a day facility was going to cost one point three billion dollars.

What does the EIS say DOE can build essentially the same facility now for? About 232 million, about one-fifth the cost.

In totality, in the preferred alternative for phase one the EIS says that the two 20-ton a day vitrification facilities, two pretreatment facilities tied onto the side, and one HLW vitrification facility, in total five facilities, can be built for about one point four billion.

Again, I refer back to the one relatively small vitrification facility that DOE said that it would take one point three billion to build. I say no way can DOE build these facilities for that cost.

Are these costs due to privatization savings? The answer to that is no. The EIS does not deal with privatization. It assumes that these are traditional DOE facilities.

Further, if these costs are actually correct, there is not a need for privatization. The privatization set-aside account that everybody has been wrangling over the last couple of months has more than enough money in it right now to start building these facilities and get on with cleanup.

Either these numbers need to be changed, or we need to switch paths and start building vitrification facilities.

Response Please refer to the response to Comment numbers 0055,06 and 0057.06 for a discussion of the approach used to develop the cost estimate for this alternative.

The HWVP capital cost estimate is not directly comparable to the capital cost estimated for the Phase 1 HLW facility because it includes support facilities and infrastructure that are estimated as separate components for Phased Implementation.

The cost estimating methodology has been reviewed and revised cost estimates have been completed for the Phased Implementation and combination alternatives. These revised costs are shown in Volume One, Section 3.4 and in Volume Two, Appendix B.

Comment Number 0035.07

Martin, Todd

Comment Just in my cursory look at some of the other costs in the EIS things jump out at me. For instance, in the preferred alternative, phase one, basically DOE has to retrieve about 36 tanks to vitrify in that phase.

How much does the EIS say this will cost? Zero dollars. Not a penny. I think there are some retrieval costs there. There must be.

Response During Phase 1, readily retrievable and well-characterized DST waste would be retrieved and transferred to two DSTs used as receiver tanks for the demonstration facilities. This retrieval effort was assumed to be accomplished by using the existing tank farm work force and infrastructure, in the same manner that wastes currently are transferred. The cost associated with DST waste retrieval during Phase 1 was assumed to fall within continued operations. Continued operations costs of $1.58 billion, including 10,000 person-years of labor, were included in the cost estimate for Phased Implementation. The Draft EIS also states that selected SST wastes could be processed during Phase 1. It was assumed that wastes retrieved under retrieval demonstrations (e.g., tank 106-C) could be transferred to the demonstration facilities. Because the cost associated with these retrieval demonstrations is included in other programs, it is not included in the estimate for Phase 1, but is accounted for in the estimate for continued operations of the tank farms. The cost involved would be small in comparison to the overall project costs.

The Phased Implementation alternative identified in the TWRS Draft EIS would produce, during Phase 1, approximately 11 percent of the total LAW volume. Waste retrieval would not be required from 36 tanks during Phase 1.

DOE and Ecology have reviewed and revised the cost estimates for the Phased Implementation alternative for the Final EIS. These revisions are shown in Volume One, Section 3.4 and Volume Two, Appendix B, and are reflected in the

Summary.

Comment Number 0036.03

HEAL

Comment The costs in the EIS are incredible and must be redone. The EIS should not be finalized until a formal, credible data package for the preferred alternative is completed.

The EIS assumes the following for Phase 1 of the preferred alternative:

1. The cost of a 100 metric ton per day vitrification facility is half the cost of a 200 ton per day facility. There is no engineering data to support this assumption. In fact, there is data to refute it. About 15 percent of the cost of a vitrification facility is dependent upon its throughput (the rate at which it makes glass). Therefore, the cost of a 100 metric ton per day facility would be less than a 200 ton per day facility -- but not much less -- and certainly not 50 percent less.
2. The "six tenths rule" is an engineering rule used for extrapolating the cost differences between chemical facilities of different sizes. The EIS uses this to determine the costs of vitrification facilities of different sizes. This is a wholly inappropriate use of the rule. Again, it applies for facilities where about 85 percent of the facility cost is dependent upon processing equipment -- primarily chemical facilities. Vitrification facilities only have about 15 percent of their cost dependent on processing equipment. Therefore, vitrification facility costs are not particularly sensitive to sizing differences -- which means use of the "six tenths rule" results in grossly underestimated costs.

These two assumptions have resulted in grossly underestimated costs for the preferred alternative. The EIS estimates the cost of the Phase 1 facilities as follows:

- A 20 metric ton per day LAW vitrification facility can be built for $248 million.
- A 1 ton per day HLW vitrification facility can be built for $232 million.

Comparing these numbers to much more rigorously developed cost estimates we can see exactly how far off the EIS's numbers are. The Hanford Waste Vitrification Plant, which was designed to produce between 1 and 3 tons per day of glass, was estimated to cost $1.3 billion. This is almost exactly the same facility that the EIS says DOE can build for $232 million.

The EIS claims that for Phase 1 the total capital cost will be $1.4 billion. In other words, DOE is going to build two 20 ton per day LAW vitrification facilities, a one ton a day HLW vitrification facility and two pretreatment facilities for about the same cost as the one ton per day Hanford Waste Vitrification Plant!

Response Please refer to the response to Comment numbers 0035.04, 0035.06, 0055.06, and 0057.06.

Comment Number 0036.04

HEAL

Comment If the costs in the EIS are indeed accurate, there is no need for privatization.

If DOE's cost estimates are accurate, there is no need to take the extra risks of privatization. All of DOE's cries that there is not enough money to build vitrification facilities are false. The money DOE is currently putting in a set aside fund for privatization is more than enough to build these vitrification facilities.

Response Phased Implementation approach reduces the technical risk associated with tank waste remediation over a full implementation alternative. Phased Implementation also provides a greater opportunity to reduce overall program costs by applying lessons learned and experience gained during Phase 1 to the design and construction of the full-scale Phase 2 treatment facilities. The cost estimates developed for the TWRS EIS were developed using common assumptions. The Phased Implementation alternative cost estimate assumed the same contracting strategy, government-owned and contractor operated, as the other alternatives. As discussed in Volume One, Section 3.3, the EIS does not address the contracting strategy that would be used to privatize tank waste remediation. Please refer to the response to Comment number 0043.04 for more information.

Comment Number 0036.05

HEAL

Comment A cursory review of the cost estimates identified many other problems. Following are just a few: The EIS assumes that tank farm operation costs will be the same for both the Phased Implementation and Ex Situ Intermediate Separations alternatives. This is a faulty assumption. The Intermediate Separations alternative would begin treating waste in 2004 at a relatively high rate, resulting in tanks being emptied. This would allow DOE to dramatically reduce its tank farm operation costs. The estimate for operations for Intermediate Separations is $8.6 billion.

The operations estimate for the Phased Implementation alternative is also $8.6 billion. It should be much higher. Phased Implementation will treat waste at a much slower rate than Intermediate Separations, requiring DOE to fund operations programs for a longer period of time and thus at a higher level.

Response A difference in the rate at which the cost declined for different rates of processing is expected. Many of the factors that would control the ongoing tank farm operations cost would be the monitoring and maintenance requirements and how these requirements were reduced for individual tanks and tank farms. The monitoring and maintenance requirements for a tank farm may not be appreciably lower until all of the tanks within that tank farm are empty. The tank retrieval sequencing and blending strategy, which have not been finalized, would identify when waste retrieval from individual tanks and tank farms would be complete.

Because of the conceptual level of development, it was assumed for the purposes of the TWRS EIS that continued tank farm operations cost for Phased Implementation would be the same as for the Ex Situ Intermediate Separations alternative. In fact, the difference between level funding and the annual reductions in operating cost associated with the Ex Situ Intermediate Separations alternative for the years 2004 through 2011 totals $141 million or approximately 1.6 percent of the total $8,600 million used in the TWRS EIS for continued tank farm operations.

DOE and Ecology have reviewed and revised the cost estimates appropriately for the Phased Implementation alternative. These revised cost estimates have been presented in the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B.

Comment Number 0036.06

HEAL

Comment To support the Tri-Party Agreement, DOE must retrieve waste from 36 tanks in Phase 1 of the Phased Implementation alternative. The EIS estimates that this will cost $0. Surely there is a cost associated with retrieving the high-level waste from 36 tanks.

HEAL finds the estimates in the EIS to be utterly devoid of credibility and insists that the EIS not be finalized until a credible, formal data package for the preferred alternative is completed.

Response Please refer to the response to Comment number 0035.07 which addresses a similarly worded comment.

Comment Number 0036.11

HEAL

Comment The EIS must require vitrification as technology for tank waste treatment.

For all alternatives, except the Phased Implementation alternative, the EIS assumes vitrification will be the immobilization technology. The EIS provides no rationale as to why this alternative does not also require vitrification. Given that it is the preferred alternative, this is even more disturbing.

Vitrification has been the technology that stakeholders have found acceptable. It balances the concerns for a safe waste form with a relatively available technology that allows DOE to "get on with it." Any changes to the assumed use of vitrification must be accompanied by a compelling argument outlining any emerging technologies that better respond to stakeholder values. HEAL has not seen such an argument, and strongly doubts that one could be made.

The TWRS privatization initiative, upon which the Phased Implementation alternative was designed, also fails to require vitrification as a technology. It appears that this EIS has been designed to "fit" the decision to not require glass as a waste form in the privatization Request for Proposals.

Response Please refer to the response to Comment number 0035.02 which addresses a similarly worded comment.

Comment Number 0036.15

HEAL

Comment EIS does not show any effects of privatization.

DOE has spent over a year in an unsuccessful attempt to sell its privatization plan to the public. Cost is one of the many concerns that the public has raised with DOE. DOE has consistently held that privatization would cost 30 percent less than a traditional approach. DOE has been unable to furnish the public with any information that supports the above assertion.

The EIS continues the information void concerning the benefits of privatization. The EIS refers to privatization in the description of the Phased Implementation alternative, "under Phased Implementation, either DOE or a private contractor would design, build, and operate ... (the facilities)" (p. 3-23). As was pointed out above, DOE has held that the differences between a traditional government-owned, contractor-operated approach, and the contractor-owned and operated privatization approach were "revolutionary." Yet the EIS fails to show the different impacts of this revolutionary approach. Worse, the EIS is not explicitly clear about which approach -- privatization or traditional GOCO -- is being analyzed.

The EIS does allude to how the cost estimates for Phased Implementation were reached. It was developed by, "... combining applicable components from other ex situ alternatives and applying rations as required to account for differences in facility sizes and capacities and the degree of separations in LLW and HLW" (p. 3-99). Engineering data in the TWRS program over the years has shown that facility capacity and size do not have a large impact on facility cost.

The cost savings that DOE claims are virtually guaranteed are not evident in the EIS. The Tri-Party Agreement case is estimated to be $30-41 billion and Phased Implementation $32-42 billion. Where are the savings?

Response The EIS addresses the potential environmental impacts associated with a Phased Implementation approach to tank waste remediation. It was assumed for cost estimating purposes that the Phased Implementation alternative would use the traditional government owned-contractor operated contracting strategy. This was done to allow the reader to make an equitable comparison among the alternatives. A potential exists to reduce the cost for tank waste remediation by allowing the market place to establish, through the competitive bidding process, the cost for waste treatment. Cost savings projections that might result from privatization are not included in the EIS in an effort to maintain the competitive bidding process.

The fact that privatization is not addressed in this EIS is discussed in Volume One, Section 3.3. DOE believes that privatization will result in an overall cost savings for the project but has not published an estimate of savings that may result. The 30 percent figure identified in the comment is reasonably consistent with the cost savings resulting from other activities the federal government has privatized. Privatization is not within the scope of the EIS. Please refer to the response to Comment numbers 0036.05, 0036.04, 0055.06, and 0057.06.

Comment Number 0037.05

Elredge, Maureen

Comment Mostly I am concerned with further cost estimates throughout the EIS. They seem to be questionable. And I am particularly concerned that the preferred alternative is widely perceived as a privatization alternative which is supposed to save money, and yet this is not made evident in the document.

I want to urge you to use extreme caution both in assuming that the preferred alternative will be cheaper, and even more so in assuming that a privatization scheme will be a success.

When the cleanup program was being pummeled in Congress and the media last year, privatization was held up as the Holy Grail, sort of along the lines of please give us another chance. We will bring in corporate America. They will fix everything. We will be fine. Please give us our money.

We do not need Holy Grails. We need progress. We need action on the ground now. If privatization efforts fail it will be a disaster not only for Hanford but for the entire cleanup program. Thank you.

Response Please refer to the response to Comment number 0036.15, which addresses a similarly worded comment.

Comment Number 0038.06

Reeves, Merilyn

Comment The Board is troubled by some aspects of the preferred alternative, and where the EIS has not considered the impacts of privatization as a contractor mechanism.

Response Please refer to the response to Comment numbers 0036.15, 0036.05, 0036.04, and 0057.06 for discussions related to this issue.

Comment Number 0038.07

Reeves, Merilyn

Comment The concerns the Board has voiced have to do with liability in privatization, budget, regulatory, logistics, and public participation issues.

The Board has been dubious of DOE's ability to privatize, and has been disappointed in DOE's lack of responsiveness to the Board's concern.

Response Because the issues identified in the comment are not within the scope of the EIS, no modification to the document is warranted. Please refer to the response to Comment numbers 0036.04, 0036.05, and 0036.15.

Comment Number 0038.08

Reeves, Merilyn

Comment In regard to the specific technical approach, the Board has not been adverse to Phased Implementation. DOE has not made a case for that, privatized or not.

Response The TWRS EIS does not address privatization. The Phased Implementation alternative is based on the same common assumptions as the other alternatives to ensure comparability of the environmental impacts. However, the Phased Implementation alternative does address the technical requirements of remediating tank waste with a phased approach and impacts associated with that approach. Please refer to the response to Comment numbers 0043.04 and

0035.15, for more information.

Comment Number 0038.09

Reeves, Merilyn

Comment Phased Implementation can save money over the course of the program. The Board does remain dubious that Phased Implementation will save money, and will likely be more expensive. Again, our main concern has been with DOE's particular program of privatization.

Response The costs estimates developed for the TWRS EIS were developed using the same basis for all alternatives. The Phased Implementation alternative represents the traditional government-owned contractor-operated contracting strategy as described in Volume One, Section 3.3. Please refer to the response to Comment number 0036.15 for more information.

Comment Number 0038.11

Reeves, Merilyn

Comment The Board is concerned by the preferred alternative's effect on the Tri-Party Agreement. The Board has been and remains a staunch supporter of the Tri-Party Agreement.

The Phased Implementation approach has resulted in an unfavorable impact to the Tri-Party Agreement. The Tank Waste Task Force stated the following about the Tri-Party Agreement, quote, Tri-Party Agreement is in need of strengthening and improvement.

The Tri-Party Agreement should increase meaningful public and tribal involvement in all key Tri-Party Agreement decisions, with the public and the tribes as a partner in the goals, scope, pace, and oversight of the cleanup.

The process of the goal in the site specific advisory board and ongoing oversight of the agreement and improving pubic involvement is essential to achieving successful and satisfactory cleanup.

And our Board is trying to carry on these traditions. As we stated earlier, amendment four to the Tri-Party Agreement was judged to be very responsive to the above concerns.

Unfortunately concurrence in yet to be completed negotiations that will once again change the Tri-Party Agreement are somewhat or may be seen to be reversing the progress made in amendment four.

The Tri-Party Agreement changes that are being made in order to support the Phased Implementation alternatives are very disconcerting. The Tri-Party Agreement will go from a long list of interim and long-term enforceable milestones to only a handful of milestones, many of them not enforceable.

The changes will not increase meaningful public involvement or really involve site specific boards, the Hanford Advisory Board, in ongoing oversight of the TWRS program. And this is a step in the wrong direction.

Response The amendments referenced in the comment were based upon the privatization initiative. The Phased Implementation alternative merely bounds the technical approach of staged remediation of the tank waste and analyzes the potential impacts to support a comparison among alternatives. DOE and Ecology are cognizant of the Hanford Advisory Board's concerns regarding the remediation schedule and stakeholder and Tribal Nation participation in decision making. DOE is committed to meeting milestone commitments in the agreement and to effective and meaningful public and Tribal Nation involvement in the cleanup of the Hanford Site. Please refer to the response to Comment number 0012.19 (public involvement), 0072.149 (Tribal Nations consultation), and 0043.04 (privatization relationship to the Tri-Party Agreement).

Comment Number 0055.08

Martin, Todd

Comment Secondly, I think that the chart that Carolyn showed that had to do with the technical uncertainty of the various options was misleading on Phased Implementation. The rationale is that the technical uncertainty for this alternative is low because we are starting small and we are building. We will be able to employ learning. I think that is a very subjective call and I do not buy it. That option includes pretreatment processes have never been done before. Technetium removal. That is not low on the technical uncertainty scale.

Response The phased approach allows information to be collected and analyzed concerning retrieval, separations, and vitrification technologies before constructing full-scale plants. Lessons learned from the demonstration phase would be applied to the full-scale phase, which should improve the efficiency of operations of the second phase. This may reduce construction and operating costs during the second phase. The process of building demonstration plants to verify that technologies function effectively before building full-scale plants is a standard practice used in many industries where new technologies are being used. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0057.02

Garfield, John

Comment With respect to the summary slide, Todd made this same comment, the high-waste complex separations and treatment processes involved uncertainties that will be reduced by implementing the phased approach. I concur with the basic finding of the EIS in terms of the alternative chosen, however, instead of emphasizing the need to demonstrate technology, the emphasis should be on spreading early capital dollars and using a single facility to accomplish the mission. That should be the emphasis more than demonstration. There is no technical justification for demonstration philosophy with this process. The functions of sludge washing, cesium removal, and vitrification are not unknown technologies and any uncertainty with them can be demonstrated either radioactively hot at a laboratory scale or at large-scale cold with simulants much more efficiently than two low-level demos and one high-level demo. That will set the program back 5 to 10 years treated under 5 percent of the waste and cost something on the order of $3 billion dollars. That is a waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The demonstration process provides the opportunity to reduce overall program costs while completing remediation of the tank wastes within Tri-Party Agreement requirements, especially considering the uncertainty associated with the tank waste inventory. The lessons learned and process knowledge gained during Phase 1 would be incorporated into the design and operation of the full-scale treatment facilities during Phase 2. Please refer to the response to Comment number 0055.08.

Comment Number 0068.02

Martin, Todd

Comment Further, another one that is very easy for anybody to understand is you look at the EIS, and you see in Phase 1 they need to retrieve and vitrify the waste from about 36 tanks. How much would that cost? How much would it cost to pump the nuclear waste out of this auditorium if it were full? According to the EIS, zero dollars. Won't cost a penny. Surely there's a cost there. But the EIS doesn't reflect it. Again, the costs need to be fixed.

Response Please refer to the response to Comment number 0035.07 which addresses a similarly worded comment.

Comment Number 0072.121

CTUIR

Comment P 3-92: Sect. 3.4.10: This alternative is unacceptable if the implementation consists of decommissioning any process that produces waste acceptable to the HLW permanent repository, the added push of continuing to operate the test facility will reduce the time it take to finish the job.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Decommissioning of facilities for this alternative is addressed in Volume One, Section 3.4.

Comment Number 0072.122

CTUIR

Comment P 3-92: Phase 1: The selection of the SST waste is an integral component and effort has to be taken that this section include language reflecting that waste from all SSTs be test reacted as to ensure complete acceptability.

Response The waste processed during Phase 1 could include selected SST waste. As explained in Volume One, Section 3.4, the retrieval and treatment of the remaining DST and SST waste will be completed in the following stages of the alternative (Phase 2) following completion of the demonstration phase (Phase 1). Before any waste is retrieved it would be characterized and analyzed to ensure compatibility. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.193

CTUIR

Comment P B-132: Sect. B.3.9: This alternative, while good for a conservative industry approach does not take into account the uncertainties associated with the characterization program. Unless the demonstration phase proved beyond a doubt it could handle waste forms from all the tanks.

Response Considerable uncertainty associated with the tank waste inventory data remains, and additional tank characterization is required before final design of any alternative. Please refer to the response to Comment numbers 0012.14, and 0072.07 for discussions of characterization of tank inventory and characterization in programs. Phase 1 of the Phased Implementation alternative would include technical evaluation, demonstration, and detailed design for the separations and immobilization processes for various categories of waste feed. Following the successful implementation of Phase 1, Phase 2 would be implemented to complete the tank waste remediation according to the technical approach most appropriate to the tank waste categories. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0088.05

Porter, Lynn

Comment One of my concerns about the preferred alternative and privatization is who decides when it's a success or not. Is this strictly going to be the DOE deciding, or will the Tri-Parties together decide on this? And there need to be enough milestones in this, spaced closely enough together that the public interest groups can track this and know whether it's succeeding or failing, whether it's on track where it should be. Because otherwise this could go on for years, and all of a sudden, as it has before, all of a sudden we find out hey it's not working and we have to start over.

Response Privatization is a contracting mechanism that is not within the scope of the EIS. DOE and Ecology have agreed on a set of criteria that will be used in making a decision on whether privatization is achieving its intended goals or failing, which would cause a change from the primary path to the alternate path. Under this agreement, should Ecology determine that compliance with the primary path is unlikely, it will inform DOE of such an opinion. DOE will respond within 30 days whether a change from the primary to the alternate path is necessary. If DOE determines that a change is not necessary, it will provide Ecology with a written rational for continuing with the primary path. Ecology will have the authority at any time to require DOE to evaluate the viability of the primary path. These activities will be among the issues routinely statused, discussed, and reviewed by the Hanford Advisory Board and its Health Safety and

Waste Management Committee. Additional review, input, and comment by Tribal Nation regulator and stakeholder representatives is encouraged. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

L.3.4.12 Ex Situ/In Situ Combination 2 Alternative

Comment Number 0005.05

Swanson, John L.

Comment As an example of some of my concerns related to (3) and (4), I cite the "last minute" addition of the "Variation of the Ex Situ/In Situ Combination alternative." I do not see that this is a bounding case at all, and I see no evidence that it is based on anything more than some assumed characterization data (perhaps on computer predictions based on a set of assumptions). Thus, I feel that you got carried away by even proposing this as a separate variation; wouldn't it be better to discuss it in the context of being in the "noise level" of the very uncertain characterization data on which I am assuming the original ex situ/in situ alternative was based? (I am assuming this because you do not tell me the source of the "currently available characterization data" that you are basing this on, and I am not aware of any sound data bank that would allow this alternative to be factually based). (See Comment 0005.09).

Response The variation of the Ex Situ/In Situ Combination alternative (known as the Ex Situ/ In Situ Combination 2 alternative in the Final EIS) referenced in the comment was added to provide a range of alternatives that includes a combination of the in situ and ex situ alternatives. Without this alternative, there would have been only one alternative to represent partial retrieval, and it is important to show the public and the decision makers the relationship between environmental impacts and the extent of retrieval. This alternative provides one more alternative on the continuum from no retrieval to minimal retrieval to partial retrieval to extensive retrieval.

The variation of the Ex Situ/In Situ Combination alternative presented in the TWRS Draft EIS was based on limited data analysis and was therefore included in a brief preface to the Draft EIS, which provided general information on the levels of impacts that would occur as a result of implementing the alternative. This alternative has been developed and analyzed to the same extent as the other alternatives in this Final EIS. The variation is known as Ex Situ/In Situ Combination 2 alternative in the Final EIS. The information is presented in Summary, Sections S.5, S.6, and S.7; in Volume One, Section 3.4, and throughout Section 5.0. More detailed information on the alternative may be found in Volume Two, Appendix B.

Comment Number 0012.08

ODOE

Comment The EIS includes an attachment which describes a variation of the Ex Situ/In Situ Combination alternative. This alternative was not analyzed in the EIS and should be excluded from consideration for that reason.

Response The variation of the Ex Situ/In Situ Combination alternative analyzed in the Draft EIS was identified very late in the process of preparing the Draft EIS. DOE and Ecology choose to include a brief summary of this alternative as an attachment to the EIS. This alternative has been fully developed and incorporated into the Final EIS. DOE and Ecology believe the Ex Situ/In Situ Combination 2 alternative provides another alternative between the no retrieval and extensive retrieval, and, as a result provides useful information to the public and decision makers. Please refer to the response to Comment number 0005.05 for more information.

Comment Number 0047.04

Ahouse, Lorretta

Comment I am very concerned that an "attachment variation of the Ex Situ/In Situ Combination alternative" was added at the last moment to the Draft EIS. As I understand, this alternative would only remove 26 percent of the total tank waste volume and would not meet the Tri-Party Agreement. This is not acceptable to me as a citizen of

Washington State. Why was this alternative even added so late in the process if its does not meet the Tri-Party Agreement? Does the Department of Energy have any plans to seek an exemption from the Tri-Party Agreement? Why are we wasting taxpayers dollars to examine alternatives that are not legally acceptable? Please, just get on with the cleanup.

Response Please refer to the response to Comment numbers 0005.05 and 0012.08 which address similarity worded comments. Please refer to the response to Comment number 0072.80 for a discussion of the NEPA requirement to analyze reasonable alternatives, even when they do not comply with regulations. In the Final EIS the Summary, Section S.7 and Volume One, Section 6.2 address the ability of the alternative to comply with Federal and State regulations and the Tri-Party Agreement.

L.3.4.13 Miscellaneous

Comment Number 0005.11

Swanson, John L.

Comment I am quite sure that the alternatives involving in situ disposal will require more extensive/costly characterization activities than the other alternatives, but I do not see that reflected in the cost comparisons. Isn't that a bias in their favor? (I learned at the May 2 hearing that characterization is not included in this EIS, but my statement re biasing of comparisons stands. Also, shouldn't the omission of characterization from this EIS be highlighted, along with the omission of closure, so that it will be clear how limited in scope this EIS really is?)

Response Additional characterization requirements for in situ alternatives have been considered. Volume One, Section 3.4 acknowledges that additional characterization would be required for the in situ alternatives have been considered. The cost estimates completed in support of the Draft EIS included an additional $903 million for the in situ alternatives to cover additional characterization activities. These cost estimates are available for review in the TWRS EIS Administrative Record and DOE Reading Rooms and Information Repositories The relationship between closure and the alternative is presented in the Summary and Volume One, Section 3.3 and the impact in Section 5.0. For a discussion of the closure issues, please refer to response to Comment numbers 0072.08, 0101.06, and 0072.50.

Comment Number 0035.09

Martin, Todd

Comment Lastly, I would like to address the issue of mortgage reduction. This is something at Hanford that we have been dealing with for two years.

It has been a very high priority, and it has to do with putting money into old facilities for the purpose of closing them down in such a way that we could free that money up for real cleanup.

The tanks are the greatest mortgage reduction opportunity at Hanford we have. If we get the waste out of the tanks, we will reduce the budget by, as Dick said, about 300 million dollars. It is time to get on with it. It is time to do the job.

Response Cost associated with continued monitoring and maintenance activities at the tank farms would be reduced as the number of tanks containing waste was reduced. Remediation of Hanford tank waste is a needed investment to environmental well-being of the Hanford area and is required to protect human health and the environment.

L.3.5 CESIUM AND STRONTIUM CAPSULE ALTERNATIVES

L.3.5.1 Preferences for Capsule Alternatives

<u>L.3.5.1.1 Specific Preferences</u>

Comment Number 0006.01

Skyes, Megan

Comment As a scientist involved in biomedical research in the area of bone marrow transplantation, I am writing to express my support for the production of Cs-137 sources at the Hanford Reservation. It is my understanding that this is the only world producer of large Cs-137 sources other than the Russian laboratories at Mayak. In view of the high prices of Cs-137 sources that results from the existing monopoly, it will be nearly impossible to purchase sources in the future, as funding for biomedical research is becoming more and more limited. Therefore, the production of Cs-137 sources (at a lower cost) would be a major benefit to the biomedical research community. There are numerous other investigators, not only in the field of bone marrow transplantation, but in immunology who are dependent upon the availability of these irradiators in order to carry out their research. I hope that it will be possible for the Department of Energy to deal with the existing Cs-137 at Hanford in a cost-effective manner and in so doing to serve a vital need for the medical research community.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. For the Final EIS, DOE has identified the No Action alternative as the preferred alternative and has modified the Summary Volume One, Section 1.3 accordingly.

The TWRS EIS addresses alternatives for management and disposal of encapsulated cesium and strontium. The encapsulated cesium and strontium are included in the EIS primarily because they were originally extracted from the stored high-level tank waste to reduce the thermal heat generation in the tanks and would be considered HLW for purposes of disposal. DOE is actively seeking commercial interest in the beneficial applications for the encapsulated cesium and strontium, and DOE remains committed to pursuing any viable commercial or other beneficial uses; at this time, the preferred alternative is No Action. These uses would not be without substantial cost for reprocessing and repackaging since the current encapsulation was designed principally for storage purposes. If viable commercial or beneficial uses are not implemented, the capsules would be designated as waste at some point in the future and would be disposed of using methods consistent with one of the alternatives identified in the EIS or a new NEPA analysis would be completed. Under no action, the capsules will be stored and maintained under current operations at the WESF, which includes a comprehensive monitoring program. This program is described in Volume One, Section 3.2.

Comment Number 0008.03

Evett, Donald E.

Comment Secondly, S.5.2 Cesium and Strontium Capsule Alternatives: I personally would prefer to select alternative (4) physically mixing the capsule contents with the high-level tank waste, which would then be vitrified and disposed of at a potential geologic repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium waste and strontium capsules.

Comment Number 0029.02

Bartholomew, Dale C.

Comment I believe that cesium capsules should be left in a condition for possible future commercial irradiation. At the public hearing on May 2, 1996, we were advised that only one capsule leaked, but no one at the hearing was able to identify the mode of failure. If the mode of failure was a bad weld, I believe that it is premature to dispose of all capsules, because there still may still be some interest in commercial irradiation. It would be imprudent to waste all of the previous time, effort, and cost that went into the separation and concentration of the cesium-137 and strontium-90 isotopes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. For the

Final EIS, DOE has identified the No Action alternative as the preferred alternative and has modified the Summary and Volume One, Section 1.3 accordingly. Please refer to the response to Comment number 0006.01.

Comment Number 0032.07

Heacock, Harold

Comment A secondary issue addressed in the Draft EIS is the disposal of the cesium and strontium capsules currently stored in the WESF facility at the B Plant.

We believe that any action to dispose of the capsules should be deferred at this time, so long as an adequate degree of environmental protection is maintained in their storage.

These capsules represent a resource that may have significant future use in irradiation programs. Pending the determination of their potential future utilization, we believe this potential asset should be retained.

This position is consistent with the Draft EIS since the high-level waste ex situ vitrification plant operation is at least 10 years away.

Ultimate disposal of these capsules with the other high-level waste is the preferred solution to the disposal of the capsules.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0040.05

Rogers, Gordon J.

Comment The cesium and strontium capsules should be transferred into air-cooled storage in the facility now being built for the Spent Nuclear Fuel project. In the meantime serious efforts should be made to see if there is a market for commercial use as radiation sources. Permanent disposal plans can wait.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0043.05

Hanford Communities

Comment The Hanford Communities would also like to comment on the plans for disposition of the cesium and strontium capsules currently stored in the B Plant. We believe that any action to dispose of the capsules should be deferred at this time. These capsules represent a resource that may have significant value. Rather than pay to dispose of these materials, the Department should actively explore opportunities for commercial use and sale.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

L.3.5.1.2 General Preferences

Comment Number 0012.13

ODOE

Comment The second issue addressed by the EIS is what to do with the cesium and strontium capsules stored at Hanford. The cesium capsules contain cesium-135 and cesium-137. These two isotopes present different hazards. Cesium is very soluble in water. Cesium-135 has a long half-life. If it is disposed at Hanford, it presents an unacceptably large risk to public safety and health and the environment. Oregon supports disposal of the cesium and strontium from capsules in a suitable form to the national high-level nuclear waste repository. The waste form selected should ensure that cesium-135 will not endanger public health and safety or the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0060.05

Davenport, Leslie C.

Comment I do not feel that a final choice can be made between the proposed alternatives yet. The No Action alternative of continued storage in WESF is acceptable during the next 10 years while DOE selects an alternate storage method for the capsules or determines if there is a use for them. I do not like the Onsite Disposal alternative because I feel that the capsules, if discarded, belong in the proposed geologic repository. Similarly, it makes little difference other than cost if the capsules are Overpacked and Shipped, or Vitrified with Tank Waste if a HLW vitrification facility is operational at Hanford.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0089.02

Nez Perce Tribe ERWM

Comment ERWM endorses the Overpack and Ship alternative for the strontium and cesium capsules.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

L.3.5.2 No Action Alternative (Capsules)

No comments were submitted for this topic.

L.3.5.3 Onsite Disposal Alternative

No comments were submitted for this topic.

L.3.5.4 Overpack and Ship Alternative

No comments were submitted for this topic.

L.3.5.5 Vitrify with Tank Waste Alternative

No comments were submitted for this topic.

L.3.6 BORROW SITE SUMMARY

Comment Number 0019.03

WDFW

Comment WDFW is concerned by stating specific (potential) borrow sites in this document future decisions will be steered by the mentioning of such locations now. Statements are made in this document without the word "potential" even mentioned. Example, section B.6.1, paragraph discussing first and second layers, last sentence, which states "The proposed topsoil would be obtained from the McGee Ranch quarry site of the Hanford Site." This document appears to be trying to steer future decisions prior to exploring alternatives for borrow sites.

Throughout the document, the author states "future NEPA documentation will specifically address in detail impacts and mitigation of post-remediation tank closure where, for example most impacts of borrow site activities would occur" (page 5-258). The summary states "The impacts of closure cannot be meaningfully evaluated at this time. U.S. Department of Energy (USDOE) will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future." Since a meaningful analysis of impacts to potential borrow sites for post-remediation activities is not being undertaken by this EIS, WDFW requests all references to potential post-remediation borrow sites be deleted from the document (i.e., figures, tables, and text).

Response The TWRS EIS frequently states that the final selection for the borrow sites must be evaluated in the document for waste site and tank farm closure. The Summary states that, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future." This question was also contained within the Notice of Intent to prepare the TWRS EIS.

Volume One, Section 3.6, states that, "The final selection of borrow sites for earthen material has not been made; however, the locations indicated represent potential borrow sites that would support each of the alternatives in both volume and location. Future borrow site decisions will be made in the ROD for the Hanford Remedial Action EIS."

Volume One, Section 4.5, states that, "The potential Vernita Quarry and McGee Ranch borrow sites have potential for both historic and prehistoric materials. Surveys have identified prehistoric or historic sites at both Vernita and McGee Ranch. The McGee Ranch area has been determined to be eligible for nomination to the National Register of Historic Places as the McGee Ranch/Cold Creek District. No prehistoric sites are known at the potential Pit 30 borrow site, although one structure from the homestead era is located at Pit 30." These statements are reiterated in Section 5.5 where it is stated that, "Archaeological surveys of the three potential borrow sites have identified a variety of prehistoric or historic artifacts and sites at the Vernita Quarry and McGee Ranch. The likelihood of disturbing additional archaeological sites in these areas is considered high." In addition, the archaeological importance of historic and prehistoric sites is reiterated in Volume One, Sections 5.5.1, 5.5.2, and 5.5.3.

Volume One, Section 5.17 identifies the potential Vernita Quarry and McGee Ranch borrow sites as undeveloped areas on the Hanford Site Development Plan's Future Land-Use Map. Further, using the potential Vernita Quarry site would involve expanding an existing quarry, while using the potential McGee Ranch borrow site would essentially be a newly developed site (though a small, old borrow area does exist). It is further stated that, "Planning for possible borrow sites for the TWRS program is still in its early stages and the CLUP and Hanford Remedial Action EIS address future land uses for the Site as a whole." Section 5.5.3 explains that any disturbance of the land surface, such as would occur in borrow site activity, is not compatible with the relationship between the Native Americans and the land.

Volume One, Section 5.20.1 states that, "Although much of the area proposed for the remedial activities is in areas currently disturbed, activities in some areas [primarily the Vernita and McGee Ranch borrow sites] have the potential to impact historic, prehistoric, or cultural sites. These areas have not been fully surveyed because they are potential borrow sites subject to change during final design. The final selection of borrow sites would be made through the Site Comprehensive Land Use Plan."

The discussion of alternatives uses these borrow sites as example locations for the materials that may be required for closure. Certainly, gravel and sand sources are required for construction of the facilities required for the various alternatives. In WHC-SD-WM-EV-103 and WHC-SD-WM-EV-104, Tables 6-12 and 9-12, respectively, state the assumption that an onsite gravel plant would provide crushed aggregate for concrete construction at a location 5 kilometers (km) (3 miles [mi]) from the construction site, the potential borrow site known as Pit 30.

Considering the earlier discussion, which states that the decisions for the borrow sites will be made elsewhere, that the prehistoric, historic, and cultural significance must be thoroughly evaluated, and the undeveloped status given to portions of the area land relationship with the Native Americans, DOE and Ecology do not believe that including these potential borrow sites alternatives for borrow sites. Using these named potential borrow sites provides only a basis to more completely discuss the potential impact of each of the alternatives covered in the TWRS Final EIS in terms of potential for traffic accidents with distance traveled, construction and operation emissions to the environment, a comparison between the alternatives, and an interrelated closure discussion for each of the various alternatives.

Comment Number 0019.07

WDFW

Comment Page 3-116, Tables 3.6.1, 3.6.2, and 3.6.3 If I were to open this EIS to this page, I would conclude from the titles of thee tables that a decision has been made on borrow site locations when in fact this document does not perform adequate NEPA analysis, i.e., a range of alternatives, for sources of different material types needed. WDFW requests all references to borrow site locations be deleted from the document since the impacts to borrow sites will require NEPA review.

Response Please refer to the response to Comment numbers 0019.03, 0072.08, and 0101.06. The EIS has been reviewed and revised as appropriate to clarify the assumed borrow sites as "potential" sites.

Comment Number 0072.123

CTUIR

Comment P 3-116: Tables 3.6.2. and 3.6.3.: These tables present figures that are for closure options. Because this EIS is a RETRIEVAL EIS, the tables are inappropriate and should be removed, or all of the closure options be equally presented.

Response The tables identified in the comment represent borrow materials required for the assumed closure scenario presented in the EIS. For more information on the closure assumption, please refer to the response to Comment numbers 0072.08 and 0019.03. As identified in the Draft EIS in Volume One, Section 3.3 closure is not within the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. The amount and type of waste that remains in the tanks after remediation also may affect closure decisions. Closure as a landfill was included in all of the alternatives except the No Action and Long-Term Management alternatives so the alternatives could be meaningfully compared. This does not mean that closure as a landfill has been proposed or would be selected for final tank closure. Because the information contained in the Draft EIS is correct, no change to the text was made.

L.3.7 COMPARISON OF ACTIVITIES ASSOCIATED WITH ALTERNATIVES

Comment Number 0005.15

Swanson, John L.

Comment I find it strange that system costs is the only metric included in the summary description of each alternative in Section 3.0 ("Description and Comparison of Alternatives"). People are certainly interested in the costs, but the major concern on the part of the public appears to me to be in the perceived risk to their health and well-being. Couldn't/shouldn't summary data of some sort in that area be included in this section along with the cost data? If this is not done, I feel that you should change the title of this section to "Description and COST Comparison of Alternatives."

Response Volume One, Section 3.0 provides a description and comparison of the alternatives based on the characteristics of the alternatives themselves. These characteristics include cost. However, the section also provides a comparison of the processes inherent to each alternative; construction, operations, and post-remediation features of each alternative; the schedule, sequence of activities, and costs of each alternative; the amount of waste to be retrieved from the tanks, treated, and disposed of onsite verses offsite for each alternative. The potential environmental impacts associated with each of the alternatives are presented in Volume One, Section 5.0. In Volume One, Section 5.14, a summary table is provided that lists each alternative and all of the associated impacts as presented in Section 5.0. Additionally, a summary of those impacts was presented in the TWRS EIS Summary, Section S.7, which was prepared to accompany the EIS or to be read separately by individuals who did not want to read the entire EIS. The level of data and summarization of the data, as well as the presentation of the data and summary information provided the public and decision makers with the appropriate level of information in a format that was accessible considering the complexity of the proposed action and associated impacts. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0005.55

Swanson, John L.

Comment Why is the number of HLW shipments required for the Extensive Separations alternative ~50 percent as large as that for the Intermediate Separations alternative (page 5-146), when the ratio of the number of canisters is only ~10 percent as large?

Response The average rail trips per year calculated and reported in Volume One, Section 5.10, Trail Traffic Volumes, for the number of canisters generated as result of the Ex Situ Extensive Separations alternative has been modified in the Final EIS.

L.3.8 ALTERNATIVE CONSIDERED BUT DISMISSED

No comments were submitted for this topic.

L.3.9 MISCELLANEOUS

Comment Number 0005.59

Swanson, John L.

Comment Page vii of Volume Two contains incorrect definitions/descriptions of B Plant and T Plant.

Response According to two references, Hanford Tank Clean Up: A Guide to Understanding the Technical Issues (Gephart-Lundgren 1996), The Hanford Site: An Anthology of Early Histories (Gerber 1993), and T Plant (DOE 1994l), T Plant and B Plant were both constructed as plutonium removal facilities. Both facilities used the bismuth phosphate separation process. In later years, B Plant was used to remove cesium and strontium from acid waste pumped from the Plutonium-Uranium Extraction (PUREX) Plant. T Plant is currently used as a decontamination and repair facility. According to DOE 1994l, these plants, along with Z and U plants, for example, were given alphanumeric names due to 1940's wartime secrecy. These descriptions are provided in the Volume One Glossary. B Plant and T Plant were deleted from the Acronyms and Abbreviations list in Volume Two, Appendix B.

Comment Number 0005.60

Swanson, John L.

Comment On page B-9, an incorrect date is given for the start of the PUREX plant.

Response According to two references, Hanford Tank Clean up: A Guide to Understanding the Technical Issues (PNL 1996) and The Hanford Site: An Anthology of Early Histories (WHC 1992), the correct date for the PUREX Plant hot start up was January 1956. All applicable, incorrect references have been revised.

Comment Number 0022.04

Sims, Lynn

Comment There is no argument that Cold War Clean Up is extremely expensive. But inadequate clean up will be more expensive. Choosing less expensive options now will probably result in contaminated soils and water, serious loss of quality of life and health and perhaps loss of land use, trade, and commerce. Our costs now are a result of military production. Perhaps military clean up should be built in up front in the military budget since that is the department which seems to receive more funds than requested while DOE monitoring and clean up funds are slashed.

Finally, it must always be of paramount importance to remember that bomb production was implemented to protect this nation and that to skimp on efforts to clean up puts our homeland at serous risk forever.

Response Comment noted.

Comment Number 0025.01

Heart of America

Comment *A public interest group distributed a questionnaire at the Spokane and Seattle, Washington public meetings. Listed below are the questions and a tally of the totals from the 33 individuals who submitted surveys. The agency responses follow after the summary of the questionnaire. Below each question in bold is the ranking system contained in the questionnaire (using a scale of 1 to 10). In parenthesis following the rank are the number of individuals who circled the number on this questionnaire.*

Please tell us the degree to which you agree or disagree with the following proposals for Hanford's high-level nuclear wastes on a scale from one to ten with #1 being Strongly Disagree; #5 No Opinion; and #10 being Strongly Agree.

1. The current Tri-Party Agreement calls for retrieving 99 percent of the wastes from all of Hanford's high-level nuclear waste tanks by the year 2028 and turning it into some form of glass (vitrification). To what degree do you agree/disagree with the Tri-Party Agreement?

Rank: 1 (3) **2** (1) **3** (1) **4 5 6** (1) **7** (1) **8** (8) **9** (3) **10** (14) . **N/**A (2)

2. Leaving 75 percent of the high-level nuclear waste in the tanks forever, and filling them with cement or gravel after removing the most radioactive 25 percent would cost less than retrieving and vitrifying 99 percent of the waste. This is the Ex Situ/In Situ Combination alternative.

a. The cost savings claimed by USDOE for this option justify leaving most of the high-level nuclear waste in the tanks:

Rank: 1 (23) **2** (1) **3** (3) **4** (1) **5 6 7** (1) **8** (2) **9** (1) **10** (2)

b. USDOE has fully considered in the EIS the evidence that waste from tank leaks is moving towards groundwater and the risks this may pose to the Columbia River and future exposed populations from this alternative:

Rank: 1 (18) **2** (1) **3 4 5** (2) **6 7** (4) **8** (2) **9** (2) **10** (1) **N/**A (4)

c. Any alternative that leaves high-level nuclear waste in the tanks and in the soil beneath the tanks poses an unacceptable risk to the Columbia River and future generations.

Rank: 1 (1) **2 3** (1) **4 5 6 7 8** (2) **9** (3) **10** (27)

d. For the same reasons that the public voted in 1986 against Hanford being an underground high-level nuclear waste dump, leaving high-level nuclear waste in tanks or threatening groundwater is NOT acceptable:

Rank: 1 (2) **2 3** (1) **4 5 6 7 8** (4) **9** (2) **10** (25)

3. USDOE's Tank Waste Task Force (public interest groups, local governments, Tribes,...) urged USDOE to base decisions assuming that the wastes, after being vitrified, will stay at Hanford for a very long time, and not to assume USDOE will move the waste to its proposed Yucca Mountain repository. Do you agree/disagree with the advice:

Rank: 1 (6) **2** (1) **3** (2) **4 5** (5) **6 7 8** (1) **9** (7) **10** (11) **N**/A (1)

4. a. USDOE should use conservative assumptions that tank leaks move down to groundwater in less than 40 years, instead of claiming that leaks will stay close to the tanks and not reach groundwater for over 100 years:

Rank: 1 (1) **2** (1) **3** (1) **4** (1) **5** (1) **6** (1) **7 8** (3) **9** (2) **10** (23)

b. Because this EIS assumes tank leaks do not move quickly to groundwater, the EIS wrongly creates a bias in favor of delaying retrieval of all wastes from leaking single-shell tanks:

Rank: 1 (3) **2** (1) **3 4 5** (2) **6 7** (3) **8** (3) **9 10** (22)

5. a. Should the EIS drop (not include) the "repository fee" in its presentation of costs and as a basis for decision making?

Rank: Yes (22) **No** (12)

b. Does the inclusion of the repository costs appear to have biased the consideration of alternatives, including how one would weigh each alternative's risk versus costs?

Rank: Yes (26) **No** (4) **N**/A (3)

c. If the cost of the No Separations alternative (make all the waste into glass logs) were in the same price range as other alternatives when the hypothetical repository fee was not added onto it, would you urge that it be considered as a reasonable alternative to building multiple vitrification and separations plants:

Rank: Yes (19) **No** (10) **N**/A (5)

Response

Comment item number 1: Please refer to the response to Comment numbers 0047.03 and 0009.01.

Comment item number 2a: Please refer to the response to Comment number 0072.05.

Comment item number 2b: Please refer to the response to Comment number 0012.15.

Comment item number 2c: Please refer to the response to Comment number 0072.08.

Comment item number 2d: Please refer to the response to Comment numbers 0072.08, 0072.100, and 0072.111.

Comment item number 3: Please refer to the response to Comment numbers 0081.02.

Comment item number 4a: Please refer to the response to Comment numbers 0012.15 and 0030.02.

Comment item number 4b: Please refer to the response to Comment numbers 0012.15 and 0030.02.

Comment item number 5a: Please refer to the response to Comment numbers 0081.02 and 0004.01.

Comment item number 5b: Please refer to the response to Comment numbers 0081.02 and 0004.01.

Comment item number 5c: DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0081.01 and 0004.01.

Comment Number 0027.03

Roecker, John H.

Comment Systems Engineering

In 1993 DOE proudly and loudly stated that it was going to use systems engineering to establish the requirements for both TWRS and also the Hanford Site. To my knowledge that has not been done in either case, yet here we are reviewing the EIS for implementing a very specific TWRS action. Looks to me as if the systems engineering commitment lasted about as long as the January 1994 Tri-Party Agreement. Two fundamental systems engineering actions are required to correct this situation. First, a top down requirements allocation from the site level to the program level is needed. Secondly, the TWRS Functions and Requirements Document, along with an integrated alternatives systems analysis, must be finalized and issued. I would request that issuance of the Final TWRS EIS be deferred until such systems engineering and analysis has been completed. Without such one cannot be sure that the right work is being performed or that the best alternative has been selected.

Response Since 1993, two systems engineering documents, TWRS Functions and Requirements (DOE/RL-92-60) and TWRS Systems Engineering Management Plan (DOE/RL-93-106) have been prepared. DOE conducted an independent Systems Requirements Review (SRR), submitted in November 1994, to validate the TWRS Functional Requirements Baseline. The SRR evaluated selected representative TWRS activities and identified the need for improvement in the implementation of systems engineering, quality of supporting documentation, and timeliness of testing assumed solutions and competitive alternatives. In response to the SRR, the TWRS System Requirements Review Action Plan (DOE/RL-95-74) was prepared, which addressed the findings presented in the SRR and presented the methodology for revising the Functional Requirements Baseline and developing the infrastructure required to support the functional requirements. Because the EIS and the TWRS Functions and Requirements have been developed concurrently, the conclusions of the TWRS Functional Requirements are anticipated to be consistent with the recommended alternative presented in the Final EIS. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives. Please refer to the response to Comment number 0101.07 for further discussion of systems engineering.

Comment Number 0027.04

Roecker, John H.

Comment Technical Balance

I wish I was more interested in the projected cost of housing in the Tri-Cities in the year 2040 because there sure is plenty of computer printout data on that and other similar items, but I am just not. Instead, I would like to see more of the technical data that supports such items as operating efficiency, number of canisters, process design, alternative costs, etc. I would like to request that the reams of computer printout data and modeling contained in the appendices be restrained a little and more of the basic technical data that really establishes how an alternative is going to perform be put into the EIS.

Response The technical data that support the areas of interest indicated (i.e., operating efficiency, number of canisters, process design, and alternative costs) are contained in the TWRS Administrative Record and are available for review. The data to support the performance capability of the recommended alternative will be contained in the detailed design document for that alternative, which will be prepared following the Final EIS. The evaluation criteria used in the EIS are defined by NEPA and are confined to impacts to the environment only. As such, the requested evaluation of alternative performance data is beyond the scope of this EIS, but will be contained in future documents.

Comment Number 0027.06

Roecker, John H.

Comment Use of Non-Optimized Alternatives

The alternatives described in the EIS represent first cut approaches and do not represent optimized alternatives that have been tuned utilizing good engineering principles. More recent optimized process design flowsheet and facility design data is available and should be used in the Final EIS. This optimized design will significantly reduce the estimated cost.

Response The purpose of the EIS is to examine bounding alternatives, including a No Action alternative. It is anticipated that the optimized process design flowsheet will be used during the detailed design of the waste retrieval, transfer, treatment, and storage facilities conducted during the demonstration phase of the preferred alternative. The TWRS baseline flowsheet is continually updated and optimized. In order to support the EIS schedule, the baseline data used for development of the Draft EIS was frozen in May 1995. NEPA requires the alternatives be compared on an equitable basis. The Draft EIS presents conceptual alternatives that were developed using common bases that allow equitable comparison. Please refer to the response to Comment number 0072.05.

Comment Number 0027.08

Roecker, John H.

Comment Cost Estimates

In this day of tight budgets the cost estimate for an alternative is a very critical item. It is impossible to understand the basis for any of the cost estimates with the information contained within the EIS itself. It is necessary to look up several reference documents. This is not the easiest task if you do not live in the Tri-Cities. It would be helpful if the backup information for the life cycle cost estimates could be included in an appendix. There are several of the existing appendices that could be greatly reduced to make room for this information. As an example, the over 50 pages devoted to socioeconomic impact could be reduced to approximately 10 pages. The endless tables representing computer modeling printout could be put in a reference document.

Response As stated in Volume One, Section 1.0, the EIS fulfills the requirement for an analysis of potential environmental impacts in the decision-making process. NEPA and The Washington State Environmental Policy Act (SEPA) provide decision makers with an analysis of environmental impacts (both positive and negative) of proposed actions for consideration during decision making. This EIS presents the impacts of the proposed action and its reasonable alternatives for review and comment by the public and interested parties. Because of the magnitude of the cost required to implement any of the alternatives, it was determined that cost estimates would be included in the EIS. The development and presentation of alternative cost estimates is not the primary purpose or major focus of an EIS. The development of bounding alternatives for the EIS would indicate the need to develop additional cost data for the decision-making process.

The technical data used to develop the alternatives presented in the EIS are contained in the TWRS EIS Administrative Record and DOE Reading Rooms and Information Repositories. The Administrative Record contains additional cost estimate detail. As indicated in the front of Volume One, EIS technical reports, background data, materials incorporated by reference, and other related documents are available at Seattle, Spokane, and Richland, Washington; Portland, Oregon; and Washington, D.C.

The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0027.09

Roecker, John H.

Comment My understanding of the capital cost estimates for the down sized facilities in the combination and Phased Implementation alternatives is that the sixth-tenths power rule was used. That is an absolute error. The sixth-tenth power rule does not work for these types of facilities. These facilities have a significant portion of their capital cost attributable to basic facility systems which are essentially independent of facility size. The sixth-tenth power rule works for facilities in which processing equipment makes up most of the capital cost. That is not the case with these waste processing facilities. That is something that must be fixed in the Final EIS. Conceptual cost estimates for the size facilities included in the EIS have been made. Why not use the available existing data which has backup rather than include erroneous data?

Response The cost estimating methodology has been reviewed for the Final EIS and revised cost estimates were completed for the Phased Implementation and combination alternatives. These revised costs are shown in Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to the response to Comment numbers 0055.06, 0057.06, and 0035.06.

Comment Number 0030.01

Krieg, Ronald K.

Comment I am also disappointed in the limited scope that the inclusion of subsurface barrier technology in this Draft EIS was only as a potentially viable component to remediation alternatives, and am dissatisfied in Appendix B's level of analysis and conclusions of subsurface barrier technology. My other areas of concern involve the focus being on future impacts and conditions of alternatives alone with no regard to current or past practices. If the DOE is to develop a systematic approach to actually solving some problems in a truly cost effective manner with the least environmental impact, all aspects and pertinent details of all alternatives should be included in this EIS.

Response Subsurface barrier technology is discussed in Volume Two, Appendix B. Subsurface barriers are a potentially viable technology available to the decision makers. The EIS incorporates by reference (Treat et al. 1995) a detailed engineering feasibility study on subsurface barriers. Subsurface barriers were added as a potential mitigation measure in Volume One, Section 5.20 in the Final EIS. Please refer to the response to Comment number 0001.01.

All of the alternatives' future potential impacts are based upon an analysis of the potential impact of the alternatives themselves, without consideration of past or current practices, as appropriate. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0030.04

Krieg, Ronald K.

Comment The Hanford Federal Facility Agreement and Consent Order set a goal for the SSTs that no more than 1 percent of the tank inventory would remain as a residual following waste retrieval activities (3-31, Vol. 1). Many times it is stated that this retrieval criteria of 99 percent may not be achieved (3-101, Vol. 1). Residuals left in tanks would not meet the water protection requirements if additional closure action is not taken (6-30, Vol. 1), with these residuals having low solubility because substantial quantities of liquid was used in the attempt to dissolve or suspend wastes during retrieval (3-31, Vol. 1). Furthermore, performance of key alternative processes have been assumed in absence of substantive data. Cost estimates may have a high degree of uncertainty because some of the processes are unproven (3-100, Vol. 1).

The Tri-Party Agreement calls for total waste removal from Hanford's single- and double-shell tanks for processing and storage offsite, unless technically unfeasible. Throughout the EIS the word "uncertainties" is used regarding costs, COC inventories and volumes, technology performance, actual risks, and SST leakage quantities. It would be a shame to see uncertainty translate to unfeasibility. The time has come to eliminate uncertainty through a systematic, cost and risk effective remedial approach with the least long-term impacts to our future populace's health and environment.

Response As required by the CEQ, the TWRS Draft EIS identifies and analyzes the range of reasonable alternatives for the proposed action, which also includes a No Action alternative. All data that support the cost and impact analysis of each alternative are presented in an objective format for comparison by the decision makers and by the public during the comment period. However, the EIS is limited to the TWRS and evaluation of reasonable tank waste remedies. Under the Tri-Party Agreement, DOE and Ecology are bound to complete specific milestones related to tank waste remediation, and given the uncertainties listed in the comment, the Agencies have selected the Phased Implementation as the preferred alternative.

Identification and presentation of the many existing uncertainties was the method chosen by DOE and Ecology to complete the evaluations and publish the EIS. To consider and resolve all uncertainties before publication of the EIS would result in inordinate delay and failure to comply with the Tri-Party Agreement. Please refer to the response to Comment numbers 0005.03, 0072.05, and 0072.80 for discussions regarding regulatory requirements for bounding alternative analyses.

Comment Number 0030.05

Krieg, Ronald K.

Comment A recent report prepared by the National Research Council regarding containment-in-place technologies acknowledges subsurface barriers as an imperative use during remediation efforts and as a feasible interim solution to hazardous substance migration at Hanford and other Department of Energy sites. The committee's comparison of costs found retrieving and processing wastes costs $15 billion more (17.5 vs. $2.4 billion) than the alternative of in situ stabilization and isolation. I do not believe the Feasibility Study of Tank Leakage Mitigation Using Subsurface Barriers (WHC-SD-WM-ES-300) fully analyzed subsurface barrier technology and recommend what the National Research Council has; that containment-in-place technology be re-evaluated on its technical, fiscal, environmental, and public health merits as a possible short- or long-term alternative for radioactive waste management and inclusion as such in this EIS.

Another problematic issue is in Appendix B's level of analysis and conclusions of subsurface barrier technology, which failed to include information from the Feasibility Study of Tank Leakage Mitigation Using Subsurface Barriers regarding subsurface barriers' cost effectiveness when supporting clean closure activities. Although closure decision are not a part of this EIS, they are stated to be interrelated with the decisions made concerning remediation of tank wastes.

The conclusion I am referring to is stated: "The most cost effective individual action is adding a close-coupled subsurface barrier to support clean-closure. This result is lowering both risk and HI and the overall cost of the alternative. This apparent anomaly arises from the substantial reduction in contaminated soil and recovered contaminants requiring treatment when a subsurface barrier is used. The resulting cost savings more than offset the cost of installing the barrier (WHC-SD-WM-ES-300 Rev. 0, pg. 8-3). Information such as this must not be overlooked, forgotten, or excluded from this EIS.

A reduction in the financial risk involved with contaminant migration and the technical uncertainties of the ex situ technologies is possible and available now. The potential cost savings to TWRS could be in the $5-7 billion range if a 10-year delay in remediation costs could be attained through effective deployment of subsurface barrier technology. This principle would carry over to many other situations throughout the DOE complex. Mitigated through the use of effective subsurface barriers under the tanks a delay in start up could save money in two ways: 1) identical real budgets have lesser present value as they are postponed farther into the future, and 2) technology productivity improvements occur as time passes, further reducing real costs. This approach would allow the DOE to improve the design, construction, and operations of initial and full scale remedial operations to the SSTs.

Barriers for confinement-in-place of buried waste have been effectively used in many environmental remediation activities. Subsurface barriers provide a cost effective option for resolving the 200 Areas' management and remediation problems either as a short or long-term approach. With their continued development, cost efficient subsurface barrier technology providing the highest containment performance standards must be retained and given serious consideration on its technical fiscal, environmental, and public health merits for inclusion in this Draft EIS.

Response The subject report by the National Research Council, titled The Potential Role of Containment-in-Place an Integrated Approach to the Hanford Reservation Site Environmental Remediation, recommended that containment-in-place technology be considered and evaluated on its technical, fiscal, environmental, and public health merits as a possible short- or long-term alternative for radioactive waste management. Such analysis should be conducted on a site-specific basis.

For analysis in the EIS, alternatives that bound the full range of reasonable alternatives were developed. In order to bound the impacts associated with in situ disposal of the tank waste or tank leakage during waste retrieval activities, subsurface barriers were not assumed to be used. This does not preclude the use of subsurface barriers during remediation activities but provides an upper bound on the expected environmental impacts. Subsurface barriers would be beneficial for retrieval of wastes from known or suspected leaking tanks. This technology would be evaluated for tank-specific application. Subsurface barriers were added as a potential mitigation measure in Volume One, Section 5.20 in the Final EIS. Please refer to the response to Comment numbers 0001.01 and 0030.01.

Comment Number 0046.03

DiGirolamo, Linda Raye

Comment We ought to convert the WHOLE NUCLEAR INDUSTRY by forming a commission name NEW AGE ENERGY - touched upon by Mr. Browning - This NAE would begin research and development at Hanford while the DOE cleans up its awful mess...beginning immediately!

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0054.01

Belsey, Richard

Comment Grout did not work because we had so many processes going on. At Savannah River, they are today using grout because they were able with relatively simple separations to clean out 99.99 percent of the high activity fraction. But Hanford kept on, the Hanford's performance assessment kept on bouncing back over, over, strung out over time saying give us more information, your I-129 releases from the grout are still rising at 10,000 years. You at least have to model it out to know where it is going to turn the corner. I raise this question because we have re-opened all of those issues almost like re-opening a wound and looking at an infection again and saying why are we doing this and I would council that in fact you all list other stabilization forms (grout and ceramics) in this Draft EIS. How did we come to glass. There has been both a rich scientific literature about stabilizing radionuclides in glass going back 20 or 30 years and whereas with other substances there is spotty science and particularly with ceramics and grout there are highly variable reactivity. You go down to Savannah River it is almost like a witches brew. They stir it up and they have to use this particular kind of stone or else the whole thing does not gel and same thing with ceramic. So from my perspective, science wise we have to be careful about changing the stabilized waste form and we also now have about a 20-year, nearly a 20-year experience, not our own, but with other people using glass particularly for the high-level wastes. So I think that we should clearly not make any change in the waste form because of the inherent delay that will come about and the one thing we can not afford to do is to delay. The delays have cost nearly a billion dollars now and every year we delay costs that much more with by and large no real value so we got to get on with it. So state clearly that you are not going to consider anything except glass and glass from whoever gets to do the job of cleaning this up. I will leave that for now. Thank you very much.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. NEPA requires that a full range of alternatives be examined in the EIS. This range of alternatives must include a No Action alternative, and may include other reasonable alternatives to allow analysis of a full range of alternatives. Some alternatives do not produce a glass waste form. Consequently, the EIS cannot omit glass from analysis as the waste form for a given alternative. It should be emphasized that for the ex situ alternatives, glass was the primary waste form to be produced. Similarly, the EIS also discusses alternate immobilization technologies to allow their analysis. These technologies were not included in the alternatives developed for impact analysis, but may serve as potential components of a remediation alternative. The discussion of alternate technologies, including grout, will be found in Volume Two, Section B.9.0. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the response to Comment numbers 0005.40, 0005.18, 0072.179, and 0009.08 for a discussion of issues related to grout.

Comment Number 0058.01

Swanson, John L.

Comment I have heard tonight different people give their biases. They blame somebody else for subjective judgement while they are drawing their own. In recent years have used a saying many times that I will repeat here. It applies to these costs analyses and comparisons of alternatives and that is the assumptions drive the conclusions.

Response When assumptions were made in the EIS, every effort was taken to ensure that these assumptions were applied equitably among the alternatives to ensure comparability. Please refer to the response to Comment number 0005.03.

Comment Number 0059.02

James Jordan Associates

Comment A brief white paper entitled, A Comparison of BNL's Small Modular HLW Treatment System with a Large Central Melter System is attached in support of JJA's request to include the BNL concept in the EIS analysis. Finally, an economic analysis of the estimated costs of producing high-level radioactive glass using the Small Module Inductively Loaded Energy concept invented by BNL is attached to this request. JJA has formally requested that the BNL concept be developed for possible use at Hanford and other DOE sites.

Response Alternatives were developed that bound the full range of reasonable alternatives and reflect the results of the public scoping process for the EIS and discussed in Volume One, Section 1.2. Representative alternatives that incorporate the range of cost, human and ecological health risk, and technologies have been developed for analysis in the EIS. The alternatives in the EIS have been developed to bound the applicable alternative technologies, including the one proposed by the commentor. Because the EIS contains bounding alternatives that will be presented to the decision makers, no change has been made to the EIS. Please refer to the response to Comment numbers 0072.05 and 0072.79.

Comment Number 0062.02

Longmeyer, Richard

Comment My second comment is with regard to the privatization. I have some concerns with regard to safety issues, as well as issues such as water quality issues. Both groundwater, and the Columbia River. The question is will the private contractors treat groundwater and the Columbia River with the same care that the government has been mandated to treat it, under the Tri-Party Agreement? Will they hold to the same safety guidelines, or perhaps better guidelines, that would be something that I would be interested to know.

Response Privatization is not within the scope of the EIS, as discussed in Volume One, Section 3.3 on page 3-13 of the Draft EIS, because it is a contracting mechanism. Under this concept, DOE would competitively bid a portion of the remediation work instead of having the Site Management and Operations contractor perform the work. Equivalent requirements for retrieval, treatment, and disposal of the waste, as well as quality and performance verification, would apply regardless of how DOE contracts to perform the remediation. Please refer to the response to Comment numbers 0009.19, 0060.02, and 0076.03.

Comment Number 0072.15

CTUIR

Comment It is difficult to follow the constituents through the various processes and into the environment. A mass balance showing distribution of the constituents for the tanks into various waste forms, effluents, and the environment would be helpful.

Response The detailed technical data developed to assess the environmental impacts of the alternatives addressed in the EIS are contained in referenced technical documents and calculations. The technical data are available for public review as a part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. A mass balance for each of the waste treatment alternatives was completed in order to estimate the off-gas and liquid effluents. These off-gas and effluents streams then were used as sources in the risk assessment analysis. The human and ecological health effects from these off-gas and effluent streams are addressed in Volume One, Section 5.11. The TWRS EIS is a lengthy document and the inclusion of the detailed conceptual engineering information into the EIS would greatly lengthen the document. DOE and Ecology must balance the need to present relevant supporting data against the need to have a manageable and understandable document. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.196

CTUIR

Comment P B-166: Sect. B.7.1: It is noted that the evaluation for potential sites does not indicate that the affected Tribes were not notified or consulted with. If they were, please produce references, if they were not, please contact technical representatives of the affected Tribes.

Response The Draft EIS identifies in Volume Two, Section B.7 that the final site selection for the facilities associated with the ex situ alternatives has not been made. The potential site locations indicated in the EIS were taken from Hanford Site studies that examined potential site locations for the treatment facilities required for tank waste remediation and are included as examples for calculation of environmental impacts. The identification of these sites, within the 200 Area Waste Operations areas, is consistent with the Hanford Site Development Plan and the recommendations of the Hanford Tank Waste Task Force. As indicated in Volume One, Section 5.20, before to any ground disturbance activities, consultations would be conducted with the DOE Richland Operations Office Historic Preservation Officer, the Hanford Cultural Resource Laboratory, Washington State Historic Preservation Officer, and concerned Native American Tribal groups and governments. Consultation with Tribal Nations groups and governments would be performed early in the planning process to determine areas or topics of importance to these groups such as religious areas and potential resources of medicinal plants. Please refer to the response to Comment number 0072.149 for a discussion of the Tribal Nation consultation process for the TWRS EIS. Please refer to the response to Comment numbers 0019.03, 0072.235, 0072.50, and 0101.06 for related borrow site and closure information.

Comment Number 0072.236

CTUIR

Comment P E-202: Sect. E.10.2: Although not clearly stated, this appears to be the preferred alternative. Please confirm. Additionally, it appears that the only alternative for MUSTs involves filling them with grout (sand, gravel and cement). As we have stated on several prior occasions, the selection of an alternative that results in irretrievable waste forms may be unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. There has been no attempt in the accident analyses or at the location referenced in the comment to identify any alternative as the preferred alternative. The preferred alternative is identified in the Summary, Section S.7 and Volume One, Section 3.4.

For the ex situ alternatives, the MUST waste would be retrieved and only the residual left in the tanks would be grouted. Grouting of the MUST was included in the analysis to facilitate a balanced comparison of the alternatives. Closure of the MUSTS, like closure of the tank farms, will be the subject of future NEPA analysis. For each of the alternatives presented in Volume One, Section 3.4 and Volume Two, Appendix B, remedial actions for MUST waste are described. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0083.01

Pollet, Gerald

Comment Hanford's Dangerous Nuclear Waste Tanks

They can explode! They do leak! Leaked waste will poison the Columbia River! So why does the U.S. Department of Energy want to consider leaving 75 percent of the waste in the tanks forever? Is this your idea of clean-up?

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The EIS includes an analysis of potential accidents, including explosions, in Volume One, Section 5.12 and Volume Four, Appendix E. Past tank leaks are discussed in Volume One, Section 5.4.2. A discussion of the potential cumulative impacts of past tank leaks and the TWRS alternatives is provided in Volume One, Section 5.13 and Volume Four, Appendix F. The regulations (40 CFR 1500 to 1508) that implement NEPA requirements that an EIS address the full range of reasonable alternatives. For the TWRS EIS, the full range of reasonable alternatives was determined to range from leaving all of the waste in the tanks to retrieving as much of the waste as practicable (assumed to be 99 percent) and alternatives that fall between these two extremes. The DOE and Ecology preferred alternative is to retrieve 99 percent of the waste to the extent technically practicable. Please refer to the response to Comment numbers 0072.05 and 0009.01.

Comment Number 0085.03

Klein, Robin

Comment In the mean time we're calling for funding to develop real solutions. Not just for Hanford tank wastes, but to address soundly the global problem of disposing of dangerous radioactive materials worldwide. At the same time we're being asked to comment on TWRS. I'm going on a slight tangent here on purpose. We're also being asked to comment on the PEIS for disposition of weapons usable fissile materials nation wide. There we are faced with the ominous alternative, possibility of processing the worlds stores and reactors, with the likelihood that this could occur at Hanford. I hope that in parallel, with comments on what to do with the tank wastes, we don't lose sight of the pressure mounting to fire up reactors once again along the Columbia River. This is a non-solution to a problem, for which there is no good solution. Maybe if just a fraction of the dollars that were spent on developing those horrific weapons were spent on coming up with a permanent real solution, funding those great minds at the labs in Los Alamos Sandia, we'd probably stand a chance, and I believe we would. After all, that stuff's going to be around a while one way or another. But don't revive a failing nuclear industry at the price of health and safety of our futures.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Congressional funding issues are not included in the scope of this EIS. However, Volume One, Section 5.13 (Cumulative Impacts) addresses actions at other DOE sites and programmatic actions that could impact the Hanford Site, actions adjacent to the Hanford Site, and planned or reasonably foreseeable DOE actions at the Hanford Site.

L.5.0 ENVIRONMENTAL CONSEQUENCES

L.5.1 GEOLOGY

No comments were submitted for this section.

L.5.2 WATER RESOURCES

Comment Number 0089.23

Nez Perce Tribe ERWM

Comment Page 5-15, Paragraph 2

The use of 1979 sitewide groundwater level measurements may not be a conservative approach to risk assessment as the groundwater mound at B pond forms a hydraulic barrier which delays and deflects tank wastes in the groundwater from traveling directly towards the Columbia River.

Response Please refer to the response to Comment numbers 0012.16 and 0072.259.

Comment Number 0091.01

Dyson, Jessica

Comment This new data showing contamination dangerously close to our groundwater would not even been told to us at this point if it was left up to the Department of Energy. This is vital information for the public to have and it does have significant impacts on the public. Almost all of our agriculture in Washington comes from eastern Washington and most of the land surrounding the Columbia River is irrigated with the rivers water. Any radiation in the groundwater will make it to the river and possibly to our dinner tables. It is your responsibility to account for all the risks to the public and be as conservative in your assumptions as possible to protect our communities.

Response DOE and Ecology are equally concerned about protecting the groundwater resources. The Draft EIS, in Volume One, Section 4.2 and Volume Five, Appendix I, documented that contaminants were present in the vadose zone beneath the tank farms and that one source of the contamination was past tank leaks. In Volume One, Section 3.3 the Draft EIS stated that new data were emerging that indicated contamination at lower levels than previously estimated. The new and emerging data are, in many cases, preliminary in that they indicate the presence of contamination beneath the tanks but do not provide any explanation on how they were transported. Potential contaminant transport mechanisms including chemically enhanced mobility of contaminants, preferential pathways (natural and man-made), and the effect of large liquid loss (as compared to the predicted losses for the TWRS remediation) were evaluated as part of the uncertainty analysis in Volume Five, Appendix K. This emerging information as well as future information that are being collected will be addressed by NEPA analysis for tank closure to ensure that the groundwater and Columbia River are adequately protected. The alternatives presented represent a full range of potential actions. The EIS incorporates "bounding" assumptions designed to result in conservative calculations of impacts. DOE and Ecology remain committed to selecting an alternative that will protect the valuable resources, which include the Columbia River, the groundwater beneath the tank farms and food sources produced in Eastern Washington. The preferred alternative would be protective of the groundwater and limit future contaminants from TWRS sources to well below drinking water standards in the Columbia River. An evaluation of potential Columbia River impact due to release of all tank waste is provided in Volume One, Section 5.2 and indicates that even for a large release, drinking water standards would not be exceeded. The preferred alternatives would release only about 1/100th of the waste and the rate of release would be slowed due to the infiltration-limiting cap over the tanks. Please refer to the response to Comment number 0030.02.

L.5.2.1 Groundwater

Comment Number 0005.19

Swanson, John L.

Comment I am troubled by "loose wordings" in many places; one example is in the area of the time required for leached contaminants to reach the groundwater. For example, the last sentence on S-27 says "The contaminants would reach the groundwater---", while the third sentence on 5176 says "Contaminated water would reach the groundwater---", the writers tend to use phrases like this interchangeably, but they do NOT have the same meaning because not all of the contaminants move through the soil at the same rate (deletion of the word "the" at the start of the first example would make them mean the same). This may sound like a picky matter, but I do not believe that is; for example, it is said that THE contaminants are x, y, and z and then it is later said that THE contaminants reach the groundwater after so many years, it can be concluded that x, y, and z all reach the groundwater at the same time. I believe that sentences should be accurate, so that readers do not draw incorrect conclusions because of poor sentences. This "time to groundwater" matter is addressed over and over again in the EIS, sometimes in sentences giving the correct meaning but more often not. I recommend that a technically correct sentence format be developed and consistently used for this issue (if it sounds repetitive, so be it-it is better to be accurate than to sound good).

Response Where applicable, the text of the EIS has been modified by replacing "the contaminants" or "contaminated water" with the phrase "the fastest moving contaminants."

Comment Number 0008.05

Evett, Donald E.

Comment S.6.2 Groundwater Pathways by Alternative: I consider the In Situ Vitrification as the best possible method. Your report signifies greater benefits, i.e.,:

1. The rate of leaching of contaminants would be very slow.
2. Contaminants reaching the groundwater would be small.
3. Greater the level of separations performed and the greater the effectiveness of the immobilization process.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The estimated long-term impacts of this alternative are lower than those estimated for other alternatives. These estimates are based in an assumption that the ISV technology can be developed to perform effectively. As discussed in Volume One, Section 3.4, there is much uncertainty concerning the development of this alternatives. This technology may be undergoing further testing to determine its effectiveness on large-scale applications. Modifications to this process have been suggested to improve potential effectiveness and to reduce the uncertainties on its application. Discussions related to ISV technologies are addressed in the response to Comment numbers 0023.01 to 0023.30 and in the response to comments located in Volume Six, Section L.3.4.6.

Comment Number 0012.15

ODOE

Comment Waste Properties

Report BHI-00061 on the T tank farm shows plutonium and americium deep under the tank farm. This was not predicted by USDOE's modeling. During operations, USDOE discharged large quantities of organic complexing agents to the tanks, including EDTA, HEDTA, tributyl phosphate and glycolic acid. These complexing agents have apparently bound-up a significant portion of the plutonium and americium and allowed it to move through the soil far faster than expected. The risk analysis should include these effects.

Response DOE and Ecology are aware of the contaminants under tank T-106 and the recently emerging information concerning contamination under other tank farms from past leaks. Past leaks and other closure issues are not within the scope of this EIS and will be addressed directly in future NEPA analyses for tank closure. See Volume One, Section 3.3.1 and the response to Comment numbers 0005.17 and 0072.08. Please refer to the response to Comment numbers 0040.06 and 0101.05 for a discussion of cumulative impacts. However, it is appropriate to provide in this EIS a qualitative discussion of past tank leaks and the potential transport mechanisms responsible for the contaminant migration.

Included in the uncertainty analysis provided in Volume Five, Appendix K are 1) descriptions of these data as they related to contaminant migration from past tank leaks; 2) a discussion of the various transport mechanisms that separately or in combination could have been responsible for the observed contaminant distribution beneath the tanks; and 3) how these mechanisms could impact each of the alternatives.

Report BHI-00061 contains borehole sample data collected as a part of a 1993 investigation of contaminant migration from a leak from tank 241-T-106. The data from the 1993 investigation consist of 43 split-spoon samples from borehole 299-W10-196. These samples were taken for physical, chemical, and radiochemical analysis in addition to spectral gamma geophysical logging of the borehole on eight occasions.

The 1993 investigation resulted in data on the vertical distribution of several radionuclides and chemicals. Most notably are the following results.

- Plutonium concentrations increase dramatically at the depth of the bottom of the tank (33 feet), reach a peak at 43 feet, decrease to less than 1 pCi/g at 92 feet, spike at 95 feet, and then decreases to background at greater depths.
- Cesium-137 had a significant concentration within the fill around the tanks to a depth of 13 feet, above the presumed depth of the tank leak. The concentration decreased until a depth of 30 feet, then began to increase to a maximum at 43 feet, followed by a decrease to below background until two spikes were detected at 78 and 101 feet.
- The spikes at approximately 100 feet are observed for both mobile (e.g. technetium-99) and attenuated (e.g. cesium-137) contaminants and are believed to be concentrated by a caliche layer that occurs at this depth. This may be due to a hydraulic conductivity contrast, adsorptive capacity from the increased clay content, and/or substitution of radionuclides in the calcium carbonate.

The findings from the 1993 investigation of the tank T-106 leak along with potential contaminant transport mechanisms are discussed in Volume Five, Appendix K. The data from this investigation are expected to be the basis for additional NEPA analyses for closure which will directly address potential mechanisms affecting the fate and transport of leaks from the waste tanks.

There are many possible contaminant transport mechanisms that may be responsible for the contaminants observed at depth. These mechanisms may include: chemically enhanced mobility of otherwise relatively immobile contaminants, large fluid loss from tank(s) or other sources to provide driving force, naturally occurring vertical features such as clastic dikes that may be more transmissive than the layered sediments, and inadequately sealed drywells. These potential transport mechanisms were discussed in Volume Five, Appendix K as part of the uncertainty analysis and so that mitigating measures could be developed. Each of these mechanisms is briefly discussed in the following paragraphs.

There are two general types of chemically enhanced contaminant mobility that are of concern to DOE and Ecology: 1) the chelation of some contaminants such as cobalt by complexing agents such as EDTA resulting in smaller K_d values and faster transport through the vadose zone; and 2) competition for cation exchange sites by elements such as sodium, which could result in a smaller K_d and faster movement through the vadose zone for contaminants such as cesium, whose transport is believed to be retarded largely by cation exchange.

The magnitude of fluid loss, while not a transport mechanism, can greatly affect the rate and distance a contaminant moves. The source terms (i.e., liquid loss per unit time and contaminant concentration) for the TWRS are quite different (smaller) than would be expected for many of the past tank leaks. This difference is in part, why the earliest predicted contaminant arrival at the groundwater for the TWRS alternatives is approximately 130 years (No Action alternative); whereas contaminants previously leaked from the tank may be arriving at the groundwater within a 50-year period.

Vertical zones of high transmissibility, whether from man-made features such as inadequately constructed drywells or natural features such a clastic dikes filled with clean sand, would result in faster contaminant transport. The drywells were constructed using a cable tool drill and the annular space between the casing and borehole was not sealed. Clastic dikes are geologic features that occur in the area. They are often vertical or near vertical and can also be found horizontally. The hydraulic nature of these features on the Site are not well known but they could be preferential pathways for contaminants to migrate vertically.

Comment Number 0012.16

ODOE

Comment Risk Models

The risk modeling in the EIS is sufficient to support the proposed action. We do not believe it is sufficient to support any decision which would leave waste in Hanford tanks.

The risk analysis included in the EIS uses simple linear models and simple waste source term parameters as surrogates for reality. The soil structure and hydrogeology are complex. Despite extensive drilling, boring and testing, no accurate or adequate model exists of the geohydrology of the Hanford Site. This is evident by comparison of the risk maps presented in this EIS with the draft Hanford Remedial Action EIS. These two EISs use data gathered several years apart to predict the flow paths and travel times for movement of radioactive materials through the soil and groundwater. A minor difference in input data results in large differences in movement of the wastes and larger differences in when and where the wastes are expected to reach the Columbia River.

The soil at Hanford has layers with widely varying properties. Some layers allow easy movement of water. Others slow water movement. Some layers show different horizontal and vertical rates of water movement. Simple linear models cannot adequately model the behavior of such complex systems.

We believe the modeling is also flawed by arbitrary changes in the values used for the physical properties of the soils. Page F-58 of Volume Four contains two example: 1) "Kincaid et al. (1993) specified a value of 0.498 for $_{s}$ in the Ringold Formation in the vicinity of the 200 East Area. This value was considered unrealistically high; therefore $_{s}$ and the related S_{wr} and $_{r}$ values were changed to the values reported for the Ringold Formation in the 200 West Area."; and 2) "The value reported for $_{r}$ in Wood et al. (Wood et al. 1995) was 0.0. It was assumed that the reported value was below detection and was reported as zero. Therefore, a small number (0.001) was assumed in its place to maintain the relationship between $_{s}$ and S_{wr} stated previously."

Page F-59 details other "simplifying assumptions." We have no assurance these simplifying assumptions are reasonable. They may or may not result in conservative evaluation of the risks. Combined with the other arbitrary changes and simplifications, the result may be great differences in the real risks compared to modeling results from the modeling.

Response Soil structure and hydrogeology of the Site are complex. Most important is the conceptual model of water movement through the vadose zone, into the underlying aquifer, and ultimately discharging to the Columbia River. The conceptual model for this EIS is based on observations that include geologic structure, the pattern of geologic materials deposited in the vadose zone and underlying aquifer, existing contaminant migration, and the bounding effects of features such as the Columbia River, the Yakima River, and Horse Heaven Hills. This results in an expectation that most of the contaminants from the tank sources will move in a west to east/southeast direction with a small amount flowing northerly through the gap between Gable Butte and Gable Mountain. These results are generally obtained using the 1979 water level data set, on which all of the groundwater assessments are subsequently based. The 1979 water level data represent a period of relatively steady conditions. Volume Four, Appendix F compares the EIS model results with results calculated assuming the decay of all 200 Area groundwater mounds, and the two sets of results parallel each other very closely.

The water level data set used by the HRA EIS is based on data from 1992. While this is more recent data, it is also for a period of large change with regard to wastewater disposed to the soil column. It also represents a period in time where, briefly, most contaminants from the 200 Areas flowed north through the gap between Gable Butte and Gable Mountain. Please refer to the response to Comment numbers 0030.02, 0091.01, 0069.07, and 0069.03 for additional discussions of issues related to risk.

Comment Number 0030.02

Krieg, Ronald K.

Comment My first area of concern is the focus of being on current impacts and conditions alone. This EIS states: "Previously leaking contaminants are not in the scope of this EIS (5-48, Vol. 1)." Past contamination should be. Rust Geotech's recent tests have sampled cesium-137 as deep as the well sampled, 125 feet below the surface (Seattle PI). During the 1970's, as much as 1 million gallons of water was sprayed into single-shell tank 105-C in order to facilitate cooling. It is unlikely that 800,000 gallons of this contaminated cooling water has escaped into the surrounding soil and groundwater (WHC-EP-0182-34). Dissimilar estimates of total SST leakage from various studies range from 600,000 to 1,000,000 gallons. In the Hanford 200 Area 67 tanks are known or assumed to be leaking, and on average, one additional tank begins to leak each year. Approximately 30 tanks have not been interim stabilized with eight of the SSTs that are assumed leakers yet to be stabilized. Following interim stabilization, an SST can contain as much as 189,000 L (50,000 gal) of interstitial liquid (Vol.1, pg. 3-41). This process only minimizes potential releases, it does not provide relief to long-term impacts or relieve the possibility of continued leakage as this EIS awaits review and a Record of Decision is made.

Response Previously leaking contaminants from the tanks are not within the scope of this EIS. However, these contaminants are given some consideration in the EIS, and they will be addressed in future NEPA analysis. Please refer to the response to Comment numbers 0005.14 and 0072.08. The Draft EIS acknowledged the emerging information associated with contaminants beneath the tanks. The time between the Draft EIS and the Final EIS has afforded evaluation of some of these emerging data. These evaluations are presented in the Final EIS in Volume Four, Appendix F and Volume Five, Appendix K. Contaminants beneath the tanks are being considered in this EIS, though they are not considered as directly as in future NEPA analyses for closure. Past-practice leaks from the tanks are addressed as one component of the cumulative impacts presented in Volume One, Section 5.13. The Hanford Barrier would be used in the second phase of the preferred alternative. The Hanford Barrier will be designed so that its areal extent would mitigate the potential of infiltrating precipitation mobilizing contaminants below the tanks in the vadose zone (please refer to the response to Comment number 0089.08). It is important to understand the potential contaminant mechanisms in the vadose zone that could have resulted in contaminants moving near the groundwater table so that mitigating measures can be considered. A discussion of the potential transport mechanisms that associated with the occurrence of tank-related contaminants over 100 feet below some of the tanks is provided in Volume Five, Appendix K. The comment mentions hundreds of thousands of gallons of water leaking from some of the tanks, which is an important point. Such large volumes of water entering the vadose zone over a short period of time are dissimilar to the types of source terms associated with any of the TWRS alternatives, and may be one of the mechanisms which caused the contaminant migration in the vadose zone. See the responses to Comment numbers 0012.01, 0012.15, and 0091.01 for additional related information.

Comment Number 0030.03

Krieg, Ronald K.

Comment Retrieval operations cited in this EIS involve hydraulic or robotic sluicing. A conservative figure of 4,000 gallons of leakage per tank is assumed in this EIS. It is stated in the Feasibility study leaks could range to 40,000 gals in tank 241-C-106 for traditional sluicing. This same study averaged estimated leaks at approximately 10,000 gals for traditional sluicing with the average for robotic sluicing at 4,000 gals. Regardless of conflicting numbers or arguments of source credibility and test results, retrieval options being considered will add additional contamination through leakage, thus further compounding contaminant saturated soil and the threat to groundwater.

Response The amount of leakage resulting from tank waste retrieval will vary. Certain tanks are of recent construction and have had few problems while in use. These tanks can be expected to leak very little, if any, during retrieval. Other tanks were constructed decades ago and then received rather severe use. Rather than attempting to assess potential for leakage on a tank-by-tank basis, the EIS assumed that on average, each SST would leak 4,000 gallons during retrieval. The inventory from these leaks was assumed to be the average tank inventory, which is conservative since much of the leaks would likely be sluicing liquids with lower levels of contamination. This provides an upper bound on the potential impacts, a nominal case using the inventory of the slucing liquids for a portion of the release is included in the Final EIS. Retrieval losses would add contamination to the groundwater. In the alternatives where tank waste is retrieved, the losses during retrieval are part of the starting source term for the groundwater modeling. Volume Four, Section F.2.2.3.5 of the EIS discusses contaminant losses during retrieval. When additional data become available to assess retrieval losses on a tank-by-tank basis, these potential losses may be recalculated. Until such data are available, an average loss during retrieval must be estimated.

Comment Number 0036.14

HEAL (Exhibit)

Comment The in situ alternatives have a faulty assumption.

For the No Action, Long-Term Management, and In Situ Fill and Cap alternatives, the EIS assumes that no leaks will happen during the administrative control period. This is a dubious assumption. Given the state of the tanks, it is safe to assume that there will be escalating tank leaks during such an extended administrative control period.

Response Accurately predicting the number or severity of tank leaks that will occur in the future is difficult. One factor that will increase the number of leaking tanks is the age of the tanks. As the tanks get older, the probability of a leak increases. The number of leaking tanks may decrease as well as pumpable liquid is removed from SSTs under the interim stabilization and salt-well pumping program. Using administrative controls, such as free liquid removal from the pore space and other voids in the tank solids and the sealing of tank entrances to prevent fresh liquid from accidentally entering the tanks will minimize the number of potential leaks. Because future leaks cannot be accurately predicted, the assumption was made that all the tanks of a given type would leak at some predetermined time in the future. This assumption may not represent an accurate prediction of the future, and the impacts of the 100-year administrative control compared to the 10,000-year risk may not be substantially different, but this assumption allows an even-handed comparison of the long-term environmental impacts of the proposed alternatives. For further discussion of continued tank farm operations and tank waste storage, see Volume One, Sections 3.2.1.4 and 3.2.1.5, respectively. Please refer to the response to Comment number 0072.85 for a discussion of potential leaks during the 100-year administrative control period.

Comment Number 0040.06

Rogers, Gordon J.

Comment Monitoring of vadose zone below the HLW tanks and of the groundwater plumes should be continued to assess the rates at which contaminants reach the groundwater and the Columbia River. There will be ample time to detect any real threat to the users of river water; and to take action if a real threat is shown to exist.

Response The present program of vadose zone and groundwater monitoring should be continued. The monitoring program will continue into the future to provide an assessment of contaminant transport during cleanup operations. Because existing contamination from previous activities at the Hanford Site is not within the scope of the EIS, references to the current program of vadose zone and groundwater monitoring are found in other documentation. However, the TWRS EIS does address the cumulative impacts of vadose zone contaminants from past-practice tank leaks, the EIS alternatives and other current and reasonably foreseeable actions at Hanford. Cumulative impacts are presented in Volume One, Section 5.13. Please refer to the response to Comment numbers 0072.08, 0030.02, 0091.01, and 0012.15.

Comment Number 0045.02

USDOE

Comment Page 4-13, Section 4.2.2.2, second paragraph, second sentence: As assumed recharge rate of 0.1 sediment/year (cm/yr) is used for the 200 West Area. However, a recent recharge map (Dresel et al., "Hanford Site Ground-Water Monitoring for 1993" [PNL-10082] DEIS Vol. 4, Appendix F), indicates recharge from precipitation for much of the 200 West Area is from 5 to 10 cm/yr. This is probably due to engineering/regrading of much of the surface materials which has removed the fine-grained sediments and vegetation, leaving coarse-grained, unvegetated surfaces. Also, page I-22 (Section I.2.2.2.1, second paragraph, second sentence) states that an average recharge rate of 0.1 cm/yr was used for the 200 West Area recharge calculation. However, the previous paragraph on this page states that a rate of 10 cm/yr would not be unreasonable for the tank farm areas. This should be clarified in the Final EIS.

Response Infiltration varies temporally and aerially. Infiltration in the 200 Areas is reported to range from near 0 cm/yr where the ground cover is a shrub-steppe type characteristic of predevelopment conditions to 10 to 13 cm/yr where the ground is unvegetated sand and gravel; characteristic of conditions around the tank farms since the mid-1940s or later.

The temporal variation occurs seasonally with the change in temperature, plant activity, and precipitation. It also varies with climatic change. The spatial variation occurs with changes in vegetation, surficial soil type, and human-made structures such as paved parking lots. In response to infiltration rate changes, the vadose zone flow field varies temporally and spatially. However, it is not directly measurable with conventional techniques and is calculated with the model based on vadose zone parameters and assumed infiltration rate. There is also a lag time between a change in infiltration rate at the surface and a change in the flow field in the vadose zone as the water percolates into the ground.

For each alternative, the initial infiltration rate (i.e., the rate before remediation and for the No Action and Long-Term Management alternatives) is assumed to be 5 cm/yr. This assumed initial infiltration rate is within the range of reported values for the Hanford Site and is appropriate given: 1) the recent ground cover changes in the tank vicinity; 2) uncertainties in future ground cover conditions; and 3) the one-dimensional vadose zone flow and transport model used for the simulations. Also, for alternatives that include a cap, the sensitivity analysis in Volume Five, Appendix K of the Final EIS shows that the contaminant transport through the vadose zone is not sensitive to the initial infiltration rate.

From a temporal perspective, the higher infiltration in the vicinity of the tanks is a relatively recent occurrence as stated in the comment. This infiltration increase is in response to the ground cover changes that have occurred within the last 50 years. The relatively recent changes in ground cover are not expected to have changed the flow field at depth within the vadose zone from that of predevelopment conditions. For alternatives involving a cap, conditions after the cap is installed are assumed to be representative of predevelopment conditions in that infiltration in the tank vicinity would be low (e.g., a few millimeters/yr). Infiltration is assumed to remain at 5 cm/yr for the No Action and Long-Term Management alternatives.

Spatially, the rate would be lower away from the tanks where vegetation is allowed and surficial soils are of a finer texture. The one-dimensional model used for contaminant transport simulations through the vadose zone does not account for these infiltration changes with time and space. Thus, the assumed infiltration rate of 5 cm/yr was chosen as a conservative estimate. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0045.03

USDOI

Comment Page 4-14. First full paragraph, second sentence: The previous comment regarding the 200 West Area recharge also applies to the 200 East Area [Comment number 0045.02].

Response Please refer to the response to Comment number 0045.02.

Comment Number 0069.01

Pollet, Gerald

Comment In 1989 our organization asked then Senator Adams and Congressman Don Bonker to ask the General Accounting Office to do a study of the Department of Energy's claims that leaks from the single-shell high-level waste tanks quote "pose no threat to human health or the environment" unquote, and quote "pose no threat to groundwater" unquote. The Department of Energy continues to make that claim essentially, and bases much of this EIS on that claim today. As you can see, in 1989 the General Accounting Office said in fact tank leaks imperil the Columbia River. That tank leaks are likely to be heading towards groundwater today, if they haven't already reached it, and will flow into the Columbia River. What the department was told, specifically, was that its studies predicting the eventual environmental impact of tank leaks do not provide convincing support for DOE's conclusion that the impact will be low, or nonexistent. This has been ignored in this EIS.

Response Volume One, Section 4.2 and Volume Five, Appendix I describe the affected environment and document that substantial groundwater contamination is known to occur at the Hanford Site and beneath the 200 Areas. The groundwater impacts analysis has predicted that all of the TWRS alternatives would have some impact to groundwater quality and, hence, a potential adverse impact to human health under certain future Site uses scenarios, ranging from relatively low such as for the In Situ Vitrification alternative to quite high as for the No Action alternative. Please refer to the response to Comment numbers 0012.01, 0012.15, 0091.01, and 0030.02.

Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0069.02

Pollet, Gerald

Comment The General Accounting Office also said that although DOE's maintained that the environmental impact of leaks will be extremely low, or nonexistent, the studies we reviewed do not provide convincing evidence that this is the case. New evidence, available to the Department of Energy because it was collected by its own contractor, available to the people preparing this EIS, and from which is from the Department of Energy presentation, shows underneath the tanks, that are called the SX Tank Farm, cesium-137 is detectable far below the tank, at 125 feet, basically, where it shouldn't be according to this Environmental Impact Statement. Where it isn't, and will not be, according to this Environmental Impact Statement, until we're all dead. But it is there today.

And here is another visualization of the cesium plume at depth. And here is a logging of the contamination in a bore hole, down to 125 feet. This is the ground level, this is the bottom of the tank. Here you have a massive spike far below the tank, and another massive spike right here at nearly 125 feet. And you say, now wait a minute, the Department of Energy says it will take 130 years at least for the waste to get from here to groundwater. Yet it is at massive concentrations at the bottom of bore holes, 125 feet below the tanks already. We are wondering if the Department of Energy has additional evidence, and is sitting on that evidence until after the public comment period is over, as to what other tank wastes might be beneath the tanks, and moving to groundwater as we speak. This is the Department of Energy's own presentation. It is a significant contradiction to the current model, that cesium-137, that's the radionuclide which is very radioactive, does not migrate far from the leak source. It tears apart this Environmental Impact Statement. What would be much more reasonable is if this Environmental Impact Statement was redone on the basis of an assumption that it takes in the vicinity of 25 years for tank leaks to reach groundwater, and from thence to the river is a matter of 10 to 25 years. The clock is ticking.

Response DOE is implementing a program to obtain the emerging information concerning contaminants beneath the SX Tank Farm, but complete resolution of the issue may not occur for more than a year. These data and others were evaluated for consistency with the groundwater impact assessment approach and for identification of other potential active contaminant transport mechanisms in the vadose zone. The results of these evaluations are provided in Volume Five, Appendix K. Please refer to the response to Comment numbers 0012.15, 0012.01, and 0030.02 for additional information and extensive discussion on the evaluation of contaminants beneath the tanks. Please refer to the response to Comment number 0069.01 for information regarding the description of existing Hanford Site groundwater contamination. Please refer to the response to Comment number 0040.06 regarding consideration of vadose zone contamination in the Volume One, Section 5.13 presentation of cumulative impacts.

Comment Number 0072.165

CTUIR

Comment P 5-11: Why do the current drinking water quality standards not apply beyond one thousand years? The people of the CTUIR will be here one thousand years from now and may be impacted.

Response The cited statement is incorrect and has been revised in the Final EIS. The drinking water standard is not limited to 1,000 years. Please refer to the response to Comment number 0036.17.

Comment Number 0072.166

CTUIR

Comment P 5-12: bullet 5: The CTUIR technical staff do agree that this bullet is a major assumption.

Response DOE and Ecology acknowledge the comment but believe it should be retained in the Final EIS.

Comment Number 0072.167

CTUIR

Comment P 5-19: Sect. Contaminant Groups: Of the one hundred contaminants was their mobility determined using the K_d of chelating agents such as EDTA?

Response The mobility of the contaminants for the impact analysis presented in Volume Four, Appendix F does not include the potential effects of chelating agents. The potential effect that chelating may have on contaminant mobility has been incorporated into the Final EIS in Volume Five, Appendix K. Please refer to the response to Comment number 0012.15.

Comment Number 0072.237

CTUIR

Comment P F-10: Sect. F.2.2: There are several assumptions that reduce the effectiveness of this section including, the assumption that there will be only residuals in tanks and vitrified LAW. The other options such as total tank inventory are not explored. This is unfortunate because a substantial portion of total tank inventory is assumed to already have leaked. Ignoring the leaked fraction will change the risk results. Additionally there is new evidence that the leakage is not a vertical conduit, but has regions that resemble lateral spread, such as with the caliche layers at depth.

Response DOE and Ecology are concerned with the total risk associated with past and future releases from the tanks. The groundwater impacts assessment focuses on those impacts associated with the range of future TWRS remedial alternatives. These evaluations are provided in Appendix F, Section F.3. Assessments of cumulative impacts, including the potential impacts from past tank leaks are provided in Volume One, Section 5.13 and Volume Four, Section F.4.5. For discussion of closure issues that are beyond the scope of the EIS, including past leaks from tanks, please refer to the response to Comment number 0072.08.

Some lateral spreading of contaminants in the vadose zone is expected to occur given the layered nature of the sediments at the Site. The one-dimensional model used in the groundwater impacts assessment did not account for lateral spreading, and does provide conservative predictions of contaminant concentration at the vadose zone/groundwater interface. Conservative predictions mean that the predicted contaminant concentrations are higher than would be predicted had a model been used that included lateral spreading. A discussion of potential contaminant transport mechanisms in the vadose zone and their impacts on the alternatives are discussed in Volume Five, Appendix K. Please refer to the response to Comment number 0012.15 for additional information and discussion on the topic of contaminant transport in the vadose zone.

Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.238

CTUIR

Comment P F-11: Sect. F.2.2.2: within this section there should have been discussion related to chelating chemicals such as, EDTA, in regards their ability to mobilize metals. Please include a discussion regarding this both here and in the uncertainty section.

Response Please refer to the response to Comment numbers 0072.167 and 0012.15.

Comment Number 0081.06

Pollet, Gerald

Comment I'd also like to submit for the record relevant pages from the United States General Accounting Office report of 1989 regarding tank leaks. And I hope that we have captured the dialogue sufficiently from this evening for the record, so the record will reflect our concerns about the use of any assumption as to the travel time for tank leaks to groundwater. We believe that tank leaks to groundwater travel time in this EIS should be based on the assumption that it takes 25 years or less for tank leaks to reach groundwater. And that the entire vadose zone, not just the tank itself, needs to be looked at as part of integrated system in this EIS.

Response Please refer to the response to Comment numbers 0069.01, 0069.02, and 0012.15.

Comment Number 0083.02

Pollet, Gerald (Exhibit)

Comment The TWRS EIS and USDOE's proposal to leave wastes in tanks forever is based on the false assumption that tank leaks do not move rapidly through the soil to groundwater and the Columbia River.

In 1989, the U.S. General Accounting Office (in a report initiated by Heart of America Northwest) found that the USDOE's claims that tank leaks would not contaminate the groundwater and the Columbia River were false.

The Draft TWRS EIS ignores new evidence found by a USDOE contractor team, headed by a former whistleblower, which found extremely radioactive cesium, 125 feet below the ground near tanks that have leaked.

Response The recently emerging information was discussed in Volume One, Section 3.3 of the Draft EIS. Additional discussions, based on data that became available after the Draft EIS was published, has been included in the Final EIS in Volume One, Section 4.2; Volume Four, Appendix F; and Volume Five, Appendix K. Please refer to the response to Comment numbers 0040.06 and 101.05 regarding cumulative impacts. Please also refer to the response to Comment numbers 0030.01, 0069.01, 0069.02, and 0012.15.

Comment Number 0089.06

Nez Perce Tribe ERWM

Comment Page 3-4, Paragraph 1

Results from the current TWRS Vadose Zone Characterization and Monitoring Project in the Tanks Operations Division, indicate that cesium-137 is much deeper in the vadose zone than previously estimated. Cesium nitrate and other cesium salts are quite soluble and if absorption sites on soil particles are occupied by other more attracted ions, nothing will impede the movement of cesium to groundwater. Compounds like ammonium and potassium may replace and release soilbound cesium and initiate further cesium migration. This problem highlights a need for more research and vadose zone monitoring.

Response DOE and Ecology acknowledge this need. The mechanism for transport of these contaminants is currently being investigated with additional boreholes. The source term associated with past leaks is much larger, in terms of liquid released per unit time, than any of the conditions associated with any of the alternatives, including No Action. Thus, the presence of cesium at depth may be partially explained by the large liquid loss associated with some of the past leaks. Also, please refer to the response to Comment numbers 0012.15 and 0030.02.

Comment Number 0089.08

Nez Perce Tribe ERWM

Comment Page 3-38, Paragraph 3

The Hanford Barrier may not be fully adequate as a means of isolating tank waste from the environment. Although the barrier may be successfully used to isolate near surface waste in a dry environment, we do not advocate barrier use to isolate deep-seated contaminated waste beneath 200 Area tanks. The barrier may not halt moisture flow under the barrier along impermeable zones. It will not isolate deep-seated contamination from the probable rise in groundwater elevation if local plans to irrigate on the Hanford Site are realized.

Response A very simple infiltration model would have infiltrating precipitation moving vertically through the vadose zone with no lateral spreading. This is not the case at the TWRS facilities given the layered sediments, caliche layers, and potential vertical and horizontal features associated with clastic dikes. Infiltrating precipitation is expected to have some lateral spreading as these various layers and features are encountered. Knowing this allows for the appropriate design of the Hanford Barrier, particularly the lateral extent of the barrier. Past leaks and other closure issues will be addressed in future NEPA analyses for tank closure. For a discussion of the related closure issue, please refer to the response to Comment numbers 0019.04, 0089.08, and 0072.08.

Deep-seated contamination beneath the tanks would have little impact from irrigation given the observations from groundwater mounding associated with U Pond and B Pond, in conjunction with the assumption that irrigation will not be allowed at or near the TWRS facilities. Observations of the extent of the groundwater mound associated with U Pond on the western portion of the Site indicate that the lateral extent of groundwater level rise is limited to the near vicinity of the surface water application. This happens because of the relatively low permeability of the vadose zone soils in the U Pond area. In the 200 East Area and the eastern portion of the 200 Areas Plateau, the vadose zone soils are more permeable. Water level rise from surface applications (e.g., ponds or irrigation) are expected to be relatively flat with a relatively large lateral extent as indicted by the groundwater mound associated with B Pond. In some important ways, the impact assessment provided in Volume Four, Section F.3.0, could be representative of a future extensive irrigation scenario because it is based on 1979 water level data; a point in time when the B Pond and U Pond groundwater mounds were near their highest point. The discharge from these ponds would correspond to extensive irrigation in these areas. For this EIS, it was assumed future land use would prohibit irrigation near the TWRS facilities. Future NEPA analyses for closure would include the potential land use activities.

Comment Number 0089.13

Nez Perce Tribe ERWM

Comment Page F-9, Paragraph 4

The Distribution Coefficient (K_d) of cesium-137 and strontium-90 are discussed as being quite high and therefore not subject to travel from tank leaks through the vadose zone and into the groundwater. Recent information from the Tank Farms Vadose Zone Characterization Project indicates cesium has traveled much further than what would be expected with a K_d of 51, and in fact has already reached groundwater. Information from the vadose zone characterization effort indicates the K_d of cesium may be between 0.7 and 13. A possible cause for the lower than expected K_d may be other ions competing with cesium for adsorptive space on the soils. For example, ammonium and potassium have higher affinity for soil particles than cesium and will preferentially replace and free cesium facilitating cesium movement through the vadose zone. A future irrigation scenario will provide many of the above cesium releasing ions. This information implies more risk to down gradient sources from cesium than the EIS indicates; and we suggest you consider this data.

Response Tank contaminants such as sodium could compete for cation exchange sites in the vadose zone with the result of other contaminants such as cesium (the transport of cesium is retarded primarily by cation exchange) being transported at a rate faster than predicted. Potential mechanisms such as this and many others were assessed. A discussion of the potential causes of the recently emerging information on cesium in the vadose zone was added to Volume Four, Appendix F and Volume Five, Appendix K. Please refer to the response to Comment numbers 0012.15 and 0032.02.

Comment Number 0089.14

Nez Perce Tribe ERWM

Comment Page F-66, Paragraph 1

It states the groundwater modeling approach, based on the December 1979 groundwater level data is conservative in light of uncertainties of waste disposal, future land use, climate change and uncertainty in the depth of contamination in the unconfined aquifer. It is not clear that the modeler has accounted for the amount of water added the water table by irrigation and the amount of increase in groundwater table elevation that could occur. Moisture infiltration at sites where irrigation is initiated will increase from a few centimeters per year to several feet per year. Such activities will greatly multiply the speed of unconfined groundwater movement flooding and mobilizing previously soilbound contaminants within the vadose zone. Modeling completed for the Final EIS should give irrigation scenarios more weight.

Response Irrigation that occurs to the west of the Site is accounted for indirectly via the boundary conditions established at the Cold Creek and Dry Creek drainages onto the Site. The potential for irrigation near the tanks, increasing water levels, multiplying the speed of unconfined groundwater movement, and mobilizing previously soilbound contaminants within the vadose zone will be addressed in a future NEPA analysis on closure. For a discussion of the closure issue, please refer to the response to Comment numbers 0101.06, 0019.03, and 0005.17. Please also refer to the response to Comment numbers 0089.15 and 0089.03, which discuss future land use and irrigation, respectively. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0089.15

Nez Perce Tribe ERWM

Comment The most important modeling assumptions and uncertainties are listed. Not included in this list are uncertainties related to land use such as irrigation, which in our view, is the most important uncertainty parameter.

Response Land use issues such as irrigation are important parameters and have been added to the list of important assumptions. It is difficult to predict future land use. For the impact analysis in this EIS, the areas adjacent to the TWRS facilities are not expected to be irrigated. Under some irrigation scenarios, the vadose zone could become thinner due to rising groundwater levels. This would result in a shorter contaminant transport time to the aquifer. Additional thinning of the vadose zone at the TWRS is unlikely, given the observations from groundwater mounding associated with U Pond and B Pond in conjunction with the assumption that irrigation will not be allowed at or near the TWRS facilities. Please refer to the response to Comment numbers 0089.14 and 0089.08 for a discussion of the potential management of irrigation and EIS modeling assumptions.

Comment Number 0090.02

Postcard

Comment Please listen to us say no:

to ignoring hard evidence that Hanford's High-Level Nuclear Waste leaks will poison the groundwater and the Columbia River.

Response DOE and Ecology acknowledge the concern expressed in the comment and are committed to a remediation plan that is protective of groundwater and the Columbia River. Emerging information on leaks from the tanks are being evaluated and are incorporated in this EIS primarily in Volume Five, Appendix K and Volume Four, Appendix F. Future information on tank leaks will be addressed by NEPA analyses for tank closure. The predicted impacts to the groundwater for all alternatives are provided in Volume Four, Section F.3.0. The cumulative impacts of past tanks, the TWRS alternatives, and other actions on groundwater quality are addressed in Volume One, Section 5.3 The predicted impacts to the Columbia River are provided in Volume One, Section 5.2.2.2. Using the bounding assumptions of minimum 7-day mean river flow, time of maximum contaminant discharge to river (500 years for Long-Term Management alternative), and highly mobile contaminants, it was found that there would be a slight increase in contaminant levels, but drinking water standards would not be exceeded (see Volume One, Section 5.2.2.2). The preferred alternative, Phased Implementation, was not analyzed for Columbia River impacts because the contaminant release for this alternative is only about one-tenth of that released for the Long-Term Management alternative. Please refer to the response to Comment numbers 0091.01, 0030.02, 0012.15 and 0072.08.

L.5.2.2 Surface Water

Comment Number 0073.02

Yazzolino, Brad

Comment You haven't, the people that picked that spot were thoughtful in the sense that yes they found a place with nearly 3 miles of volcanic strata underneath it that is relatively hard, but it of course has relatively soft areas in between it. But the river is sitting on top of all that hard material. The basalt. And so are your tanks. And so it's simply, if you would just apply childhood physics to this matter, you have a rock hard basin with the tanks sitting up on the surface. And you have a very tremendous and powerful river sitting next to those tanks. And that river, if you'll all study the Missouri floods, that very well respected theory, but geologically provable, that river about 11,000 years ago for a period of 2,000 years was flushing water over the top of the Hanford, as I call it, peninsula, at a level of probably more than 800 feet deep. So with the coming atmospheric affects that may take place due to global warming, no one can actually predict whether you will, in the next 4 or 5 hundred years. And I think you need to take a longer term, 130 years. Shame on you all. Does radioactivity observe those kinds of microseconds? No, and you all know that. And you need to begin to face the long life of radioactivity, and the long life of the river. So, in the next 4 or 5 hundred years your likely to see floods on the magnitude overtop the section of Hanford that you have your tanks in. Now that's why you need to move that stuff out of there. It needs to be moved. And of course it costs billions. But these are the things humans are good at, these kind of projects.

Response The current and foreseeable future climatic conditions would preclude catastrophic flooding of the TWRS facilities. This conclusion is supported by the analysis provided in Volume One, Sections 4.2 and 5.2; Volume Four, Appendix F; and Volume Five, Appendix I.

L.5.3 AIR QUALITY

Comment Number 0072.28

CTUIR

Comment The emission estimates were not documented.

Response Emission estimates were provided in the Engineering Data Packages for the various alternatives, which are available for public review in DOE Reading Rooms and Information Repositories. Emission rates were calculated from these emission estimates using the construction and operating schedules presented in the packages. The resulting emission rates are presented in Volume Five, Appendix G. Emission calculations in tons emitted for each constituent are contained in the references shown in Volume Five, Appendix G. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.29

CTUIR

Comment No onsite receptors were evaluated and no risks were calculated.

Response Onsite receptors were evaluated and risks were calculated in Volume One, Section 5.11 and Volume Three, Sections D.4, D.5, and D.6 of the Draft EIS in Volume Three, Appendix D. A rectangular grid of 834 receptors, which encompasses the entire Hanford Site, was used to evaluate potential air impacts onsite. The risk associated with potential air impacts, along with those from other media evaluated (groundwater and soil), was calculated for each exposure scenario evaluated and presented in Volume Three, Appendix D. Risk contour maps are presented in Volume Three, Section D.5 of the Final EIS.

Comment Number 0072.30

CTUIR

Comment Only a small subset of released constituents were modeled.

Response The pollutants presented in Volume One, Section 5.13 represent a small subset of the pollutants modeled. The results presented were for the pollutants that contributed to impacts. The complete list of pollutants and the modeling results are located in Volume Five, Appendix G. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.31

CTUIR

Comment There was no recognition that tank farms are only part of the annual Hanford dose; some apportionment is needed.

Response In Volume One, Section 2.0, Purpose and Need for Action, it is stipulated that this EIS addresses Hanford Site tank waste and encapsulated cesium and strontium to reduce existing and potential future risk to the public, Site workers, and the environment. An assessment of the contamination at the entire Hanford facility (Sitewide assessment) would facilitate apportionment of the contribution of TWRS. The Sitewide assessment is not within the scope of this document; consequently, no apportionment is presented. However, Volume One, Section 5.13 does address potential cumulative impacts of TWRS alternative emissions with emissions from ongoing and reasonably foreseeable activities. Please refer to the response to Comment number 0072.243. Because the information requested in the comment was included in the Draft EIS to the extent appropriate for the TWRS analysis, no modification to the document is warranted.

Comment Number 0072.32

CTUIR

Comment Particulate deposition should be included, since this is part of the annual NESHAPs reporting requirement.

Response The inclusion of particulate deposition in air emission modeling would reduce airborne concentrations and thus minimize offsite impacts. Ignoring the effect of particulate deposition results in a conservative estimate of air emission impacts. Particulate deposition was accounted for in the determination of anticipated risks to the general public due to ingestion of vegetation, meat, and milk contaminated by airborne deposition, as discussed in Volume Three, Appendix D. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.239

CTUIR

Comment P G-2: Sect. G.2.1: It is not clear whether fugitive emissions are included in the Area Sources. The relation between Stack/Fugitive-Area and Normal/Unplanned releases (per NESHAPs) should be made clearer. Are the stack numbers the same as those reported in the annual NESHAPs report? Is there a 1:1 correspondence between all the sources in the EIS and the NESHAPs reports? Please clarify the regulatory framework. For each source, please add the anticipated duration of operation or emission for the various alternatives (also add columns to the tables after the emission rate columns).

Response This comment contains six sections, each with its separate explanations. For clarity, each explanation has been given a number.

1. When fugitive emissions are included in the Area Sources, the text of the EIS points this fact out. In the Draft EIS, Volume Five, Section G.2.1, the following area sources associated with fugitive emissions are specifically called out: Waste Retrieval Annexes Areas, page G-3; and Process Facilities and Tank Farm Construction, page G-5.
2. All emissions are considered under National Emissions Standards for Hazardous Pollutants (NESHAPs) regardless of their source. There is no relation between Stack/Fugitive-Area and Normal/Unplanned releases, because all contribute to the emissions from the Hanford Site.
3. Because the stack designations used in the EIS are for air modeling and environmental planning purposes and have therefore not been constructed, they will not be found in the annual NESHAPs report.
4. The sources in the EIS are of a conceptual nature. The exact sources that will be active during construction and operation would be determined during final design. Consequently, there is no correspondence between the sources in the EIS and the NESHAPs reports.
5. The regulatory framework of the EIS is explained in detail in Volume One, Section 6.0. In particular, the relevant environmental requirements are detailed in Volume One, Section 6.1.
6. The anticipated durations of the construction and operating phases for each alternative are shown by alternative in Volume Five, Section G.2.2, Model Scenarios.

Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.240

CTUIR

Comment P G-13: Sect. G.3.1.2: Please forward information regarding particle sizes, Ranges, densities, and deposition rates for this section. This information was not in the tables referenced. Additionally filter failure rates should also be included.

Response A study conducted on cooling towers (Wistrom and Ovard 1973) shows the size of particulate matter (PM) emitted from cooling towers to range from 20 µm to 2,400 µm. Particles larger than 450 µm settle out within 400 feet from the tower. Approximately 30 percent of tower emissions are less than 450 µm and may drift offsite. These particulates will decrease in size as the water drop evaporates.

Particulate matter nominally 10 micrometers (µm) or less (PM-10) emissions associated with construction mainly are due to engine exhaust and fugitive dust. AP-42 Table C.2-2 (Wistrom and Ovand 1973) shows that 95 percent of PM due to engine combustion is smaller than 10 µm and 90 percent is smaller than 2.5 µm. Fugitive dust emissions tend to be smaller than 30 µm with 20 to 40 percent less than 10 µm, depending on source.

Radiological PM emissions emitted from HEPA air filters will be much smaller than 10 µm. The term HEPA was designated by the U.S. Atomic Energy Commission for filters that are at least 99.97 percent efficient by volume on 0.3 µm particles (Austin and Timmermann 1965). A control efficiency of 99.95 percent per filter was assumed in the Engineering Design Packages, which are cited in the EIS and available for reviews in DOE Reading Rooms and Information Repositories. Particle size data, densities, and deposition rates from the various emission sources are currently not available.

Comment Number 0072.241

CTUIR

Comment P G-13: PP 3: What are the filter failure rates for the tank farms and the WESF?

Response WSRC-TR-93-262 gives a recommended value of 5.0E-07 per hour for failure from rupture under regular operating conditions (4.4E-03 per year). The HEPA filtration systems have monitoring and alarm systems. If the filter plugs or blow out, the differential pressure gives indication. HEPA filter failure accidents are not covered in Volume Five, Appendix G but in Volume Four, Appendix E, Accident Analysis.

Comment Number 0072.242

CTUIR

Comment P G-15: Sect. G.3.1.4: No onsite receptor locations were evaluated. Since parts of the Hanford Site will be accessible to the public well before the 100 year assumed duration of Site-wide institutional controls is up, some on-site receptors should be added. Public dose limits apply to Site visitors as well as to the offsite boundary receptor. The only points of compliance indicated in this section were the Site boundary and the nearest residence. Although this is conventional for NESHAPs reporting, it is unacceptable for this EIS.

Response Sitewide institutional controls are designed to protect the public and restrict public access to areas of the Site that may pose a risk. In deciding which areas may be open to the public, a detailed assessment of potential exposure must be made and compared to the public dose limits then in effect. A discussion of anticipated health effects both during and after remediation may be found in Volume One, Section 5.11. Contour maps of potential health effects from air released during remediation are presented in Volume Four, Appendix E and Volume One, Section 5.11. Please refer to the response Comment number 0072.29.

Comment Number 0072.243

CTUIR

Comment P G-18: PP 2: The NESHAPs citation (40 CFR 61, Subpart H0 applies to *the entire Hanford Site as a single source*, not to a single program, activity or Area. Therefore, the proper comparison of air modeling results is not to the upper limit of allowed dose, but to a fraction of that limit. NRC uses the term "apportionment" (see, for instance, the WIPP permit) to set limits for individual activities within a larger unit; in the case of WIPP, the storage facility is not allowed to exceed 25 percent of the overall source term. The federal total dose limit for offsite receptors is 100 mrem (all pathways) and 10 mrem (inhalation only). This limits applies to the entire Hanford Site, and the ROD must specify what portion of this limit can be "filled" by TWRS activities. The 1 mrem contour (Phase 2, for instance) occurs in locations where non-rad workers work, and that are outside the bounds of the 200 Area. There is a second impact zone offsite (Ringold area, on the other side of the Columbia River) that will be of concern during actual operations.

Response The 40 CFR 61 Subpart H exposure limit is applied to the Site as a whole. As part of the Hanford Site Air Operating Permit, the annual potential emission from each discharge point has been identified. NESHAPs compliance is based on exposure at the nearest actual residence. Inhalation pathway exposure for the nearest resident for the

TWRS alternatives ranges from 0.019 to 2.4 mrem/yr as shown in Volume Four, Tables G.4.0.20 to G.4.0.30. For 1994, the nearest resident received 0.01 mrem by the inhalation pathway from all Hanford Site emissions (PNL 1995). Assuming the other Site facilities emissions continued at the 0.01-mrem/yr rate, the inhalation pathway exposures for the Site, including the TWRS alternatives, would range from 0.029 to 2.41 mrem/yr (0.019 plus 0.01 mrem/yr to 2.4 plus 0.01 mrem/yr). To be conservative, the TWRS EIS analysis also was performed for hypothetical residences at currently unoccupied locations along the Columbia River and Highway 240. All of these hypothetical residence locations were calculated to be below 1 mrem/yr (10 percent of the 10-mrem/yr NESHAPs) except for the In Situ Vitrification alternative, which was 18.8 mrem/yr at the maximum location. The potential for this exposure could be mitigated by including such measures as continued restriction on location of residences in the subject area.

However, because there are no residences at these hypothetical residence locations, the NESHAPs of 10-mrem/yr would not apply and there would be no exceedance. Volume One, Section 5.13 contains an analysis of the cumulative air quality impacts of the TWRS alternatives and other Site activities. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.244

CTUIR

Comment P G-36: Table G.3.1.2: No rationale is given for the selection of non-radiological constituents. Please do not refer us to endless other documents - the TWRS EIS is a stand-alone product that will be the sole basis of the ROD. It must provide complete information for evaluation. In particular, the document "Jacobs 1996" that is cited as the basis for the emission estimates is not publicly available, and may not have received any peer review at all. Presenting table after table of emission rates without any explanation is meaningless, and CTUIR cannot accept any results based on such unsupported data.

Response Incorporation of technical data and information by reference is used as a means to limit the volume of the EIS. Referenced supporting technical data, including Jacobs 1996, are publicly available in the Administrative Record and were provided to DOE Reading Rooms and Information Repositories during the Public Comment Period. An independent technical review of the Draft EIS was completed and a copy of this report is available in the TWRS EIS Administrative Record. This independent technical review found that data used in the analyses were derived from valid and fully documented sources that were traceable, and models used to predict impact analyses either were EPA-approved or accepted by experts as fundamentally sound.

Non-radiological constituents and emission rates for current operations (including the No Action alternative) at the tank farm were derived from the Hanford Site Air Operating Permit Application, which covers existing tank farms and evaporator operation. The selection of non-radiological constituents was based on measured emissions from monitoring instrumentation or tank vapor space sampling results. Constituents and emission rates for waste treatment operations addressed in other alternatives were derived from material balance calculations developed for each alternative.

Comment Number 0072.245

CTUIR

Comment P G-57: Table G.3.1.20: Only 5 radionuclides were used for some of the air modeling. 10 nuclides were used for other alternatives, without any explanation. Various sets of hazardous air pollutants were also used. Since the tank contents do not change between the various alternatives, this is illogical. This entire section must be improved.

Response The tables cited in Volume five, Appendix G provided radionuclide emission rates for the alternatives presented in the EIS. The tables showing five radionuclides were based on radionuclides presently reported by the tank farm operations groups. Because no additional information is available, these radionuclides form the basis for emission rates for alternatives where no activities are performed on the tank contents, (i.e., No Action, Long-Term Management, In Situ Fill and Cap). For the remaining alternatives, there is additional information on radionuclide emissions in the flowsheets contained in the engineering data packages. Where additional information is available, additional radionuclides are shown in the tables for a particular alternative, along with the source (e.g., process plant stack). The hazardous air pollutants referred to in the comment are shown in the preceding tables. The tables for No Action, Long-Term Management, and In Situ Fill and Cap alternatives show the emissions presently reported by the tank farm operations groups. The tables for the remaining alternatives show emissions during construction and operation, which are both taken from the engineering data packages. Construction emissions are those anticipated from use of heavy equipment on the Hanford Site. Operating emissions are those given in the flowsheets in the engineering data packages, which are available for review in DOE Reading Rooms and Information Repositories. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.246

CTUIR

Comment P G-21: Sect. G.5.3: No description of the presumed filter efficiency (and failure rates), particulate size range and deposition rates were given. Additionally, no consideration whatsoever of the long-term impacts of deposited material (either radiological or nonradiological) was given. If deposition rates had been evaluated, there would have been high impact areas identified (Gable Mountain and White Bluffs). Since federal NESHAPs reporting requires deposition and incorporation into agricultural products as part of the annual dose evaluation, corresponding calculation should be presented in the EIS. If they are not, it will be impossible to demonstrate that any of the alternatives will, in fact, be able to meet compliance limits.

Response Routine emissions are discussed in Volume One, Section G.3.1. HEPA filter efficiency was factored into the emission rates provided in the engineering data packages that support routine emissions. HEPA filter failure accidents are discussed in Volume Four, Appendix E, Accident Analysis. Please refer to the response to Comment number 0072.241.

Dose evaluations from routine emissions are not covered in Volume Five, Appendix G, but are discussed in Volume Three, Appendix D. The intent of Appendix G is to access whether or not the air emissions are in conformance with air quality standards. Please refer to the response to Comment numbers 0072.32, 0072.239, and 0072.240 for related information. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.247

CTUIR

Comment P G-33: Fig. G.4.0.12: Even without any deposition being included, it is apparent that there are high concentrations at the high elevations on Gable Mountain and Rattlesnake Ridge. This means that tribal members visiting those sites will receive a greater exposure than the general public. Further, more deposition will naturally occur at these higher elevations, thus placing these culturally important areas and the people who visit them at increased risk. This section must be revised and linked to socio-cultural impacts.

Response DOE and Ecology acknowledge the concern regarding potential concentrations of radionuclides on Gable Mountain and Rattlesnake Ridge. Further information on the short-term impacts of air emissions during operation of TWRS facilities is contained in Volume Five, Figures G.4.0.1 through G.4.0.12. At higher elevations, predicted concentrations and dose values could be somewhat greater than in the lower elevations, in the immediate area. For areas near Gable Mountain and Rattlesnake Ridge, predicted radionuclide doses are well below the Washington State Acceptable Source Impact Levels (ASILs) and radionuclide dose limits established by State and Federal standards. It would be reasonable to conclude that, even if the predicted doses are somewhat greater at higher elevations, these doses would not be expected to exceed State or Federal standards. The long-term impacts of remediation on Tribal members are addressed in a separate Native American scenario presented in Volume One, Section 5.11 and Volume Three, Appendix D. For information on this scenario, please refer to the response to Comment numbers 0072.198 and 0072.225 for post-remediation accident impacts.

Comment Number 0072.248

CTUIR

Comment P G-20: Sect. G.5.2.2: No description of the actual vitrification operations was given including temperatures, feed materials, emissions, air pollution control device efficiency, effects of startup, trial melts, upsets, and maximum rated capacity. The recent vitrification event at Savannah River should serve as an indication of anticipated variances in emissions.

Response A description of the vitrification operations is provided in Volume Two, Appendix B and was based on information in the referenced Engineering Data Package, which is available for review in the DOE Reading Rooms and Information Repositories. Please refer to the specific data package for vitrification to obtain the most detailed information available. Emissions are based on design rates for the equipment, which should represent peak emissions. Average operating rates (and emissions) are estimated to be approximately 40 percent of the design rates. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.249

CTUIR

Comment P G-83: Tables G.4.0.1-19: these Tables seem to have been prepared solely for reporting purposes and have no identifiable relation to dose and risk. Each individual contaminant is compared to a regulatory level, but no other information is presented. The concentrations vary from 1 hour to annual averages, again without explanation as to whether this assumes maximum continuous operation, or something else.

Response As is stipulated in Volume Five, Section G.5.3 (page G-21), these tables were used to screen the potential impacts associated with air contaminants at the Site versus applicable regulatory (State and Federal) levels. The tables compare the modeling results to the Federal and State standards. The maximum 1-hour average concentration that resulted from the modeling was converted to 3-, 8-, and 24-hour average concentrations to compare to applicable standards when appropriate. The 1-hour average concentration was multiplied by 0.9 to obtain the 3-hour average, 0.7 for the 8-hour average, and 0.4 for the 24-hour average (EPA 1992b).

Predicted maximum emissions for hazardous air pollutants and pollutants for which a Washington State ASIL exists are provided along with the applicable level in Tables G.4.0.1 through G.4.0.19. Some of the pollutants evaluated have Washington State ASIL of Federal Standards reported for 1-hour, 3-hour, 8-hour, or 24-hour concentrations. For instance, PM-10 has a Federal and State 1-, and 8-hour standard. Consequently, for carbon monoxide, the 1-hour model predicted concentration was adjusted by multiplying it by 0.7 to obtain an 8-hour concentration. Because the 1-hour concentration can be altered by multiplying it by the appropriate conversion factor; a conservative estimate of the contaminant concentration is available for comparison to the applicable standards. The modeling results for all alternatives show no exceedances of Federal or State air quality standards for criteria pollutants, hazardous air pollutants, or radionuclides. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.250

CTUIR

Comment P G-83: Tables G.4.0.19: Groundshine must be included in the evaluation, with and without an assumption of intervention, and with varying degrees of intervention success.

Response Table G.4.0.19 is not in Volume Five, Appendix G on page G-83 as indicated; it is on page G-105. It is assumed the commentor is to referring to Tables G.4.0.1 to G.4.0.19. Because the constituents presented in Tables G.4.0.1 to G.4.0.19 are not radioactive, these constituents would not contribute to a groundshine pathway. However, Tables G.4.0.20 to G.4.0.30 compare the maximum dose per year from radiological constituents with State air quality standards (the purpose of Volume Five, Appendix G is to measure air emissions against air quality standards). The radiological releases do not exceed the air quality standards so intervention would not be required. The groundshine pathway was included in the evaluation of remediation risk to onsite and offsite receptors. Results of the remediation risk evaluation are presented in Volume Three, Appendix D. These results indicate that the impacts from groundshine are orders of magnitude less than from inhalation. The additive impact from groundshine, therefore, would not change the maximum dose shown in Volume Five, Tables G.4.0.20 to G.4.0.30 and no change to the document is warranted.

Comment Number 0072.251

CTUIR

Comment P G-12 - P G-19: Sects. G.3.0 and G.5.1: This section provides insufficient detail about modeling methods. Exposure assumptions must be presented, as well as assumptions about the particulate size range and respirable fraction used in the dose estimation.

Response The model used for this investigation is the Industrial Source Complex Model (ISC2). The model is a Gaussian dispersion model, which can be used for estimating the concentration of pollutants at a receptor. The model is a guideline air quality model accepted by the EPA for regulatory applications. The assumptions in Gaussian dispersion modeling are as follows.

- Pollutant emissions are continuous.
- Mass of pollutants released remains in the atmosphere during transfer from the source to the receptor.
- Meteorological conditions do not change.
- Diffusion in the downwind direction is negligible in comparison to transfer by the wind. Thus diffusion occurs in only the vertical and crosswind directions.
- Time averaged concentrations in the crosswind and vertical direction are assumed to be distributed normally.

ISC2 was run using the standard rural dispersion coefficients. Standard EPA procedures were followed and the regulatory default option was used. The options implemented included the following:

- Final plume rise that accounts for the effective height of the source of emission;
- Buoyancy-induced dispersion that allows for the plume size to increase at the stack exit point;
- Default wind profile exponents;
- Default potential temperature gradients; and
- Upper bound values for building downwash.

The respirable fraction of particulates is assumed to be those with diameter less than or equal to 10 µm (PM-10). Respirable particulates that are greater than 5 µm typically are trapped by hair follicles in the trachea and never reach the lungs.

The risk calculations for each exposure scenario are calculated in Volume Three, Appendix D. For the residential farmer exposure scenario, the exposure parameters for inhalation are as follows:

Inhalation rate - 20 $\frac{m^3}{day}$

Exposure frequency - 365 $\frac{day}{yr}$

Exposure duration = 6 yrs (child)
24 yrs (adult)

Body weight = 16 kg (child)
70 kg (adult)

Averaging time = 365 $\frac{day}{yr}$ * 30 yr

The exposure parameters for each scenario evaluated are presented in Volume Three, Appendix D. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0100.01

WDOH

Comment First, Washington's standard for radioactive air emissions is CAP-88. CAP-88 should be used for the modeling in the EIS.

Response There were several reasons why EPA's preferred radionuclide dose model was not used in this analysis. While portions of the dose calculation methodology of the Clean Air Assessment Package-1988 (CAP-88), as well as other site-specific models such as GENII, may have been incorporated in the risk assessment, the air dispersion algorithms of those models were not. The ISC2 was selected as the general air dispersion model for the following reasons:

- ISC2 is a sophisticated model with capabilities comparable to CAP-88, such as the ability to account for a wide spatial separation of many varied source types;
- ISC2 is an EPA guideline model, and was the choice for assessing traditional pollutants (e.g., dust and combustion products) and air toxic emissions;
- Use of ISC2 for all air dispersion modeling provided for consistency in the EIS; and
- A sitewide compliance demonstration with the radiological standards was not the goal of this EIS.

Volume Five, Appendix G contains a comparison of the ISC2 and CAP-88 modeling results and shows that these results compare closely.

Comment Number 0100.02

WDOH

Comment Second, the state standard for total radionuclides is misstated at 25 mrem/yr.

Response The text in Volume Five, Appendix G has been modified to state that the Ambient Air Quality Standard (WAC 173-480) for the maximum accumulated dose equivalent at any offsite receptor from a commercial nuclear facility is 25 mrem/yr. As a Federal facility, the Hanford Site could be expected to comply with the EPA regulation (40 CFR 61), which limits the maximum predicted dose at the nearest residence to 10 mrem/yr dose equivalent.

L.5.4 BIOLOGICAL AND ECOLOGICAL RESOURCES

Comment Number 0019.12

WDFW

Comment Page 5-64, third paragraph, third bullet. Should include "candidate" category as well.

Response The EIS text presents this key issue of the biological and ecological resources impact analysis in the following sentence: "... potential impacts on plant and animal species of concern (those listed or candidates for listing by the Federal government or Washington State as threatened, endangered and sensitive)."

Comment Number 0019.13

WDFW

Comment Page 5-65, section 5.4.1, first paragraph. WDFW believes it is more appropriate to discuss the percent loss of shrub-steppe within the waste management zone (WMA) to emphasize the impacts to shrub-steppe there. Currently, there is approximately 5,800 acres of undisturbed shrub-steppe within the WMA. Impacts to undisturbed shrub-steppe would range up to 6 percent in the WMA from the TWRS alternatives.

Response The EIS was modified in Volume One, Section 5.4 to add the percentage of undisturbed shrub-steppe that potentially would be affected by TWRS EIS alternatives within the waste management area.

Comment Number 0019.14

WDFW

Comment Page 5-67, Table 5.4.1, Phased Implementation (Total). Impacts do not match what is stated elsewhere in the text. 470 acres is stated here. 540 acres (pg. 5-230) and 690 acres (pg. 5-123) are mentioned elsewhere. Please clarify.

Response The EIS was modified to clarify and correct the potentially affected acreages for the Phased Implementation (Total alternative), based on revisions to the Phased Implementation alternative that occurred since publication of the Draft EIS. Volume One, Table 5.4.1 identifies the total amount of shrub-steppe that would be affected. Volume One, Section 5.4 identifies the total amount of land that would be affected, not only the amount of shrub-steppe. Table 5.14.1 has been revised to indicate that shrub-steppe impacts for the Phased Implementation (Total alternative) would be 94 hectares (240 acres) in the 200 Areas and 140 hectares (350 acres) at the potential borrow sites for a total impact of 240 hectares (590 acres). Volume One, Section 5.7 (page 5-123) indicates that approximately 320 hectares (790 acres) would be the total temporary construction-related land use, including both shrub-steppe and non shrub-steppe areas.

Comment Number 0019.15

WDFW

Comment Page 5-71, section 5.4.2, first paragraph. The nesting period should also include a discussion on passerines (sage sparrow, etc.) and that site clearing would avoid the breeding season for these species. These species also receive protection under the Migratory Bird Treaty Act.

Response The EIS has been modified in Volume One, Section 5.4 to include potential impacts on nesting passerine (songbird) species. Mitigation of potential impacts to these species would be described in the Mitigation Action Plan.

Comment Number 0019.16

WDFW

Comment Page 5-75, section 5.4.5, first paragraph. WDFW concurs with the importance of the McGee Ranch as a wildlife corridor for species migration, proliferation, and genetic diversity. Impacts to the McGee Ranch would have a significant adverse affect on wildlife.

Response DOE and Ecology acknowledge the position of the WDFW on McGee Ranch and addressed the wildlife corridor in the Affected Environment discussion in Volume One, Section 4.4 and Volume Five, Appendix I, and potential impacts to the wildlife corridor under each of the alternatives in Volume One, Section 5.4. It is important to note that the TWRS EIS will not support decisions associated with closure of the tanks and it is only under the hypothetical closure option analyzed in the EIS that adverse impacts to McGee Ranch would occur. Thus, no action taken as a result of this EIS would affect species migrations proliferation, or genetic diversity associated with the corridor. Please refer to the response to Comment numbers 0019.03 and 0072.08 for related information on how closure is addressed in the EIS and related impacts on potential borrow sites.

L.5.5 CULTURAL RESOURCES

Comment Number 0089.16

Nez Perce Tribe ERWM

Comment Page I-60, Paragraph 2

It needs to be emphasized that disturbed areas still have potential to contain cultural resources.

Response The EIS has been modified in Volume One, Section 5.5 to indicate that disturbed areas may contain cultural resources that were not identified during the cultural resources survey. This fact is acknowledged by DOE and Ecology and is the reason why the mitigation measures identified in

Volume One, Section 5.20 of the Draft and Final EIS include a commitment to conduct cultural resource surveys, consult with affected Tribal Nations, and mitigate through avoidance whenever feasible.

Comment Number 0101.03

Yakama Indian Nation

Comment In addition we consider that the actions should assure that cultural values of the Yakama Nation, not directly related to public health and safety or the ecological aspects of the environment, should be protected. These other cultural values stem from what could be termed religious beliefs and are associated with the sanctity of the land forms and other natural resources at Hanford.

To accomplish objective establishment of performance bases, i.e., a valid suite of scenarios to be used in the performance assessments, we consider experts knowledgeable in predicting future possible demographic conditions and societal land use patterns, including intruder scenarios, should be utilized. Delphi methods for polling expert opinions on such subjective topics should be employed. YIN representatives should be involved with this activity to assure the demographers, anthropologists, archaeologists, geologists and other experts having the knowledge to anticipate future conditions adequately incorporate scenarios involving Indian usage of the land, the water and the other natural resources, reflecting historical data as warranted. Without the valid determination of such conditions, including those which may occur and would be limiting with respect to the design confidence level, any of the actions described in the subject EIS may be unfounded and not protective of the public health and safety and the environment. In addition, actions justified as a result of the impact assessments may not meet requirements stemming from cultural values discussed above.

Response Please refer to the response to Comment number 0072.149 for a discussion of consultation with Tribal Nations on the TWRS EIS, and Comment numbers 0072.37, 0072.40, 0072.268, 0072.251, and 0072.53 for discussions of changes to the EIS based on Tribal comments on cultural values, cultural sites, and land uses. The discussion of Treaty rights and privileges has been modified in the Final EIS, based on consultation with the affected Tribal Nations, in Volume One, Section 4.4 and Volume Five, Appendix I. The EIS used reference cases, including the Native American subsistence scenario, for comparative purposes to predict unrestricted future land uses beyond the 100-year administrative control period to 10,000 years. These are incorporated into the Native American User Scenario, which is addressed in Volume One, Section 5.11 and Volume Three, Appendix D. For a complete discussion of this issue, refer to the response to Comment number 0072.149. For discussion of how the EIS addresses environmental justice analysis relative to the Tribal Nations, please refer to the response to Comment numbers 0072.271, and 0072.252.

In response to this and other comments by affected Tribal Nations, the risk assessment for the EIS was revised to include an evaluation of anticipated post-remediation risk to a Native American subsistence user of the Hanford Site. Inclusion of a Native American scenario in the Draft EIS was not feasible because a methodology for the assessment had not been developed sufficiently to be incorporated into the Draft EIS. The scenario used for the analysis was developed through consultation with representatives of the affected Tribes and included discussions regarding societal land use patterns, the intruder scenarios, and demographic conditions. Please refer to the response to Comment number 0072.198, which contains a complete discussion of the information included plus a document reference list regarding the addition of a Native American scenario. Please refer to the response to Comment number 0072.225 for a discussion of post-remediation accident impacts to Tribal Nation sacred sites and cultural values.

L.5.6 SOCIOECONOMICS

Comment Number 0072.33

CTUIR

Comment Counting the number of Native Americans living in the 3 nearest counties does not satisfy the Environmental Justice Executive Order or DOE policy.

Response As discussed in the response to Comment number 0072.53, the EIS environmental justice analysis provides demographic data in Volume One, Section 4.6 on Native Americans, as well as low-income and minority populations within an 80-km (50-mi) radius of the Hanford Site Central Plateau. This area includes portions of 10 counties in Washington and Oregon. Volume One, Section 5.19, Environmental Justice, presents a review of all TWRS alternatives' impacts on the natural and human environment that were addressed throughout Volume One, Section 5.0 to determine whether any potentially disproportionate and adverse impacts would occur to the identified minority or low-income populations, including Native American populations. Volume One, Section 5.20 identifies potential mitigation measures that DOE could adopt to address potential environmental justice impacts identified in Section 5.19. Please also refer to the response to Comment numbers 0072.252 and 0072.149.

Comment Number 0072.34

CTUIR

Comment Economic impacts of accidents were not included.

Response The model used to analyze economic impacts incorporates historical data on Tri-Cities socioeconomic conditions to test its results (e.g., the accuracy with which the model, using historical data yields output for past employment that agrees with known past employment levels). The model was then applied to future Hanford Site employment under each alternative to estimate area employment, housing prices, and taxable retail sales. Total area employment estimates were used to estimate impacts on public services. This analysis was presented in Volume One, Section 5.6.

DOE's Recommendations for the Preparation of Environmental Assessments and EISs (DOE 1993d) directs that impacts from low-probability events be analyzed with the amount of detail commensurate with their likelihood of concurrence and potential consequence. The likelihood of an accident under the TWRS alternatives that could affect the local economy is low. Further, there are no historical data for the Tri-Cities that could be used to provide a basis for analyzing potential economic impacts of accidents at the Hanford Site. Volume One, Section 5.6 and Volume Five, Appendix H have been modified to explicitly state that economic impacts of accidents have not been analyzed for post-remediation accident impacts. Please refer to the response to Comment number 0072.225 for a discussion of post-remediation accident impacts on Tribal Nation sacred sites and cultural resources and modifications to Volume Four, Appendix E regarding this issue.

Comment Number 0072.35

CTUIR

Comment No costs for storage, mitigation or disposal were included

Response An econometrics model was used for the economic impact analysis in the EIS to assess the impacts of TWRS alternatives. Hanford Site employment is used in the model as the key independent variable, and then equations based on historical data for the Tri-Cities area, are used to forecast the impacts of changes in future Site employment on socioeconomic conditions (e.g., total nonfarm employment, housing prices). Employment associated with TWRS activities such as waste storage and disposal is included in the analysis; thus, the costs of storage and disposal are included indirectly in the socioeconomic analysis. The direct costs of storage and disposal under each alternative are provided in Volume One, Section 3.0 and Volume Two, Appendix B. Please refer to the response Comment number 0072.225 for a discussion of the impact of mitigation of post-remediation accidents. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.36

CTUIR

Comment Jobs and housing as the only socioeconomic measures is unsatisfactory.

Response In addition to jobs and housing, the EIS socioeconomic impact analysis includes impacts on taxable retail sales, population, and a wide range of public facilities and services, including schools, police and fire services, medical services, solid and sanitary waste disposal systems and electricity and natural gas energy services in Volume One, Section 5.6 and Volume Five, Appendix H. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.252

CTUIR

Comment P H-1: Sect H.1.0: The topics covered in this section include the impact on local jobs, impact on the Tri-Party Agreement Milestone schedule, and impacts on demographics, housing prices and similar items. Therefore, we would expect to also see a full treatment of community and tribal quality of life, and intra- and intergenerational equity. This is, in fact, the intent of NEPA and is required under Executive Order 12898. We are aware that scoping discussions pertaining to this type of analysis were held with contractors and Headquarters personnel, yet it is entirely omitted from the Draft EIS.

Executive Order 12898 and DOE Environmental Justice Policy. The Executive Order states that the human health and environment of minority populations must be evaluated, including differential patterns of consumption, social and economic impacts, and whether there is a disproportionate burden of exposures and/or risks on these populations. DOEs Environmental Justice Strategy includes provisions for identifying high risk populations (including subsistence consumption patterns), and for identifying DOE activities that might have a disproportionately high human health or environmental effects on minority populations. This goes far beyond merely counting the number of Native Americans in the three Hanford counties. ***CTUIR expects DOE to consult with technical staff in order to ensure that adverse impacts on a traditional subsistence lifestyle and characterization of populations at highest risk are adequately evaluated for the baseline conditions and for each alternative for as long into the future as the contamination or post-remediation conditions persist..*** The DOE Strategy also directs programs to "encourage ... participation [of American Indian Tribes] in the development of NEPA documents." Since a typical simple "scoping" briefing does not satisfy this directive, and since many of the deficiencies of this EIS could have been anticipated and corrected before publication of the Draft EIS, ***CTUIR further expects DOE to proceed with the revision of the EIS and negotiation of the Record of Decision to genuinely include CTUIR as an equal participant in the decision-negotiation process and in the development of mitigation action plans.***

Response Volume One, Section 5.19 was devoted to a summary of the environmental justice analysis included in the EIS. Volume Five, Appendix H is intended describe the analysis of the socioeconomic impacts of the TWRS EIS alternatives. A summary of this impact analysis is presented in Volume One, Section 5.6. The impacts of the alternatives on other aspects of the human and natural environment are presented in Volume One, Section 5.0 (e.g., air, water, human health, and land use).

The environmental justice requirement states that the environmental justice analysis should be completed to the "extent practicable and appropriate" (EO 12898). In developing the data to support the analysis, the Executive Order instructs agencies to "collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have substantial environmental, human health, or economic effect on the surrounding populations." This information is to be used to determine if "programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations."

The Executive Order mandate to collect data that are readily available on the area surrounding the site likely to be impacted by a proposed action and to analyze impacts that may have disproportionately high and adverse effects on minority and low-income populations is consistent with NEPA requirements. NEPA requires that a sliding scale be applied to analysis of potential impacts on the human and natural environment. "The sliding scale approach to NEPA analysis recognizes that agency proposals can be characterized as falling somewhere on a continuum with respect to environmental impacts. This approach embodies instruction that CEQ has provided (40 CFR 1502.1 and 1502.2, for example) with respect to preparation of EISs. The term 'scale' refers to the spectrum of significance of environmental impact. Do not attempt to quantify impacts on environmental resources when it is clear form the context that any impacts would be virtually absent" (DOE 1993d).

For the purposes of complying with the environmental justice and NEPA requirements, the TWRS EIS adopted the following approach to analysis of potential impacts to minority and low-income populations. The data presented in Volume One, Section 4.0 and Volume Five, Appendix I support the environmental justice analysis by describing the affected environment, including potentially affected populations. Consistent with Executive Order 12898 requirements, Section 4.6 and Appendix I identify minority and low-income populations that may be impacted by the proposed action. The second NEPA requirement is to determine the potential impacts of the EIS alternatives on the affected environment. The analysis of potential impacts to the affected environment is presented in Volume One, Section 5.0. This analysis considers the potential impacts on all populations and if an impact would adversely and disproportionately impact minority or low-income populations, the impact was identified.

Based on the analysis of potential impacts to the human and natural environment, the environmental justice initiative requires the agency to determine if any of the impacts would pose a disproportionately high and adverse impact on minority and low-income populations. This analysis is presented in Volume One, Section 5.19. For each area of potential impact (e.g., land use, human health, air quality, water quality) impacts presented in Volume One, Section 5.0 were reviewed to determine if there were any potential disproportionate and adverse impacts to the surrounding populations. If an adverse impact was identified, a determination was made as to whether minority or low-income populations would be disproportionately affected. In the Draft EIS, two potential impacts were identified that would present a concern based on the requirements of the environmental justice initiative. The analysis of the impacts for the Final EIS have been reviewed based on comments and consultation with Tribal Nations. The result of this review has been a modification to the text of Volume One, Section 5.19 to indicate that under all of the alternatives, except No Action and Long-Term Management, certain adverse impacts to sacred sites would occur.

The final requirement of the environmental justice initiative is to mitigate any disproportionate and adverse impacts. In the EIS, mitigation measures that address the environmental justice impacts are addressed in Volume One, Section 5.20. Based on the decision documented in the ROD, DOE will prepare a Mitigation Action Plan, which will document mitigation measures to be implemented

For the Draft EIS, the analysis of human health impacts determined that minority and low-income populations would not be disproportionately and adversely impacted by TWRS actions compared to non-minority and non-low-income populations. However, one area of potential differential impacts could not be fully analyzed in the Draft EIS. This area of potential impacts, long-term risks to human health under a Native American Subsistence scenario, could not be incorporated into the Draft EIS because a methodology for the analysis had not been developed to a level sufficient to support incorporation into the EIS. Subsequent to publication of the Draft EIS, a Native American subsistence scenario has been developed for use on the Hanford Site. Following consultation with affected Tribal Nations, this scenario has been incorporated into the Final EIS. This analysis is presented in Volume Three, Appendix D and summarized in Volume One, Section 5.11. For discussion of consultations with Tribal Nations, please refer to the response to Comment number 0072.149.

Throughout the NEPA process, DOE and Ecology have been proactive in consulting with the affected Tribal Nations regarding the content of the TWRS EIS. Many substantive portions of the Draft EIS were the result of consultation with affected tribes from scoping to the publication of the Draft EIS; just as many of the changes in the Final EIS reflect consultation that has occurred since the Draft EIS was issued for comment. Consultation is a valuable part of the NEPA process. As with any intergovernmental relationship, DOE and Ecology understand that the consultation process requires improvement and will continue to work with the affected Tribal Nations to that end. A proactive consultation process results in the meaningful exchange of technical information between both parties and a shared understanding of the challenges, issues, and concerns that the agencies and Tribal Nations face as they work to improve the environment of the Hanford Site. Please also refer to the response to Comment numbers 0072.53 and 0072.271 for related discussions. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.253

CTUIR

Comment P H-2: Sect H.1.1: This section deals solely with Hanford employment numbers. We would also expect to see baseline information about local services (for example, school attendance and student-teacher ratios; number of emergency and enforcement personnel per capita, and so on). Various economic impact analysis methods, such as economic base models, econometrics analysis, or input/output models, would require some of this data.

Response Baseline data about local services (e.g., schools, police, and fire services) are provided in Volume Five, Appendix I (Affected Environment), rather than Volume Five, Appendix H (Socioeconomic Impact Modeling). The model used in the EIS uses the historical statistical relationship between Hanford Site employment and other socioeconomic factors (i.e., total nonfarm employment, population, and housing prices) to predict the effects of the TWRS alternatives employment on total nonfarm employment, population, and housing prices. Changes in Hanford Site employment drive the changes in these other socioeconomic aspects of the Tri-Cities area. The model outputs, in terms of future population changes, then were used to assess the TWRS alternatives potential impacts on school enrollments, police and fire services, and other local services. The assessment of impacts on these services was performed by evaluating how the additional TWRS demands on the service systems would affect their ability to meet the total demand (non-TWRS related demands plus TWRS-related demands). This element of the assessment did not involve using the socioeconomic impact model. Please refer to the response to Comment number 0072.36.

Comment Number 0072.254

CTUIR

Comment P H-4: Sect. H.2.0: No documentation for the 2.4 multiplier (2.4. non-Hanford jobs created/lost for each Hanford job) is provided. Various estimates have been used by local civic planners.

Response The socioeconomic impact assessment model uses the historical statistical relationship between Hanford Site employment and total Tri-Cities nonfarm employment as the basis for predicting how changes in future Site employment would affect total area nonfarm employment. The analysis of historical data shows a relationship of approximately 2.4 non-Hanford jobs created/lost (for each Hanford job). This 2.4 multiplier is in reasonably close agreement with employment multipliers used in other Site NEPA analysis. For example, the Final SIS EIS used an employment multiplier of 2.2, based on socioeconomic input/output analysis performed by PNL in 1987 and 1991 (DOE 1995i). The socioeconomic model used for the TWRS EIS also was used for another recent Hanford NEPA document, the HRA EIS. The socioeconomic model used in the TWRS EIS is the most recent model specifically designed to analyze the Tri-Cities economy and incorporated the most recent data available at the time the Draft EIS was prepared.

Comment Number 0072.255

CTUIR

Comment P H-6: Sect. H.2.3: There needs to be identification of the age distribution was used, only total population seems to be here.

Response The socioeconomic impact assessment model utilizes and predicts total population only. The model does not utilize or predict age distribution of the local population. Age distribution modeling would have limited utility in analyzing the relative difference in impacts among the alternatives. For the purpose of this EIS, the only socioeconomic indicator reliant on age distribution in the population would be the impact to public schools in the Tri-Cities area. For this analysis, it was assumed that the age distribution in the future population under each alternative would be the same as the present age distribution (Volume One, Section 5.6). The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.256

CTUIR

Comment P H-7: Sect H.2.4: This section needs to be edited to count for accident impacts.

Response The socioeconomic impact assessment model and methodology used for this EIS does not incorporate possible economic impacts of potential accidents. Language has been added to Volume One, Section 5.6 and Volume Five, Appendix H.2.4 to inform the reader that the economic impact analysis does not address potential impacts associated with accidents. The probability of an accident that would have major economic impacts is extremely low, as described in Volume One, Section 5.12 and Volume Four, Appendix E. Please refer to the response to Comment number 0072.225 for a discussion of post-remediation accident impact on Tribal Nation sacred sties and cultural resources. Please also refer to the response to Comment number 0072.34 for a discussion of economic impacts caused by accidents.

Comment Number 0072.257

CTUIR

Comment P H-7: Sect H.3.0: Same comment as above. (See Comment number 0072.256.)

Response Please refer to the response to Comment number 0072.256, 0072.34, and 0072.225.

L.5.7 LAND USE

Comment Number 0036.18

HEAL (Exhibit)

Comment EIS does not deal with most important aspect of permanent land-use commitments.

According to the EIS, there are no potential implications for future land use that need to be dealt with in this EIS. This is because the EIS does not include closure decisions, and Hanford's land use plan is not done. According to the EIS, "No exclusion or restricted use zones have been defined, but this type of land-use issue is expected to be addressed in the land use planning process for the Hanford Site that is currently underway" (p. 5-121). This is a cop-out. The decisions that will be made in this EIS have clear, far-reaching, and critical future land use implications.

The alternatives leave behind waste resulting in risks for future generations that are between significant and downright scary. Some of the alternatives result in risks that absolutely mandate land use restrictions. Potential land use restrictions are a real and important aspect of determining an alternative's impacts.

By limiting the land use commitments to essentially the amount of shrub-steppe that is torn up, the agencies ignore the important health and economic aspects of potential future land use restrictions. In dealing with deadly tank wastes, a few acres of shrub-steppe is nothing compared to keeping Hanford off-limits forever.

Response Volume One, Section 5.7 addresses three distinct land-use implications of the TWRS alternatives. These include permanent land use commitments in the 200 Areas associated with the remedial activities addressed in the EIS, permanent land use commitments in the 200 Areas associated with the potential closure scenario included in the EIS to support a comparative analysis of the alternatives, and land use commitment implications outside the 200 Areas associated with the remedial activities and potential closure scenario.

The impact analysis for commitments in the 200 Areas associated with remedial activities concluded "Temporary and permanent proposed land use commitments for remedial activities under all TWRS EIS alternatives would be consistent with past and existing land uses for the 200 Areas, as well as with proposed use of the area as an exclusive-use waste management area." These land use commitments would range from 0 to 99 acres according to which alternative was implemented and would largely consist of the tank farms and LAW disposal vaults.

For permanent land use commitments associated with the potential closure scenario presented in the EIS, the EIS concluded that land use commitments would include, "the areas that would be covered by the Hanford Barriers under all alternatives except No Action and Long-Term Management." These land use commitments would require approximately an additional 20 to 40 acres beyond those committed under that remedial phase of the implemented alternative.

For land use implications outside the 200 Areas, the EIS indicates that "Groundwater contamination has land use implications. While land uses might not be precluded because of underlying groundwater contamination, the value of land for potential future uses such as agriculture could be diminished or restricted because the underlying groundwater could not be used. Under all EIS alternatives, TWRS activities would contribute to future Site groundwater contamination."

The EIS also states that "No exclusion or restricted use zones have been defined, but this type of land use issue is expected to be addressed in the land use planning process for the Hanford Site that is currently underway." This land use planning process, the CLUP, would consider the implications of the impacts of the TWRS alternatives in the identification of land areas requiring exclusive and/or restricted use. Thus, the information provided in the EIS is a critical part of the land use planning process and provides an important basis for future decisions. When considering the impacts of land use options associated with the TWRS alternatives, land use planners will have available for consideration an extensive amount of information regarding risks to future generations under various land use scenarios. The EIS analyzes health risks associated with alternative land uses in Volume One, Section 5.11 and Volume Three, Appendix D, including residential farmer, industrial worker, and shoreline recreational user. Since the publication of the Draft EIS, a Native American subsistence user scenario has been added to the analysis. For more information on this scenario, please refer to the response to Comment number 0072.198. The EIS also provides information regarding the implications for the waste site intruder or residential farmer who uses waste site drilling spoils site. Finally, the EIS provides data regarding the extent of groundwater contamination that potentially could result from each alternative. All risks and impacts analyzed were extended to 10,000 years into the future.

The EIS does not limit the analysis of land use commitments to "essentially the amount of shrub-steppe that is torn up." None of the land use impacts identified are based on shrub-steppe disturbance as a criteria for determining land use impacts. Rather, for temporary land use commitments, the EIS does identify the amount of land that is not currently disturbed within the 200 Areas that would be needed to support "construction and operating the alternatives and construction activities associated with closure." This land would be unavailable for alternative uses during the period of construction or operations and then after construction or operations was completed. Permanent land use commits land used for waste disposal facilities to permanent waste disposal. These areas become unavailable for alternative uses. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.5.8 VISUAL RESOURCES

No comments were submitted for this topic.

L.5.9 NOISE

No comments were submitted for this topic.

L.5.10 TRANSPORTATION

No comments were submitted for this topic.

L.5.11 ANTICIPATED HEALTH EFFECTS

Comment Number 0005.16

Swanson, John L.

Comment I would like to see the cancer risk estimates presented in the context of comparison with the cancer risk to the involved population due to background radiation and to other "naturally" occurring cancers. I would also be interested in seeing estimated values of something like "dollars per cancer prevented" for the alternatives.

Response The context requested by the comment is presented in Volume One, Sections 4.11 and 5.11, which discuss the effects of radiation on humans, including the cancer risk from exposure to natural or background radiation sources. DOE and Ecology believe that presenting estimates such as dollars per cancer prevented would be inappropriate because such estimates could be construed as a value judgment. The purpose of the EIS is to provide decision makers and stakeholders with a balanced, unbiased assessment of the impacts associated with the alternatives.

Comment Number 0072.197

CTUIR

Comment P D-2: Table D.1.0.1: The first bullet in the post remediation risk is unacceptable because closure was addressed within earlier sections, and the leakage is tank waste leakage, not some other form or source of leakage.

Response The existing contaminants from past practice are not in the scope of this EIS. The impact of closure is not evaluated for this EIS. DOE will conduct an appropriate NEPA review in the future (59 FR 4052). For purposes of comparing the alternatives, a single and consistent method of closure, closure as a landfill, was assumed for all alternatives. This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. Volume One, Section 3.3.1 discusses the closure issue in greater detail. The leakage of tank waste during the remediation is considered in the risk assessment in this EIS. Past tank waste leaks are considered in the analysis of cumulative impacts presented in Volume One, Section 5.13 and Volume Four, Appendix F. For additional information on the relationship between closure and this EIS, please refer to Comment numbers 0072.08 and 0101.06 for discussions of the closure issue and 0030.02, 0091.01, and 0012.15 for a discussion of vadose zone contamination. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.198

CTUIR

Comment P D-12: Sect. 2.1.3: Please insert a subsistence Native American scenario into this section. The subsistence Native American scenario represents a Native American living on the land subsisting from all the natural resources inherent on the Hanford site. This scenario involves complete acts or activities, is assumed to have access to ground water and is assumed to live anywhere on the site or anywhere along the Columbia River.

Response In consultation with the affected Tribes, a Native American scenario has been developed and used to evaluate the post-remediation risk to a Native American user of the Hanford Site. This scenario represents exposures received during a 70-year lifetime by a Native American living on the land and subsisting on its inherent natural resources. Subsistence activities included in this scenario include hunting, fishing, and gathering of plants and materials. Pathways include those defined for the residential farmer scenario in the Hanford Site Risk Assessment Methodology (HSRAM) (DOE 1995c), plus additional pathways, such as sweat bathing, which represent activities unique to the Native American subsistence lifestyle. The ingestion rates of native foods are based on a combination of EPA-suggested intake rates (EPA 1989b), intake rates used for the Native American scenarios in the Columbia River Comprehensive Impact Assessment (Napier et al. 1996), and data obtained through consultation with the affected Tribes. A complete description of the Native American exposure scenario and the method for its evaluation have been added to Volume Three (Appendix D, Section D.2.1). Results of the post-remediation risk calculations for the Native American scenario have been added to Volume Three (Appendix D, Section D.5.0). A summary of the scenario description and the risk results have also been added to Volume One (Section 5.11.2). For related information on post-remediation accident impacts to Tribal Nation sacred sites and cultural resources, please refer to the response to Comment number 0072.225.

Comment Number 0072.199

CTUIR

Comment P D-14: Please insert the subsistence Native American scenario here.

Response The risk assessment for the EIS was revised in Volume One, Section 5.11 and Volume Three, Appendix D to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. Please refer to the response to Comment number 0072.198 for more information on the Native American scenario.

Comment Number 0072.200

CTUIR

Comment P D-16: Please insert table D2.1? Exposure pathways included in subsistence Native American Scenario: Subsistence Native American Exposure factors; Subsistence Native American Summary Intake factors.

Response Three new tables containing the data and assumptions used for evaluating post-remediation exposures for the Native American scenario were added to the post-remediation methodology discussion presented in Volume Three, Appendix D, Section D.2.1.3. Table D.2.1.2 presents the exposure pathways included in the Native American scenario, Table D.2.1.3 presents the Native American scenario exposure factors, and Table D.2.1.4 presents the Native American scenario summary intake factors. In addition, please refer to the response to Comment number 0072.198 for more information on the scenario.

Comment Number 0072.201

CTUIR

Comment P D-23: External-exposure route shielding is spelled incorrectly.

Response The spelling error has been corrected in Volume Three, Table D.2.1.6.

Comment Number 0072.202

CTUIR

Comment External-other factors 'shielding' is spelled incorrectly.

Response The spelling error has been corrected in Volume Three, Table D.2.1.6.

Comment Number 0072.203

CTUIR

Comment Same comment as above. (see comment number 0072.202)

Response The spelling error has been corrected in Volume Three, Table D.2.1.6.

Comment Number 0072.204

CTUIR

Comment P D-32: The Strenge-Chamberlain 1995 reference does not differentiate between roots and leafy matter.

Response The risk calculation for all receptors indicates that the contribution of roots and leafy vegetables to the overall risk is very small compared to drinking water. This is demonstrated in the uncertainty analysis developed for the Final EIS and presented in Volume Five, Appendix K.

Comment Number 0072.205

CTUIR

Comment P D-33: The fish ingestion pathway should be based upon the whole fish and not just on what is considered to be 'edible' portions. For further information contact CTUIR technical staff regarding this issue.

Response The concept of edibility varies from culture to culture and Native Americans might consume portions of fish and other animals not commonly consumed by other cultures. The Native American scenario added to the Final EIS, which was developed through consultation with the affected Tribal Nations, includes pathways for ingestion of fish organs, animal organs, and wild bird meat. Intake of fish organs was accounted for by increasing the total fish muscle tissue intake by 10 percent and assuming that contaminated concentrations in fish organs were 10 times the concentrations in fish muscle tissue. Intake of animal organs and wild bird meat was similarly accounted for by increasing the total meat ingestion rate. Please refer to the response to Comment number 0072.198.

Comment Number 0072.206

CTUIR

Comment P D-35: Please re-look at this paragraph, it is awkward and needs to be redone in relation to recent material regarding the Chernobyl accident. Additionally, there is new information regarding genetic affects as presented in NCRP no. 116.

Response Although some epidemiological data for the Chernobyl accident are available in the scientific literature, the studies are not yet complete and the ICRP has not yet issued revised recommendations for hereditary risk factors based on Chernobyl data. The international risk community is now evaluating the hereditary effects of the Chernobyl accident by tracking the incidence of hereditary effects in the progeny of the exposed population and statistically comparing this incidence to that of a nonexposed control population. Until these studies are complete and the ICRP publishes revised recommendations regarding hereditary risk, it would not be appropriate to use Chernobyl data as the basis for an evaluation of hereditary risk.

In response to this comment, the genetic effects information in National Council on Radiation Protection and Measurement (NCRP) No. 116 has been reviewed. This information suggests that the human and animal genetic studies mentioned in the EIS might underestimate the genetic effects of ionizing radiation. The text of the EIS in Volume Three, Section D.2.1.3.3 has been modified to indicate that genetic effects might be greater than indicated by previous human and animal studies, but that the data are not sufficiently validated to permit analysis at this time.

Comment Number 0085.04

Klein, Robin

Comment At the same time, we must act aggressively and do what we can now to prevent further calamity and contamination. Also, the Draft EIS considers these hypothetical users over the next 10,000 years. It is ludicrous to consider such bearing uses, or to consider controls or restrictions for use of soil, groundwater, whatever, so many years hence. Therefore we have a responsibility, an obligation to clean up the site to the fullest extent possible, and as aggressively as we can to reduce spread and impact of the contaminants.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Consideration of land uses over long periods of time extending into the future was carried out for purposes of comparing alternatives that would have impacts far into the future. The alternatives evaluated represent a reasonable range of alternatives for accomplishing the TWRS mission. Long-term impacts are calculated to support the decision-making process. The EIS also presents short-term impacts associated with implementation of the alternatives and within the 100-year administrative control period. Both long-term and short-term impacts are presented to provide the public and the decision makers with information on environmental and human health impacts that support the comparison of the impacts among the alternatives. Because both short- and long-term impacts are provided, no change to the document is warranted.

Comment Number 0085.05

Klein, Robin

Comment For the record, the anticipated numbers of cancers and fatalities in the Draft EIS that would result from various scenarios and alternatives are a subject of scientific and political controversy in and of themselves, and should not be taken as absolute in this Draft EIS, but rather as relative measures.

Response The risk calculations were performed to support the impact assessment and comparison of alternatives. These risks were not intended and should not be interpreted to represent absolute risks. The Final EIS in Volume One, Section 5.11 and Volume Three, Appendix D presents ranges of risk for each alternative, which provides a better estimate of the potential risks associated with each alternative. For the Final EIS, an expanded uncertainties analysis has been incorporated in Volume Five, Appendix K. This analysis addresses the nominal bounding risk estimate.

L.5.11.1 Remediation Risk

Comment Number 0005.56

Swanson, John L.

Comment One page 5-154 it is said that the cesium and strontium capsules contain no nonradiological chemicals. This is not true; they contain nonradioactive isotopes of cesium and strontium as well as stable isotopes produced on decay of the radioactive isotopes, and also the added chloride and fluoride. (On page 6-22 it is said that these capsules contain hazardous, characteristic, and/or listed wastes).

Response Wording to clarify that the capsules contain chloride, fluoride, and decay products (barium-137 and zirconium-90), in addition to the cesium and strontium, has been added to Volume One, Section 5.11. Risk from nonradiological chemicals during remediation was not evaluated because no nonradiological chemical emissions are associated with any of the capsule alternatives. Wording to clarify this point has also been added to Volume One, Section 5.11.

Comment Number 0028.01

DHHS

Comment The Draft EIS TWRS section dealing with potential adverse human health effects resulting from environmental releases of radioactive or hazardous materials, Volume Three and Appendix D, appears to be well developed and comprehensive:

1. Radiological and hazardous waste exposures to the public from treatment, storage, and disposal operations were estimated using information on waste loads (source terms) and potential at-risk years. Exposure modeling included meteorological data, hydro-geologic data, and potential release scenarios that included both facility and transportation accidents. Pathway modeling included use of GENII-S environmental modeling code. The function and source of each model type are well documented.
2. Risk estimate endpoints for the public included a) cancer incidence from radionuclide and chemical exposures, b) cancer fatalities from radionuclide exposure, c) adverse effects from transportation and/or transportation accidents.
3. Risk from radiological exposures were estimated using ICRP 60 risk factors. The uncertainties in the risk analysis procedure included model uncertainty, scenario uncertainty, and parameter uncertainty (sampling error, data sources).
4. The risk to public health from the transportation and storage of DOE waste materials, as expressed by the Draft EIS TWRS are reasonable.

Response DOE and Ecology acknowledge the comments concerning risk assessment. In response to public comments, the risk assessment has been enhanced by adding a Native American scenario to the evaluation of anticipated post-remediation risk and the analysis and presentation of risk ranges to request uncertainties. Please refer to the response to Comment number 0072.198 for a discussion of the Native American scenario and Comment number 0085.05 for a discussion of risk ranges.

Comment Number 0069.08

Pollet, Gerald

Comment Next, it is wrong to assume that the public in the near term, that is between now and the year 2028, will remain at the Site boundary in calculating risks. Even if you use the Site boundary, the risk calculations are out of date, and fail to consider risks from people using the river, and the new residences that are far closer than the previous north Richland case used.

Response The risk assessment in the Draft EIS addressed users of the Columbia River, the Fitzner Eberhardt Arid Lands Ecology Reserve, and areas of the Hanford Site north of the Columbia River. This information is presented in Volume One, Section 5.11 and Volume Three, Appendix D. The risk assessment in the Draft EIS does not use north Richland as the Site boundary. Rather, the assessment uses a modified boundary, which includes areas likely to be released by DOE in the near future. The maximally-exposed individual receptor is assumed to be located much closer to TWRS contamination sources than north Richland. The site boundary and receptor locations are discussed in Volume Three, Section D.2.2.3. Potential changes in onsite and offsite population and its effect on the risk calculation are addressed in the uncertainties discussion in Volume Five, Appendix K, which has been added to the EIS.

Comment Number 0069.09

Pollet, Gerald

Comment Third, the EIS must clearly show the risk from releases and explosions during the remediation period for each alternative. It's important that you show and use a conservative assumption as to the impact of delay. Throughout the EIS, in determining costs, you use a 40 percent cost contingency factor. In other words the costs are inflated just 40 percent as a contingency. Risk is a function of time, and what is amazing is that there is no contingency factor for time throughout this EIS in calculating risks. So we say that a plant will run 4 years, because that's the design basis for Phase 1 plant. Well if we have a 40 percent contingency for cost, one would also rationally say we might want to have a 40 percent contingency in terms of delay for that same plant. Therefore we have to re-calculate the risks.

Response Risks from releases during remediation were addressed in the Draft EIS in Volume One, Section 5.11 and Volume Two, Appendix D and remediation accidents, including explosions, were addressed in Volume One, Section 5.12 and Volume Four, Appendix E. The EIS analysis used bounding assumptions in analyzing health and accident impacts. A 60 percent efficiency factor was calculated into the remediation operations for each alternative. This assumption is presented in Volume One, Section 3.4.1. This is reflected in the length of operation time for each alternative in the TWRS EIS, and therefore, provides a contingency in the schedule. The probability of an accident (which would drive the risk) is based on the operation duration with the 60 percent efficiency factored in. Based on the assumed efficiency factor, the substance of the comment's suggestion that the EIS use a conservation estimate for facility operations has already been incorporated into the analysis, and therefore no change to the document is warranted. Please also refer to the response to Comment numbers 0072.225 and 0069.09 for discussions of accident risk during remediation and the 100-year administrative period.

Comment Number 0072.17

CTUIR

Comment For each scenario, the airborne release fraction (ARF) and respirable fraction (RF) should be presented separately, not as a single factor, because the nonrespirable fraction would be the fraction that deposits.

Response The airborne release fraction (ARF) and respirable fraction (RF) for planned atmospheric releases, such as would occur during routine TWRS remediation operations, would be the same. This is because planned releases would pass through a filtration system and all particulates that escape the filter would be in the respirable size range. Nevertheless, these particulates would eventually deposit, although they would stay suspended for long periods of time and be dispersed over large areas. The exposure calculation accounts for the contribution from these deposited particles. Please refer to the response to Comment numbers 0072.250, 0072.251, and 0072.17 for related information. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.207

CTUIR

Comment P D-87: Ground releases resulting in contaminant error concentrations would result in exposure to subsistence Native Americans.

Response The receptors evaluated for the remediation risk assessment (involved worker, noninvolved worker, and general public) were selected to represent a reasonable range of plausible onsite and offsite exposure scenarios that could arise during the construction and routine operational phases of the TWRS program. Because use restrictions and administrative controls would be in place at the Site throughout the remediation period, an onsite Native American scenario is not plausible. Plausible onsite exposures would be to the TWRS workers and noninvolved workers having access to the Site routinely during the remediation period.

Although an offsite Native American scenario is plausible during remediation, the exposures for such a scenario would not differ appreciably from the exposures presented in Volume Three, Section D.4.0 for the general public. This is because the inhalation pathway, which dominates all other pathways in the offsite remediation risk calculation, does not vary between the Native American scenario and the general public scenario. Because the remediation risk for the general public provides a reasonable approximation of the risk to the Native American, risk during remediation to the Native American has not been calculated separately and the EIS has not been changed. For a discussion of inhalation exposure for onsite receptors, please refer to the response to Comment number 0072.29, and for a discussion of inhalation impacts during remediation associated with sacred sites please refer to Comment number 0072.247.

The onsite Native American scenario, although not plausible during remediation, is considered plausible for the period following remediation. DOE and Ecology have developed a Native American scenario in consultation with the affected Tribes. This scenario has been added to the analysis of post-remediation risk presented in Volume Three, Appendix D and Volume One, Section 5.11.2 of the EIS. Please refer to the response to Comment number 0072.198.

Comment Number 0072.208

CTUIR

Comment P D-89: Sect. D 4.2.2: Please indicate what fraction of the Hanford site permit would be the allowable admission rates for the tank farms tank waste retrieval and evaporators.

Response At this time, it is not known what alternative will be implemented, and potential emissions associated with tank waste disposal actions are not covered by existing permits. Once the decision is made, the applicable permits would be obtained including possible revision or amendment of existing permits. Volume One, Section 6.0 discusses possible permitting necessary for implementation of the different alternatives. The chemical emissions for each of the alternatives are presented in Volume Five, Appendix G and are compared with the applicable Federal and State standards or permissible levels. Please refer to the response to Comment numbers 0072.243 and 0072.246 for related discussions. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.209

CTUIR

Comment P D-102: PP2: Please change dilution to dispersion.

Response Dilution has been changed to dispersion in the discussion of transport for this and all other alternatives in Volume Three, Section D.4.1 through D.4.9.

Comment Number 0072.210

CTUIR

Comment P D-105: What portion of each tank is expected to volatilize during gravel filling. As the tanks liquid is displaced by the gravels mass, raising the liquid level and disturbing the settled contents, a portion of the tanks contents can be assumed to exhale.

Response Tank emissions during gravel filling were calculated and included in the impact assessment. Emission data are provided in Volume Five, Section G.3. Additional technical data are provided in the Administrative Record for the TWRS EIS and are available for public review in the DOE Reading Rooms and Information Repositories locations listed in Volume One, Section 7.0. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.211

CTUIR

Comment P D-118: Sect. 4.1.1: Please indicate what portion of the overall source term is represented by the tanks contents.

Response One hundred percent of the source term is from the tank contents as presented in Volume Two, Appendix A. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.212

CTUIR

Comment P D-268: Sect. D.4.14: The mention of accumulation of contaminants in food products indicates that there may have been discussion of Native American food products. Please indicate when and where you have consulted with the affected Tribes regarding this topic.

Response The cited statement refers to a generic source of food products used for the remediation risk analysis. The remediation risk assessment in the Draft EIS addresses risk to the TWRS worker, the noninvolved worker, and the general public, but does not specifically address risk to a Native American receptor. Risk to a Native American receptor during the remediation period would be dominated by the inhalation pathway. For this reason, it would be similar to the risk presented in Volume Three, Appendix D, Section D.4.0 for the general public. The discussion of uncertainty in the risk assessment has been moved from Volume Three, Appendix D to a new Volume Five, Appendix K.

In response to Tribal Nations comments, DOE and Ecology have consulted with the affected Tribes and have developed a Native American scenario for inclusion in the post-remediation risk assessment for the Final EIS. The analysis of post-remediation risk to the Native American receptor has been added to Volume Three, Appendix D, Section D.5.0. Please refer to the response to Comment numbers 0072.149, 0072.55, 0072.198, 0072.207, and 0072.225 for more information on this topic.

Comment Number 0072.213

CTUIR

Comment P D-271: PP1: The consideration that age dependence is not expected to be as important as other factors is unacceptable to the people of the CTUIR whose very lives depend on the health and safety of their elders.

Response The statement regarding age dependency pertains to the internal dose calculation and its sensitivity to the overall dose and risk results. The statement "Age-dependent variations are considered to be less important because the generally higher internal dose factors (ICRP 1975) for the lower age groups are offset by lower breathing and food consumption rates" does not support or oppose the risk response for low or high age groups. For clarity, this sentence has been changed in Appendix D to read "Age-dependent variations are considered to be less sensitive..." In addition, the exposure duration for the Native American scenario added to the risk assessment assumes 70 years instead of the 30 years used for the other receptor scenarios. Please refer to the response to Comment number 0072.198 for related information. The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.214

CTUIR

Comment P D-272: PP 2: This paragraph is confusing, where was the total population evaluated?

Response The population for the onsite and offsite risk calculations is presented in Volume Three, Tables D.2.2.3 and D.2.2.4, respectively.

Comment Number 0090.05

Postcard

Comment Please listen to us say no:

I urge USDOE and the State of Washington to fully calculate the risks of explosions and leaks from any delay in vitrifying these wastes.

Response For a discussion of the relationship between closure, including past tank leaks, please refer to the response to Comment numbers 0012.15, 0072.08, 0101.05, and 0101.06. The risk of tank deflagrations and explosions has been further analyzed by DOE and Ecology for the Final EIS. The results of the new analysis have been incorporated into the Final EIS in Volume Four, Sections E.2.2, E.3.3, E.4.3, E.5.3, E.6.3, E.7.3, E.8.3, E.9.3, E.10.1, and E.10.2. A bounding risk from delay in vitrifying these wastes is presented in Volume Four, Section E.2.2 where the risk is shown from accidents that could result if vitrification is delayed indefinitely under the No Action alternative. Please refer to the response to Comment numbers 0069.10, 0069.12, and 0081.07 for more information regarding risk analysis relative to delays in remediation.

L.5.11.2 Post-Remediation Risk

Comment Number 0009.02

Broderick, John J.

Comment Potential health effects must be reasonable--not zero. There is not enough money to try to clean Hanford so completely that there will be no health impacts. For this reason, the remediation of the tank waste must permit leaving some waste in place with reasonable number of potential health effects.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The risk assessment is intended to provide an unbiased analysis of the anticipated health effects associated with the alternatives, and health effects are only one of many impacts analyzed in the EIS.

Comment Number 0012.17

ODOE

Comment Risk Assessment

The risk assessment in the EIS is sufficient to support the proposed action. We do not believe it is sufficient to support any decision which would leave waste in Hanford tanks.

The risk assessment shows long-term substantial environmental and public risks across most of the Hanford Site. The uncertainty in these estimates is so large, we believe the risk assessment should therefore not be relied upon or used as a decision making tool to micro-manage cleanup. It should only be used as a rough measure of the relative effectiveness of the various alternatives at reducing risks. The risks shown are large and justify complete removal and vitrification of all tank wastes.

The risk assessment shows great risk reduction from ISV. It does not however, include the large uncertainty in the technical feasibility of this alternative. ISV has only been demonstrated to a depth of 15 feet in soil. It has not been demonstrated for the depth and areas required for ISV of tank wastes. The risk assessment gives no indication a large uncertainty exists for this alternative. The uncertainty this creates in the ultimate risks is too large for this to be considered a viable alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

The risk assessment was conducted to support a comparison of alternatives rather than to determine the absolute risk associated with a particular alternative. Health effects are but one of many impacts considered in selecting the preferred alternative.

DOE and Ecology understand the concern regarding uncertainty and have identified the need to provide additional information in the EIS to clarify the sources and magnitude of uncertainty in the risk calculations. Further uncertainty analysis has been completed and presented in the EIS in Volume Five, Appendix K. Issues concerning uncertainty in the implementability of the ISV alternative are discussed in Volume One, Section 3.4 and Volume Two, Appendix B. The ISV design is recognized as being conceptual in nature and having a high degree of associated uncertainty.

Comment Number 0036.12

HEAL (Exhibit)

Comment Risk from tank waste may be underestimated.

For the preferred alternative, the risk calculations assume that 99 percent of the waste will be retrieved. HEAL supports this assumption and the goal of total retrieval. However, it is unlikely that fully 99 percent will actually be retrieved given current and reasonably foreseeable technologies. Therefore, the risk may actually be much greater due to a larger amount of waste left in the tanks. This is not a request to change this assumption. Rather, it is a point stressing the importance of retrieving all the waste.

Response As is pointed out in Volume Four, Appendix F, Section F.2, the goal of the Tri-Party Agreement is to leave no more than 1 percent of the waste in the tanks after retrieval. Until waste from a sufficient number of tanks has been retrieved, it is not known whether the residual content will be greater or less than the goal of the Tri-Party Agreement. The amount and type of waste that would remain in the tanks after retrieval is also uncertain. The engineering data for the waste retrieval and transfer function common to all ex situ alternatives were developed using 99 percent retrieval as a goal. This information is presented in Volume One, Section 3.4 and Volume Two, Appendix B. The retrieval assumption also included a conservative assumption that the 1 percent residual would be as soluble as the 99 percent retrieved from the tank. This assumption provides a bounding case for impacts to groundwater and health risks under conditions where less that 99 percent of the waste is retrieval. Please refer to the response to Comment numbers 0005.18, 0089.07, 0072.59, and 0076.01 for related information. Because of the uncertainties associated with waste retrieval and the assumptions used in the EIS to bound the impact analysis, no change to the document is warranted.

Comment Number 0036.19

HEAL (Exhibit)

Comment Risk confirms importance of this program.

The high human health risks posed by all of the alternatives emphasize the importance of the Hanford tank waste disposal program. While the uncertainty involved with the EIS's risk calculations is high, the calculations still serve as a rough guide to future health risks.

The EIS shows that the human health risks are directly related to the amount of tank waste left behind. Assuming only 1 percent of the waste is left behind still leaves the farmer at 10,000 years with a 3 in 10,000 chance of cancer. The risk resulting from tank waste being left behind is demonstrated by the Ex Situ/In Situ Combination alternative in which 90 percent of the contaminants are removed by retrieving 50 percent of the waste volume. The risks resulting from this alternative for the farmer at 10,000 years are 3 in 1,000 -- an increase of an order of magnitude over the ex situ alternatives.

The reduction in risk gained in removing 99 percent of the contaminants as opposed to 90 percent shows the importance of the tank waste treatment and disposal program.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0038.04

Reeves, Merilyn

Comment It has also been assumed that the Hanford tank wastes pose a great risk to future generations. And this EIS confirms that assumption.

The EIS shows that the future risk is directly correlated to the amount of waste left behind in the tanks.

The impact of leaving only a small amount of contamination behind is evidenced by the difference in long-term risk for the preferred alternative, where one percent of the waste is left in the ex situ, in situ alternatives, where there is 10 percent left behind, and by leaving nine percent more waste the risk for the residential farmer in 5,000 years increases the factor by 10. These clearly show that the only responsible solution is to retrieve all the waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0040.03

Rogers, Gordon J.

Comment I reject dangers to hypothetical intruders as not a realistic concern (for the In Situ Fill and Cap alternative); which is also connected to the administrative control assumption.

Response It is common for purposes of NEPA assessment to assume that government agency administrative controls will end after a period of 100 years. In the absence of administrative controls, there is a probability of inadvertent human intrusion into the waste remaining onsite. To assist in differentiating between the alternatives, and to provide a more complete picture of the health risks posed by leaving waste onsite, the risk assessment included a hypothetical intrusion scenario. The scenario analyzed, well drilling, was considered the most likely intruder scenario. The probability of occurrence of this scenario is evaluated in the uncertainty analysis presented in Volume Five, Appendix K. Please refer to response to Comment number 0101.01 for a related discussion.

Comment Number 0041.02

Berry, Bill

Comment On Appendix D, the long-term analysis of risks, which unavoidably involves uncertainty to the point of being meaningless, assumes that a large industrial facility of 2,200 workers might exist on the Site in the future. The analysis then assumes that the facility would have a land use area of 785 sq. km., yielding a population density of 2.81 individuals/sq. km. Although this analysis may produce a type of average risk assuming the facility could be randomly located anywhere within the 785 sq. km. area (the facility clearly would not require anything near the entire area), a better approach would be siting the facility within the area of highest risk. This approach would provide a bounding estimate of risks to workers in the vent that the future industrial facility was located at the worst possible location.

Response The uncertainties regarding the risk assessment are presented in Volume Five, Appendix K, which has been added for the Final EIS. The industrial worker scenario is not land-area dependent; therefore, in calculating the total risk to the industrial worker, the population density of 2.81 and land use area of 785 km^2 were not used. As discussed in the response to Comment number 0041.03, population density and land use area were needed only for the residential farmer calculation. Volume Three, Table D.5.14.1 has been modified to show that population density and area of land use are not applicable to the industrial scenario. Please refer to the response to Comment number 0012.17.

The comment suggestion regarding the assumed siting of the industrial facility was considered. In response to this comment, the risk to the industrial worker has been recalculated assuming the facility is located in the area of highest risk. The text in Volume Three, Section D.5.14, has been modified to reflect the revised assumption.

Comment Number 0041.03

Berry, Bill

Comment In Table D.5.14.1 the population density for the recreational scenario appears incorrect (1950/104=18.75). I did not check the calculated incidence and fatalities to determine the population density that was used in the calculation. Those numbers should be checked or an explanation of why the lower population density was used should be provided as a footnote with the table.

Response The population density value given in Volume Three, Table D.5.14.1 for the recreational scenario was in error and has been changed. However, the cancer incidence and cancer fatality calculations are correct. To perform these calculations, a value for receptor population was required for each scenario. For the residential farmer scenario, a population estimate was not available; therefore, the population was calculated by multiplying an assumed population density by the Hanford Site area. Population estimates were available for the other scenarios; therefore, a population density was not needed. Population densities are shown in the table for all scenarios for the sake of consistency. The text in Volume Three, Section D.5.14 has been modified to clarify how population density was used in the calculations.

Comment Number 0055.07

Martin, Todd

Comment Moving off of costs, the risks that we see in the EIS are profoundly troublesome to me and I think they under estimate the actual risk. This is not something that I think should be changed, but I think it should be noted. 99 percent retrieval is probably a dubious assumption. It is the correct assumption and it is where we should be going but we are probably not going to get there. In addition, if sluicing does result in more leaked waste we can expect to see much higher risks when you are seeing a residential scenario 10,000 debt years down of three in 10,000 cancer rate with only 1 percent of the waste left behind. Imagine what it is for 2 percent, 3 percent, or maybe 10 percent.

Response As discussed in Volume One, Sections 3.3.1 and 3.4.1, there are many technical uncertainties associated with the alternatives for remediating tank waste. Although the design information for these alternatives is an early planning stage, the technologies represented are considered sufficient to bound the range of viable technologies that are applicable to tank remediation. For purposes of analysis, 99 percent retrieval efficiency was considered a reasonable assumption for the ex situ alternatives. Please refer to the response to Comment number 0036.12 regarding tank waste retrieval assumptions and Comment numbers 0005.18, 0089.07, 0072.59, and 0076.01 for additional discussions regarding the 99 percent retrieval assumption.

Because of uncertainties regarding the amount and type of residual waste that would remain in the tanks, it was assumed for the ex situ alternatives that the residual waste would contain 1 percent of all constituents in the original tank inventory, including the water-soluble constituents. In actuality, the residuals would contain less of the water-soluble constituents because they would be preferentially retrieved through sluicing. The assumption that 1 percent of the water-soluble waste remains in the tanks thus provides an upper bound on the impacts associated with the ex situ alternatives. The In Situ Fill and Cap and Ex Situ/In Situ Combination 1 and 2 alternatives leave more waste in the tanks and provide an upper bound on the impacts associated with the amount and type of waste disposed of onsite. Additional discussion of the uncertainties surrounding retrieval are presented in Volume Five, Appendix K.

Regarding leaks during sluicing, the predicted groundwater contaminant concentrations used for the risk analysis in the Draft EIS were calculated assuming that SSTs leaked a volume of 15,000 liters (4,000 gallons) per tank during retrieval. Detailed discussion of the tank release assumptions used for the groundwater modeling effort is presented in Volume Four, Appendix F, Section F.2.2. For additional discussion regarding this assumption, please refer to the response to Comment numbers 0029.01, 0030.03, and 0072.75.

Comment Number 0069.03

Pollet, Gerald

Comment This is a long-term risk scenario where the risks to people in this area here from groundwater contamination are essentially 1 person dies out of every 100 exposed. And that is without taking into account the type of assumption that should be made for leaks today. That means, the risks are far greater if we leave any tank waste in-place. Call it in situ capping, it's gravel, folks. It's cemented gravel on top of it. It will reach groundwater.

Response For the No Action, Long-Term Management, and In Situ Fill and Cap alternatives, the maximum anticipated post-remediation risk (incremental lifetime cancer risk) reaches levels as high as 1 in 100. However, as shown in Volume One, Table 5.11.4, the post-remediation risk for the other alternatives is anticipated to be less (i.e., no risk or risk less than 1.0E-06).

Impacts associated with past leaks from the tanks, based on data that became available following publication of the Draft EIS, are addressed in Volume Four, Appendix F and in the cumulative impacts discussion in Volume One, Section 5.13. For more information related to this issue please refer to the response to Comment numbers 0012.05, 0030.02, and 0091.01.

Comment Number 0069.06

Pollet, Gerald

Comment Now I come to the issue of risks. The, I'm going to turn this off, Environmental Impact Statement makes a number of assumptions about risks that are clearly erroneous, and out of date as well. First, it apparently uses a recreational exposure scenario for calculating risk, which we have criticized repeatedly recently, of the public using the Columbia River just 56 hours a year. It is ludicrous. In fact, we believe that a rational scenario for recreational exposure is 1,040 hours a year. The risks shown for recreational exposure, and I want to remind everyone that and for the record remind everyone that risk is a function of time, therefore the risks presented for these scenario's are 18 times too low.

Response The exposure scenarios used in the risk assessment were based on the recommendations published in the HSRAM (DOE 1995c). These recommendations have been approved by the signatories to the Tri-Party Agreement for use in Hanford Site risk assessments. In the case of the recreational shoreline user scenario, the HSRAM scenario was modified to increase the exposure duration from one week to two weeks for 30 years. This provided a more bounding estimation of risk than would have resulted from using the HSRAM scenario and is considered by DOE and Ecology to be appropriate. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0069.07

Pollet, Gerald

Comment Second point as to this exposure scenarios along the Columbia River, folks where is the Native American Treaty Right usage? It is not presented here. That is a usage, guaranteed by the Treaty of 1855, which one can rationally assume will be asserted during this timeframe, and which allows Native American treaty right tribes to live along this area of the Columbia River, and to gather foods and fish in the usual accustomed places while living along the river for extended periods of time.

Response Please refer to response to Comment numbers 0072.37, 0072.198, 0072.252, and 0072.225 for discussions of the analysis of impacts in response to Comments submitted by Tribal Nations regarding treaty rights, cultural resources, and future land use.

Comment Number 0072.18

CTUIR

Comment No Native American exposure scenario is included. During the revision of the EIS, if such a scenario is added, it *must be preceded by consultation with CTUIR.*

Response The risk assessment for the EIS has been revised to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. The scenario used for the analysis was developed through consultation with representatives of the affected Tribes. Please refer to the response to Comment number 0072.198 for more information on the Native American scenario. For impacts associated with post-remediation accidents, refer to the response to Comment number 0072.225.

Comment Number 0072.19

CTUIR

Comment Deposition of particulates was not included.

Response The size of the particulates released during remediation would be very fine. These particulates would stay suspended in the atmosphere for long periods of time and would be transported over very large distances. A typical deposition velocity for particulates dispersed in the atmosphere is 1.0E-03 m/s. The post-remediation risk from deposition of particulates released to the atmosphere during remediation is very small. This risk is 3 to 4 orders of magnitude smaller than the inhalation risk during remediation. Anticipated health risk during and after remediation is contained in Volume One, Section 5.11, and Volume Three, Appendix D. Air quality issues are discussed in Volume One, Section 5.3. Please refer to the response to Comment numbers 0072.32 and 0072.240. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.20

CTUIR

Comment Genetic effects must be included, both for individual generations and for multiple generations.

Response The health effects endpoints used for the risk assessment (cancer incidence and cancer fatalities) were selected for consistency with other EISs prepared by DOE and with the endpoints used for the accident analysis presented in Volume Four, Appendix E. Cancer incidence and cancer fatalities are the endpoints commonly used for NEPA reviews, where the purpose of the assessment is to compare impacts among alternatives rather than to calculate absolute risks. A calculation of hereditary effects would not affect the ability of the decision makers and stakeholders to discriminate among the alternatives, because the results of the calculations would provide data that would support the same understanding of the relative difference among alternatives as does the existing calculation of cancer occurrences and cancer fatalities. For this reason, the decision to omit consideration of genetic risk from the EIS is considered appropriate, and the EIS has not been changed. The anticipated hereditary effects associated with the alternatives may be calculated by multiplying the radiological doses (rem) presented in Volume Three, Appendix D by the dose-to-risk conversion factor of 1.3E-04 (genetic risk per rem) published by the ICRP in 1991. Please refer to the response to Comment number 0072.206.

Comment Number 0072.21

CTUIR

Comment Existing soil and groundwater contamination was not included in the source term.

Response Existing soil and groundwater contamination are not included in the scope of the TWRS program and were specifically excluded from consideration in this EIS. However, existing soil contamination is addressed, in terms of its cumulative impacts with the TWRS alternatives in Volume One, Section 5.13 and Volume Four, Appendix F. Please refer to the response to Comment numbers 0030.02, 0072.08, 0012.15, 0091.01. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.22

CTUIR

Comment No evaluation of socio-cultural quality of life was included.

Response Volume Three, Appendix D is the technical support document for analyzing remediation and post-remediation health risks to human health and ecological and biological resources. This appendix does not and was not intended to provide an assessment of quality-of-life issues. The human health analysis presented in Volume Three, Appendix D is summarized in Volume One, Section 5.11. Impacts to ecological and biological resources are summarized in Volume One, Section 5.4.

To the extent that impacts to human health and biological and ecological resources are an indicator of the socio-cultural quality of life, the relative differences in impacts reported in Volume One, Sections 5.11 and 5.4 provide the public and decision makers with information on which a comparison among the alternatives may be formed. This same statement would apply to all areas of impact assessment summarized in Volume One, Section 5.0. In addition to human health and ecological and biological impacts, Section 5.0 documents potential impacts by alternative to geology, air quality, water quality, land use, biological and ecological resources, the economy, public services, and visual effects, among others. In total, the analysis presented in Section 5.0 represents the potential impacts of the alternatives on the human and natural environment and hence on the socio-cultural quality of life.

The broad range of data regarding potential impacts are presented in the EIS so that the public, agencies, Tribal Nations, and decision makers can be aware of potential impacts during the decision making process. It is the role of each of these participants in the decision making process to compare the impacts and apply their values when determining which among the factors that will influence the selection of the alternative to be implemented should be considered in comparison to other factors. The role of the EIS is to objectively present alternatives, provide a comparison of impacts among alternatives, and provide an opportunity for public, agency, and Tribal Nation participation in the NEPA process. Please refer to the response to Comment numbers 0072.37, 0072.53, 0072.271, and 0072.252. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.23

CTUIR

Comment For ecological evaluation, instantaneous dilution in the River is unacceptable.

Response The ecological impact analysis presented in Volume One, Section 5.4 and Volume Three, Appendix D does not assume instantaneous dilution of groundwater reaching the Columbia River. Potential hazards were estimated for direct exposure to the groundwater before dilution, with organisms using no other water source. Please refer to the response to Comment number 0072.217 for a discussion of dilution factors used in the analysis. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.24

CTUIR

Comment The ecological dose limits need to be revised (terrestrial is more protective than aquatic), and the ecological Hazard Indexes (HI) that were developed for the EIS need to add a safety factor for sensitive life stages.

Response The ecological radiation dose limits used for terrestrial and aquatic receptors are consistent with those recommended by the International Atomic Energy Agency (IAEA) (IAEA 1992) and NCRP (NCRP 1991), respectively. IAEA states that "It would appear that chronic does of 1 $mGyd^{-1}$ or less to even the more radiosensitive species in terrestrial ecosystems are unlikely to cause measurable detrimental effects in populations and that up to this level adequate protection would therefore be provided....In the aquatic environment it would appear that limiting chronic dose rates to 10 $mGyd^{-1}$ or less to the maximally-exposed individuals in a population would provide adequate protection for the population" (1$mGyd^{-1}$ equals 0.1 rad d^{-1}, and 10 mGy d^{-1} equals 1.0 rad d^{-1}, the units used as benchmarks in the text) (IAEA 1992). NCRP (NCRP 1991) addresses aquatic organisms only and concurs with the 1.0 rad d^{-1} value used as a benchmark in the EIS.

It is unclear what safety factor would be appropriate to protect sensitive life stages. The ecological hazard indexes (HIs) used in the EIS to estimate potential hazards from nonradioactive chemicals are conservative in that they are based on high exposure parameter exposures. For example, the No Action alternative analysis assumes direct contact with stored wastes, which is highly unlikely. Adding a safety factor to the HI in this scenario would not alter the conclusion in the EIS that such exposure would be lethal. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.54

CTUIR

Comment Hypothetical Future Land Users should include specific Native American usage scenarios - these are not "hypothetical" but inevitable.

Response The risk assessment for the EIS has been revised to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. The land use scenarios analyzed in the risk assessment are referred to as hypothetical in the sense that they would not occur until TWRS activities and other remediation activities outside the scope of this EIS are completed. Please refer to the response to Comment number 0072.198 for information on the Native American scenario.

Comment Number 0072.215

CTUIR

Comment P D-274: Sect. D.5.0: It is noted that there is no Native American scenario. Please insert a Native American scenario after consultation with affected Tribes.

Response The risk assessment for the EIS was revised to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. The scenario used for the analysis was developed through consultation with representatives of the affected Tribes and the results of the analysis are presented in Volume One, Section 5.11 and Volume Three, Appendix D. Please refer to the response to Comment number 0072.198 for more information on the Native American scenario.

Comment Number 0072.216

CTUIR

Comment P D-275: Sect. D.5.1: Please insert MUSTs after DSTs.

Response The text of Volume Three, Section D.5.1 has been changed as requested in the comment.

Comment Number 0072.217

CTUIR

Comment P D-276: PP4: What exactly is the dilution factor used here? In addition, all contaminates in the ground water must be evaluated in the surface water.

Response As stated in the referenced paragraph (Volume Three, Section D.5.1.2), the dilution factor used is 1.21E-04. This factor indicates that a groundwater plume intersecting the river with a concentration of 1.0 Ci/L will produce a surface water concentration of 1.21E-04 for the entire Columbia River (from Hanford to the Pacific Ocean). Not all contaminants were addressed because some contaminants are not mobile in groundwater. The analysis addresses those groundwater contaminants that are the most mobile and contribute appreciably to risk. The transport of contaminants from tanks to groundwater and surface water is discussed in Volume Four, Appendix F. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.218

CTUIR

Comment P D-277: Sect. D.5.14: PP4: There are no risk free areas, please indicate exactly what this means.

Response This paragraph was included to explain why "holes" appear in the risk distributions on certain risk contour plots. These "holes" appear as white areas that have risk values less than the minimum contour interval (i.e., less than 1.0E-06). They are not risk free but have less risk than lowest value contoured. The text in Volume Three, Appendix D has been modified to clarify this point.

Comment Number 0072.219

CTUIR

Comment P D-279: PP 1: The surface water exposures should have been calculated for all constituents, not just five using an unknown dilution factor.

Response All the constituents are used in the analysis, but only five constituents (i.e., carbon-14, technetium-99, iodine-129, neptunium-237, and uranium) with high mobility (low K_d) will contribute appreciably to risk within the 10,000-year time period. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.220

CTUIR

Comment P D-284: Sect. D.5.6.1: Other sources that should be evaluated here should include tank leakage, because the one percent if left in the tanks will add to the current leakage inventory and continue to migrate just as current leakage inventory does.

Response The effects of contamination from past activities are not within the scope of the EIS but will be addressed in a future NEPA analysis on tank farm closure. Please refer to the response to Comment number 0072.08. The potential cumulative impacts of past tank leaks, TWRS alternatives, and other Site actions are addressed in Volume One, Section 5.13 and Volume Four, Appendix F. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.221

CTUIR

Comment P D-432: Sect. D.6.2.2: Ecological effects that should be documented here include loss of habitat, disintegration of habitat, loss of diversity.

Response Loss of habitat, disintegration of habitat, and loss of diversity are examples of the "variety of potential indirect effects on other ecological variables" mentioned in the text of Volume Three, Section D.6.2.2. These items have been added to the text of the methods and results sections for clarification. The following sentences have been added to Volume Three, Section D.6.

"Examples of potential indirect effects include decreased biodiversity, habitat loss or alteration, and impacts on productivity and nutrient turnover. Any direct effects on individual organisms exposed to stored wastes could lead to a variety of indirect effects on the ecosystem, including decreased biodiversity, habitat loss or alteration, and impacts on productivity and nutrient turnover. Since the direct impacts of air and groundwater exposure are estimated to be small, any associated indirect impacts on the ecosystem would be correspondingly minor. Thus, potential direct impacts on organisms and any associated indirect impacts on the ecosystem would be expected to be relatively small. Corresponding indirect impacts on the ecosystem would be similarly unlikely."

The direct impacts of loss of habitat, fragmentation of habitat, and loss of diversity for ecological and biological resources are provided in Volume One, Section 5.4.

Comment Number 0072.222

CTUIR

Comment P D-433: Sect. D.6.2.4: The conceptual model for terrestrial organisms needs to take into account impacts that result in the loss of diversity and associated potential ecosystem imbalances.

Response The conceptual model is intended to illustrate potential pathways by which ecological receptors may be exposed to contaminants. Loss of diversity and other alterations in the ecosystem, though important, are potential indirect effects of organism exposures to contaminants, and were not used as assessment or measurement end points in the analysis. Potential indirect effects have been added to the text of Volume Three, Section D.6.2.2 and to Volume One, Section 5.4. Please refer to the response to Comment number 0072.221.

Comment Number 0072.223

CTUIR

Comment P D-434: There should be an arrow from waste to plants and animals and an arrow from plants to all of the animals. It is well known that hawks and shrikes use vegetation for nesting, soil for dusting. Coyotes have been known to eat plants and are in constant contact with the soil.

Response The conceptual model figure shows those pathways that were evaluated in the analysis. The scenario examining direct exposure to stored wastes assumed the "soil" contaminant concentrations were identical to those in the waste, effectively connecting "waste" compartment directly to the "plant" compartment, as suggested. Adding additional exposure pathways with a very small contribution to total risk would not alter the conclusion in the text that direct exposure to stored wastes would be lethal. The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.224

CTUIR

Comment P D-435: The CRITRII model uses simple food chain and bioaccumulation factors to estimate doses to a very few select species in a very complex set of ecosystems. This model extrapolates from grain values and leafy vegetable values eaten by standard wild animals (the pocket mouse and the male deer) assuming that the biochemistry is similar to the typical lab rat. There is no differentiation for embryos, fetuses, pregnant females, developing young, or very old animals. Additionally there are assumptions for biological steady states which negates underlying health problems an animal could have. It would seem then that because of the large amount of unknowns associated with the biochemical uptake and transfer mechanisms, the resulting uptake factors, the impacts to different age groups and sexes of the assessment group, the lack of information of underlying health, the small receptor group size, the lack of true representativeness, the role of each species in stabilizing the biodiversity, that the uncertainty analysis would have explained the results noting these factors.

Simply leaving the reader to assume that the only secondary sources of uncertainty are those which are the most easily quantified is very unfortunate. Please address the uncertainties listed above.

Response The conceptual model used to estimate hazards to terrestrial organisms and the CRITRII model used for estimating maximum radiation doses to aquatic organism exposed to groundwater entering the Columbia River make a series of simplifying assumptions, including the use of representative species. These models do not distinguish among species subpopulations, such as differing age groups, and they assume steady-states for such factors as the transfer of contaminants through the food chain.

Volume Three, Appendix D does not address sensitive subpopulations, but transfer factors used to estimate uptake by plants and assimilation in the mouse are mentioned as uncertainty sources, as are the No Observed Adverse Effect Levels used to estimate HIs. In addition, the analysis used bounding assumptions such that risk is more likely to be overstated than understated. For example, the No Action alternative analysis assumes direct contact with stored wastes and consumption of contaminated groundwater with no dilution of the water in the Columbia River, both of which are highly unlikely. It is unlikely that detailed uncertainty analysis would alter the conclusion that direct exposure to stored wastes would be lethal. The uncertainty discussion in Volume Three, Section D.6.5 has been modified to address the issue raised in the comment by adding the following sentences.

"The CRITRII model was used only for estimating maximum radiation doses to aquatic organism exposed to groundwater entering the Columbia River at 300 and 500 years. These estimates were all lower than one millionth of a rad per day, the benchmark recommended by NCRP (1991) as protective of aquatic organisms. It is unlikely that detailed uncertainty analysis would alter the conclusion that groundwater risks to aquatic organisms are very low."

Comment Number 0081.09

Pollet, Gerald

Comment I have two minor points that I wish to say. One is, I think that in this EIS something unique was done that is very valuable, and we'd like to thank Ecology and U.S. DOE for including these visualizations of the risks. In these risk isopleth maps for the first time. It allows the public to see that if in fact you take a look at leaving waste behind, along the Columbia River, the risk of fatal cancer at a glance you can see there are areas that have extremely high risks of fatal cancer. I think this is, it's an innovation to not just present data in tables, but to present this as a map where you can visualize what the risks are for different locations.

Response DOE and Ecology acknowledge the comment regarding the contour plot method used in the EIS to illustrate the areal risk distributions resulting from the risk calculations. DOE and Ecology continually strive to present these complex issues in an understandable form and believe the areal distribution of risk is one of the best innovations in presenting the results of risk assessments.

Comment Number 0089.12

Nez Perce Tribe ERWM

Comment Page D-15

The Hanford Site use scenarios including, Residential Farmer, Industrial, Recreational Shoreline User and Recreational Land User are not adequate to describe a Native American use scenario. The recreational scenarios only assumes usage for 14 days per year for 30 years. Information is now being compiled on the Hanford Site for Native American use scenarios. This information is currently being prepared through the Columbia River Comprehensive Impact Assessment effort. Please contact Joe Fitch of the Nez Perce Tribe ERWM for specific information regarding Nez Perce Tribal use and Native American use scenarios.

Response The risk assessment for the EIS has been revised to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. The scenario used for the analysis was developed through consultation with representatives of the affected Tribes. Under this scenario, an individual engaged in a subsistence Native American lifestyle is assumed to spend 365 days per year on the Site over a 70-year lifetime. Please refer to the response to Comment number 0072.198 for information on this scenario. For information on the recreational use scenario, please refer to the response to Comment numbers 0041.03 and 0069.06.

Comment Number 0101.02

Yakama Indian Nation

Comment In order to base performance assessments on assumptions that are consistent with providing reasonable assurance of protecting public health and safety and the environment far into the future, <u>a design confidence level for the entire Hanford Sites performance must be established</u>. Then, the suite of scenarios developed to define conditions to be evaluated over the time frame protection is intended must be objectively established, consistent with providing the design confidence level intended. The legal term frequently used to define the necessary confidence level is reasonable assurance. This is generally recognized to be a very high level of confidence, consistent with the intent of various environmental laws and the Atomic Energy Act to protect public health and safety and to protect the environment.

Response DOE and Ecology recognize the potential for diversity of criteria across the projects at Hanford and concur with the consistent Hanford Sitewide environmental performance design criteria. The level of confidence in the TWRS EIS risk assessment provides reasonable assurance that impacts will not be higher than the level assessed in the EIS. In the TWRS EIS, the long-term scenarios are based on 95 percent confidence that they are bounding risks.

In accordance with CEQ requirements, the EIS is prepared early in project planning well in advance of detail design criteria, which would be needed for rigorous probabilistic risk assessment. As more information becomes available relative to the tank waste, the level of uncertainty will be reduced and

more precise estimates of impacts will be possible. Please refer to the response Comment number 0101.03 for a related discussion and 0072.225 for a discussion of the NEPA requirement to analyze impacts commensurant with their likelihood and potential consequences.

L.5.12 ACCIDENTS

Comment Number 0012.21

ODOE

Comment Table E.15.0.2 on page E-248 of Volume Four considers loading of waste glass with 40 weight percent of waste oxide. It reports a population dose of 7,900 person-rem for the Ex Situ Intermediate Separations alternative. This is beyond the limit by weight that waste oxide can be put in glass. Loadings of over 30 weight percent waste oxide are no longer glass. They are sodium silicates. As a consequence, the population dose is wrong. Errors such as this greatly increase the uncertainty in the potential real risk to the population, as compared to the modeled risk in the EIS.

Response The 40 percent waste oxide loading used for this sensitivity analysis also included a 1.5 blending factor. Use of the 1.5 blending factor would result in a net waste oxide loading of 27 percent. Published literature supports waste oxide loadings in excess of 30 weight percent. Therefore, the populations dose of 7,900 person-rem for the Ex Situ Intermediate Separations alternative is appropriate for analysis and no change to the document is warranted.

Comment Number 0072.225

CTUIR

Comment P E-3: PP 4: bullets 3-4: Page E-3: These bullets state that "unmitigated consequences" would be the basis of comparison, while page E-27 states that ingestion and groundshine were not evaluated as accident consequences because mitigation measures were assumed to occur. This is inconsistent. In addition, mitigation is never 100 percent successful, and the potential impact areas, food interdiction requirements, evacuation and relocation costs, and many other factors are all clearly consequences of the more severe accidents. Assuming that intervention is only partially effective (as is really the case), also means that, depending of the half lives of the materials released, there would be long-term and multigeneration impacts from some of the accidents. Intervention itself can be extremely destructive, as an example of event consequences that must be included. Regardless of the habitual methods for performing Safety Analyses, a full accident evaluation must include all potential consequences. CTUIR technical staff can also provide recommendations for translating environmental concentrations into human, environmental and socio-cultural risks.

Response The bullets are in reference to unmitigated consequences being compared to the Hanford Site risk acceptance guidelines for developing safety controls for the TWRS Accelerated Safety Analysis. DOE and Ecology have further analyzed the risk from the unstabalized tanks collapsing after the 100-year institutional control period. Because this is a likely event and there would be no institutional controls, evacuation and interdiction of food consumption would not be a mitigative barrier. The resulting analysis includes the added risk from groundshine, ingestion, and deposition. The new analysis is presented in Volume Four, Sections E.2.3 and E.3.4. Text also has been added to the methodology in Volume Four, Section E.1.1 to reflect this change.

All other remediation accident scenarios either have very small offsite consequences or the probability of the event is extremely unlikely. The Final EIS provides an analysis of the environmental and socio-cultural impacts from these accidents with the amount of detail commensurate with their likelihood and potential consequences as directed in Recommendations for the Preparation of Environmental Assessments and EISs, Office of NEPA Oversight, DOE, Washington, D.C., May 1993 (DOE 1993d). The text has been modified in the methodology in Volume Four, Appendix E to provide a qualitative assessment of the potential environmental and socio-cultural impacts and mitigative measures that would be taken. Please refer to the response to Comment numbers 0072.226 and 0072.26.

Comment Number 0072.226

CTUIR

Comment P E-13: Sect. E.1.1: Accident risk evaluation in general has a long history, yet methods are still archaic. As we have described elsewhere, the evaluation of risk from normal operations and from accidents needs to span the full range of potential impacts, including not only human dose, but also environmental and socio-cultural impacts. Methods are available for deriving guidelines for accident risks that include risk acceptance criteria for different accident frequency classes for each risk measure. For any revision of such risk acceptance guidelines, CTUIR expects to see risk acceptance criteria for each type of impact that could occur from accidents, and can offer technical and regulatory guidance in selecting appropriate risk levels.

Response The direction from Recommendation for the Preparation of Environmental Assessments and EISs, Office of NEPA Oversight, DOE, Washington D.C., May 1993 (DOE 1993d) is to calculate the potential risk from accidents (e.g., the number of LCFs from exposure to radiological constituents). The risk is not to be measured against risk acceptance guidelines, but against potential risks calculated in the other proposed alternatives. Risk is measured against risk acceptance guidelines in safety analysis reports for operation and facility design. Risk assessment guidelines help provide guidance in establishing administrative and mechanical barriers to mitigate or prevent unacceptable accidents from occurring. No change to the document is warranted.

Comment Number 0072.227

CTUIR

Comment P E-27: PP 4: Groundshine and ingestion pathways must be included.

Response DOE and Ecology have further analyzed the risk from the unstabalized tanks collapsing after the 100-year institutional control period. Because this is a likely event and there would be no institutional controls, evacuation and interdiction of food would not be a mitigative barrier. The resulting analysis includes the added risk from groundshine, ingestion, and deposition. The new analysis is presented in Volume Four, Sections E.2.3 and E.3.4. Text also has been added to the methodology in Volume Four, Section E.1.1 to reflect this change. Please refer to the response to Comment number 0072.225 for a discussion of impacts of remediation accidents.

Comment Number 0072.228

CTUIR

Comment P E-29: PP 3: Maximally-Exposed Individual General Public: Since the conventional offsite boundary dose was omitted from the evaluation, the MEI noninvolved worker dose (at 100m) must be considered the MEI offsite dose as well. Although not clearly stated, we presumed that the general population dose was estimated either by 160 annular sector analysis or by assuming that at each distance the entire population resides at plume centerline. In either case, the single point estimate result represents an average, with half the population being at higher risk. For this reason, we assume for the rest of this evaluation that the population dose is an average and the MEI worker dose is the same as the public MEI dose.

Response The conventional offsite boundary dose for the maximally-exposed individual (MEI) was not omitted from the evaluation (e.g., Volume Four, Table E.2.2.2 shows the MEI general public dose from a spray release due to a mispositioned jumper).

The population dose is not an average. Onsite and offsite population dose calculations were based on population-weighted Chi/Q values generated from onsite and offsite population distributions (i.e., estimates of the distribution of the population relative to the facility where the accident is postulated to occur). Both the Site and offsite areas were broken up into 16 sectors. The sector with the bounding population-weighted Chi/Q was assumed in the scenario. In addition, bounding 99.5 percent maximum sector Chi/Q values were used in the dose calculations.

The MEI worker dose is not the same as the public MEI dose. Dose is dependent on Chi/Q, which is dependent on distance. These values are reflected in the Chi/Q values (time integrated atmospheric dispersion coefficient) used for each receptor in the analysis. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.229

CTUIR

Comment P E-38: Table E.2.2.1: The column labeled "risk" either needs to be explained or omitted. The column labeled "severity" also needs some explanation - what does "No" mean with respect to severity, and how was this determined? Does this entire table apply to each tank individually? If so, then all of the anticipated accidents summed over all the tanks suggests that there would be several reportable incidents per year. Since the consequence analysis did not include any risk measure except dose, the consequences of these events (and especially programmatic impacts) are probably greatly underestimated.

Response Table E.2.2.1 in Volume Four is a screening table that is similar to those used elsewhere in the document. The table and purpose of the table were defined in Volume Four, Section E.1.1.2, which contains the explanations of "risk," "severity," and "no" and how the data were determined. The table does not apply to each tank individually but to the tank farms collectively. The intent of the analysis was to measure only health effects resulting from accidents; therefore, no change to the EIS is warranted. Please refer to the response to Comment numbers 0069.06, 0072.225, and 0072.226.

Comment Number 0072.230

CTUIR

Comment P E-40: Sect. E.2.2.1.1: It would be helpful if the discussion of the particular accident scenarios included the numerical reference from table E.2.2.1.

Response The accident scenario described can be traced to Volume Four, Table E.2.2.1 by using the name of the accident; therefore, no change to the document is warranted.

Comment Number 0072.231

CTUIR

Comment P E-40: Table E.2.2.2: Please note that in these tables there is information presented for the MEI public, although the prior discussion did not indicate that this would be the case. If this is also done consistently in the later tables, the discussion at the beginning of the section should include description of the MEI public offsite individuals location.

Response The location of the general public MEI is defined in Volume Four, Section E.1.1.5, Receptor Location. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.232

CTUIR

Comment P E-42,43,44,45,46: Tables E.2.2.4-E.2.2.5: The totals from Tables E.2.2.4 and E.2.2.5 should be added, because exposure to toxics and corrosive would be simultaneous and the effects are not necessarily independent. For the mispositioned jumper accident, the MEI worker would experience both effects at the same time, though the same portal of entry (the lungs), and therefore the effects are at least additive if not supra-additive.

Response Toxic and corrosive effects are independent and for that reason these efforts are not additive. Corrosive chemicals cause localized destructive physical damage to the exposed cells and underlying tissue with which there is direct contact (e.g., skin, eyes, and lining of the lungs). Toxic chemicals are absorbed through the cell membrane wall into the blood stream or lymphatic system where target organs are affected. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.233

CTUIR

Comment P E-57: PP1: What is the reason for using the 50 percent inventory rather than the 100 percent inventory? Is there an official Record of Assumption to track when and by whom this decision was made? This section indicates an onsite residential population of 183 people, but this is not described earlier under receptor locations. Please clarify. Given the current controversy around the possibility of any dome collapse (for example, with overload and filtration of releases upward through gravel, and so on), it might be useful to discuss all dome collapse and dome failure scenarios in a little more detail.

Response A discussion of the 100 percent inventory is found in Volume Four, Appendix E, Section E.1.1. As defined in Section E.1.1, the highest radioactivity concentration for each radionuclide was combined to define a hypothetical highest concentration tank inventory or "super tank" used to bound accidents. For single tank accidents or spray releases, this methodology is reasonable. However, for multiple tank accidents it would be unreasonable to represent all the tanks as the super tank; therefore, the nominal tank inventory would be more reasonable when an accident involves multiple tanks.

The decision to use a nominal inventory for accidents involving multiple tanks was made during the consequence analysis of the post-remediation accident scenario. The population living on the Hanford Site after the institutional control period was assumed to be 10 percent of the current Hanford Site population work force or 1,090, as discussed in Volume Four, Appendix E, Section E.2.3. The dome collapse and dome failure scenarios have been addressed in detail in Volume Four, Appendix E, Section E.2.3 and this analysis has been modified in the Final EIS to address information unavailable for inclusion in the Draft EIS analysis.

L.5.12.1 Nonradiological Occupational and Transportation Accidents

Comment Number 0072.25

CTUIR

Comment The accident scenarios need to be better described in the EIS, without referring the reader constantly to other documents, especially since there is such controversy about how frequently the accidents might happen, or even if they could happen at all.

Response The information requested is contained in the referenced documents in DOE Reading Rooms and Information Repositories for public review. The use of references in the EIS is consistent with CEQ guidance that EISs be as concise as feasible and that where appropriate supporting data and technical analysis be incorporated by reference (40 CFR 1502.21). The document is very lengthy and DOE and Ecology believe they have struck an appropriate balance between presentation of analysis in the EIS and incorporating by reference supporting materials.

The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.26

CTUIR

Comment The SAR approach to accident risks is inadequate for an EIS type of analysis: the full range of types of risk (including environmental and socio-cultural) need to be included since all of these would be affected by accidents.

Response DOE and Ecology have further analyzed the risk from the unstabalized tanks collapsing after the 100-year institutional control period. Because this is a likely event and there would be no institutional controls, no recovery action is accounted for. The resulting analysis includes the added risk from deposition to the environment and cultural resources. Therefore, the airborne release rate (ARR) and RF are presented separately in the EIS. The analysis is presented in Volume Four, Sections E.2.3 and E.3.4 of the Final EIS. Text also has been added to the methodology in Section E.1.1 to reflect this change.

All other scenarios occur within the 100-year institutional control period and have either very small offsite consequences or the probability of the event is extremely unlikely. DOE and Ecology have determined to evaluate the environmental and socio-cultural impacts from these accidents with the amount of detail commensurate with their likelihood and potential consequences as directed in Recommendations for the Preparation of Environmental Assessments and EISs, Office of NEPA Oversight, DOE, Washington, D.C., May 1993 (DOE 1993d) and following consultation with the commentor. The evaluation added to each alternative does not include a rigorous quantitative analysis but provides a qualitative assessment of the potential environmental and socio-cultural impacts resulting from deposition and mitigative measures that would be taken to offset these impacts. Please refer to the response to Comment number 0072.225.

Comment Number 0072.234

CTUIR

Comment P E-100: Sect. E.6.0: Where is the discussion of the environmental Impact due to the removal of the sand, gravel and silt? Additionally, where are the discussions regarding the impacts to known cultural sites associated with the proposed borrow sites?

Response Environmental and cultural site impacts associated with removal of sand, gravel, and silt are analyzed in Volume One, Sections 5.1, 5.5, and 5.7, and summarized in Section 5.14.

Comment Number 0072.235

CTUIR

Comment This table indicates that under the intermediation separation alternative (the preferred alternative), the closure caps (the Hanford Barriers) will require approximately over 85,000 trips to bring silt from McGee Ranch, 97,000 trips from Borrow Pit 30 for tank fill material, 122,000 trips to bring riprap from Vernita Quarry, and 100,000 trips to bring sand from Borrow Pit 30. What total volume of each material does this represent? This table indicates that *all* of this material is needed for the barriers, and no alternative sites are presented. Since the selection of a preferred alternative includes a de facto decision about closure, this EIS must include a discussion of the environmental and cultural harm that will be caused by this huge amount of clean fill, and the mitigation that will be performed should this closure plan be pursued. Closure is an inseparable part of the preferred alternative, so an excuse that closure is not in the scope of this EIS will be unacceptable.

Response The total volume of material removed from the potential borrow sites for hypothetical closure scenario is as follows:

- Silt from McGee Ranch = 853,000 yd^3
- Tank fill from Borrow Pit 30 = 986,000 yd^3
- Riprap from Vernita Quarry = 1,220,000 yd^3
- Sand from Borrow Pit 30 = 1,000,000 yd^3

The environmental and cultural impacts to the borrow sites listed are discussed in Volume One, Sections 5.1, 5.4, 5.5, and 5.7, and summarized in Section 5.14.

A hypothetical closure scenario was addressed to show the relationship between closure and remediation of the tank waste. For discussion of the closure scenario, please refer to the response to Comment numbers 0072.08 and 0101.06 and for more information regarding borrow site impacts, refer to the response to Comment number 0019.03. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0081.07

Pollet, Gerald

Comment There is one other area of risks that we would like to spend another piece of paper on, and that has to do with explosion risks. We believe that the assumptions used are erroneous, and the Department of Energy had more than ample time to incorporate additional data about the risk of explosions in far more tanks than that are on the watch list today. The Wyden Safety Watch List Law requires the listing of tanks that have the potential for uncontrolled release of fission products, i.e., an explosion. We know that the Department has been sitting for months and months on a recommendation that 25, in other words twice as many tanks, have the potential to explode. That greatly changes the risk assumptions used and the presentation of data in the EIS.

Response In December 1995, Westinghouse Hanford Company (WHC) recommended to the DOE that 25 additional tanks be added to the Flammable Gas Watchlist. DOE-RL submitted the same recommendation to the U.S. Department of Energy, Headquarters (DOE-HQ), the organization responsible for formally making the decision. DOE-HQ requested that the Chemical Reactions Sub-Panel review and comment on the basis for the recommendation. DOE-HQ, on the basis of the sub-panel review, recommended to DOE-RL that the recommendation to add the tanks to the Watchlist to be withdrawn. DOE-RL withdrew the recommendation about the same time that WHC withdrew its original recommendation to DOE-RL.

The risk of tank deflagrations and explosions has been analyzed further by DOE and Ecology. The results of the new analysis that shows the event to be more credible (a higher annual frequency) have been incorporated into the Final EIS Volume Four, Appendix E, Sections E.2.2, E.3.3, E.4.3, E.5.3, E.6.3, E.7.3, E.8.3, E.9.3, E.10.1, and E.10.2.

L.5.12.2 Radiological Accidents

Comment Number 0069.10

Pollet, Gerald

Comment Fifth, we know that there are five times as many tanks with the potential for a hydrogen gas explosion as this EIS assumes. This assumption, found in the documents provided which are Westinghouse documents, the assumption is six flammable gas tanks. There are 25 awaiting to be added to the Watchlist. Which is the Wyden Watchlist. They've been awaiting being put on that Watchlist, which is a legal requirement for tanks of the potential to explode, since long before this EIS was issued. The department has known that tanks, additional tanks have the potential for hydrogen buildup above the flammability limit for a year now. It is not shown in the EIS at all. You should be clearly showing the annual risk of delay in terms of tank leaks, pressure vents, and explosions. Clearly show the risks per year of each alternative, and reveal which wastes would be retrieved, and which delayed in each alternative.

Response The annual frequency of a hydrogen deflagration as analyzed in the Draft EIS was based on 25 flammable tanks (Volume Four, Appendix E, Section E.2.2). Please refer to the response to Comment number 0081.07.

A bounding risk from the delay in remediating these wastes is presented in Volume Four, Section E.2.2, where the risk is shown from accidents that could result if remediation is delayed indefinitely under the No Action alternative. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0069.11

Pollet, Gerald

Comment The ultimate question is which alternative gets on with retrieval of wastes, with what risks on the fastest timeline... beyond the design basis accident, i.e., greater than 10 to the -6th one million events. It's also incredible that the same one million chance, or greater, is given to red oil exothermic reactions. Based on the Westinghouse report which say's that the exothermic reaction will only occur by the 135 centigrade. Yet, in 1994, when the Department of Energy agreed not to restart the Plutonium Finishing Plant, it had placed administrative controls on the calciner, which are equivalent to the evaporators in many respects, had place administrative controls because it's own studies, including those done at Los Alamos and at Hanford, showed that the exothermic reactions could occur at temperatures far less than 135. This data was available, but ignored. It basically means that the risks presented here are entirely underestimated. Especially for tank explosions and pressure events, and other releases.

Response The Hanford solvent extractions separations plants (e.g., Plutonium Finishing Plant) operate with nitric acid systems where tributyl phosphates could react to form red oil. The exothermic events relating to red oil have occurred in mixtures of fuming nitric acid and normal paraffinic hydrocarbons (which are commonly called red oil). The explosion occurs when the mixtures are overheated and low molecular weight gaseous decomposition products are generated. Safeguards have been put in place at these facilities to limit the chance for a runaway thermal reaction, which would produce large quantities of flammable hydrogen gas. Unlike the Plutonium Finishing Plant, the waste in the Hanford Site tanks has been neutralized before transfer to the tanks and the waste is being maintained at an alkaline and not at an acidic pH. The material used for construction of the Hanford Site tanks is not suitable to store acidic wastes; therefore, alkalinity was and is measured and controlled before waste is placed or transferred into the tanks.

Red oil, a reaction product of tributyl phosphate, nitric acid, and heavy metal nitrates, cannot be formed on the alkaline wastes stored in the tanks. In the unlikely event that red oil is routed to the waste complex due to a process upset in an operating plant (i.e., material is not neutralized with sodium hydroxide [caustic]), contact with the large volume of diluted caustic in the storage tanks would neutralize the waste. Because the Hanford Site tank waste is in an alkaline and not an acidic state, a red oil exothermic reaction was determined to fall in the incredible range (less than 1.0E-06/yr) and the potential risks have not been underestimated in the EIS. The information relative to this issue was included in the Draft EIS in Volume Four, Appendix E; therefore, modification to the document is warranted.

Comment Number 0069.12

Pollet, Gerald

Comment One must wonder is the Department of Energy delaying placing additional tanks on the legal Watchlist until this comment period is closed? Why aren't we showing the risks from hydrogen events and from exothermic reactions, as the Department's own studies have shown them to be?

Response These decisions regarding placement of tanks on the Watchlist were made independent of the EIS schedule and do not reflect an intent to not address these issues in the EIS. Please refer to the response to Comment numbers 0069.10 and 0081.07.

Comment Number 0069.13

Pollet, Gerald

Comment As Todd Martin said earlier this evening, all that we know about some of these events is that they have a far greater probability than 1 the million. We cannot put a definitive figure on them. I would agree with that. We can't put a definitive figure on them. But we do know, for instance for the exothermic reaction, we know that the Department of Energy has had 3 explosions, at Hanford and Savannah River, involving this same material, same exothermic reaction. Yet this EIS is based on a Westinghouse study that assumes the possibility of one event is greater than one in a million. We have had three events, therefore, in the last 50 years and that does not equal a rate of occurrence of one in a million.

Response Please refer to the response to Comment numbers 0081.07 and 0069.11, which address similarly worded comments.

Comment Number 0072.27

CTUIR

Comment Deposition needs to be included, and therefore the ARF and RF need to be presented separately.

Response Please refer to the response to Comment numbers 0072.17, 0072.26, and 0072.251, which address similarly worded comments.

Comment Number 0089.19

Nez Perce Tribe ERWM

Comment The risks from tank wastes to the environment and the public appear to be understated and inconsistent with those on the Risk Data Sheets for the Hanford Site.

Response The risks to the environment and the public from tank waste as stated in the TWRS EIS are based on more current data and analyses than those used in the RDSs. Also, they serve different purposes. RDSs are used to obtain funding for Hanford operations and evaluate the cost of

environmental, socio-economic, and health impacts. The TWRS EIS only evaluates the health risks in terms of health effects, not cost; therefore, no change to the document is warranted.

Comment Number 0090.03

Postcard

Comment Please listen to us say no:

to ignoring the risk of tank explosions.

Response Please refer to the response to Comment numbers 0081.07 and 0069.11, which address this issue.

Comment Number 0098.05

Pollet, Gerald

Comment Explosion risks in this EIS. This EIS is based on a 1995 Westinghouse document that assumes a plutonium or uranium nitrate and tributyl phosphate or other solvent exothermic reaction, i.e., a red oil explosion, will only initiate at a 135 degrees centigrade and bases a lot of the risk estimates in terms of things like evaporator risks and explosion risks on that assumption. That assumption was disproven by Los Alamos National Laboratory study a year before this Westinghouse report which is the basis of the EIS. I would like to know why we are paying contractors to ignore official findings of the Department of Energy including there at Hanford which said, We had to put administrative controls on Plutonium Finishing Plant because of an acknowledgement that this reaction could occur temperatures far below 135 degrees centigrade. I think that Westinghouse should be penalized for producing a document that ignored the rest of the data at Hanford and from Los Alamos National Lab about the risk of a red oil explosion. The state needs to take a look at that and take a look at how those explosion risks are calculated because frankly, they did the same thing that the state fought in terms of the Plutonium Finishing Plant and they continue to try to get away with saying that this exothermic reaction only occurs at 135 degrees. Secondly, the data ignores the fact that the evidence shows that these reactions release hydrogen at flammable ... above the flammable limits at far lower temperatures and you're likely first to get a hydrogen explosion before you get the explosion from the red oil.

Response Red oil explosions are considered an incredible event and not discussed in the risk evaluations in the EIS; however, data pertaining to red oil explosions in the Hanford waste tanks are presented in Volume Four, Appendix E. Please refer to the response to Comment number 0069.11, which provides a more extensive discussion of the issue in response to a similarly worded comment.

L.5.12.3 Potential Toxicological Accidents

No comments were submitted for this topic.

L.5.13 CUMULATIVE IMPACTS

Comment Number 0019.17

WDFW

Comment Page 5-210, section 5.13.3.1, second paragraph. The EIS states that "closure of the SSTs and DSTs is beyond the scope of this EIS." If closure is beyond the scope, WDFW believes it is inappropriate to mention potential borrow sites for post-remediation activities since a thorough analysis has not being performed.

Response Although closure is not included in the TWRS EIS scope, as discussed in Volume One, Section 3.3.1, a generic closure method was included in all the alternatives (except No Action and Long-Term Management) to allow meaningful comparison of the in situ and ex situ alternatives on a relatively equal basis. It is necessary to address potential impacts at borrow sites in order to identify all impacts that may occur. The borrow sites shown in the Draft EIS were used only for calculational purposes. The EIS was modified in the Summary and Volume One, Sections 1.0, 3.3.1, and 5.0 to clarify that the borrow sites addressed are only identified for calculational purposes. A decision on which sites would be used will be made in the future when NEPA analysis is prepared for closure purposes. Please refer to the response to Comment numbers 0078.08 and 0019.03 for more information on this topic. Because the information contained in the Draft EIS is correct, no change to the text was made at the location specified in the comment.

Comment Number 0053.02

Carpenter, Tom

Comment I think that we have got waste that have leaked into the ground under the tanks. The figure varies. I have heard 950,000 gallons is the official figure of what has leaked from the single-shell tanks into the ground; however, a number of engineers out there have told me that, for instance tank 105A which had a serious steam event back in the mid-60's resulted in a great deal of contamination going down to the ground underneath the tank and the 500,000 gallon tank ended up needing over a million gallons of cooling water. So cooling water or evaporating water that was not counted as leaks to the ground. So that 950,000 gallon figure is not accounted into there.

Response Approximately 600,000 to 900,000 gallons of liquid are known or assumed to have been released to the soil beneath leaking tanks and this information is presented in the EIS in Volume One, Section 1.0 and 4.2. Cooling water that may have leaked from SSTs would be included in that volume. Cooling water that has evaporated would not be included in the leak volume. It is because of the insufficient information available regarding contamination of soil and groundwater that closure is not within the scope of the TWRS EIS. For more information on this issue, please refer to the response to Comment numbers 0091.01, 0030.02, 0072.63, and 0072.08. The Final EIS analysis of cumulative impacts, including soil contamination from past leaks has been modified and is presented in Volume One, Section 5.13 and Volume Four, Appendix F.

Comment Number 0101.05

Yakama Indian Nation

Comment Need to Consider Cumulative Impacts--Consideration of key actions and their resulting impacts having already occurred or potentially occurring in the future should be assessed by the subject EIS, consistent with NEPA guidance regarding consideration of cumulative impacts. Particular attention should be paid to impacts from other waste disposal sites, partially remediated sites or contaminated ground water posing an additional hazard from either simple additive effects and/or more complicated synergistic effects.

We consider it is inappropriate to base actions on a partial evaluation of impacts affecting the public health and safety and the environment, particularly when it is known or expected that other impacts from known or expected actions are cumulative.

Response Cumulative impacts of past, present, and future Hanford operations, together with the potential impacts of the TWRS alternatives, are included in the cumulative impacts section (Volume One, Section 5.13) of the EIS. No potentially synergistic effects were identified.

L.5.14 UNAVOIDABLE ADVERSE IMPACTS

Comment Number 0019.18

WDFW

Comment Page 5-230, Table 5.14.1, Phased Implementation alternative, Row on Biological Resources. There is a discrepancy between the figures on shrub-steppe habitat loss here (540 acres total) and that mentioned on 5-123 which states 690 acres. This is the second comment regarding clarification on upper impact level for the Phased Implementation alternative. What is the correct figure?

Response Please refer to the response to Comment number 0019.14 for the corrected information on the potentially affected acreages.

L.5.15 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

No comments were submitted for this topic.

L.5.16 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

No comments were submitted for this topic.

L.5.17 CONFLICTS BETWEEN THE PROPOSED ACTION AND THE OBJECTIVES OF FEDERAL, REGIONAL, STATE, LOCAL, AND TRIBAL LAND-USE PLANS, POLICIES, OR CONTROLS

No comments were submitted for this topic.

L.5.18 POLLUTION PREVENTION

No comments were submitted for this topic.

L.5.19 ENVIRONMENTAL JUSTICE

Comment Number 0072.53

CTUIR

Comment Despite initial scoping agreements to include environmental justice as a separate section (per Executive Order 12898), no such section was prepared. The mere counting of the number of Native Americans residing in the three closest counties is not adequate.

Response DOE agrees that re-compiling existing demographic information would not satisfy the intent of Executive Order 12898. The environmental justice initiative has a technical component that involves analyzing whether there is a disproportionately elevated and adverse health or environmental impact on any minority community or low-income community and, if such impacts are identified, mitigating those impacts. In response to the environmental justice requirement, the TWRS EIS project included the following tasks.

- Identify potentially affected low-income populations and minority populations within an 80-km (50-mi) radius of the Hanford Site central plateau.
- Conduct technical analyses to establish if disproportionately high and adverse impacts to low-income and minority populations are associated with any EIS alternative.
- Identify mitigation measures, if appropriate.

The basic EIS consists of a description of the affected environment and environmental consequences in Volume One, Sections 4.0 (supported by a more detailed analysis in Volume Five, Appendix I) and Section 5.0 (supported by detailed analysis in Volumes Two through Five), respectively. Volume One, Section 4.0 contains a description of the potentially affected minority, Native American, and low-income populations (Section 4.6). Section 4.0 also contains, where appropriate, other information pertinent to those populations within the affected environment including relationship of Native Americans to the Hanford Site in Section 4.4 (biological and ecological), Section 4.5 (cultural resources), Section 4.7 (land use), and Section 4.8 (visual resources). A more detailed description of each is provided in the associated section of Volume Five, Appendix I.

Identifying potentially affected minority populations, Native American, and low-income populations in the 80-km (50-mi) area surrounding the Hanford Site central plateau involved analyzing census data (Section 4.6). Identifying this area for analysis conforms to the geographic maximum extent of potential environmental impacts as described in the other sections of the EIS. This area included Benton County, Washington, and portions of nine other counties in Washington and Oregon, as well as portions of the Yakama Indian Reservation. The 1990 census was used as the source of the population data. Data were produced and analyzed for all census blocks located completely or partially within the 80-km (50-mi) area surrounding the Site. The results are summarized in Volume One, Section 4.6 and provided in greater detail in Volume Five, Appendix I. This section also included an acknowledgement that Tribal Nations located outside of this area "have historical and treaty interest in the Hanford Site area."

Socioeconomic data presented in Volume One, Section 4.6 were limited to Benton and Franklin Counties, Washington. The more limited area was identified because the socioeconomic impacts (e.g., jobs, tax revenue, retail sales, housing, and public facilities and services) of the Hanford Site on areas beyond the two-county area historically have been slight. Considering a smaller area does not diminish the impact of the Hanford Site on the Tribal Nations who have treaty rights and privileges to the Site. Other links to the Site are described in the relevant sections of the description of the affected environment.

The second portion of the environmental justice analysis was a description of the analysis of the potential environmental consequences of each of the TWRS alternatives presented in Volume One, Section 5.0, and in the other related appendices. Generally, these sections (i.e., Section 5.1 through 5.12) address impacts to air and water, ecological and biological resources, and human health and safety. Sections 5.13 through 5.20 contain analysis issues such as the impact of the alternatives on commitment of resources and land uses as well as environmental justice and mitigation measures.

For the environmental justice analysis, based on the minority, Native American, and low-income populations within the 80-km (50-mi) area, as well as Tribal Nations outside the 80-km (50-mi) area with treaty interests in the Hanford Site, each of the areas of technical analysis presented in the EIS was reviewed to determine if any "potentially disproportionate and adverse impacts" would occur. If "an adverse impact" was identified, a determination was made as to whether the impacts on minority, Native American, or low-income populations would be "disproportionately affected."

Volume One, Section 5.19 of the Draft EIS identified two areas of potentially adverse and disproportionate impact relative to Tribal Nations -- continued access restrictions to portions of the 200 Areas that would continue under long-term land use restrictions and potential disproportional post-remediation health impacts under in situ disposal alternatives. Subsequent to the publication of the Draft EIS, consultation with Tribal Nation identified other areas of concerns regarding potential adverse impacts to cultural resources. This section has been modified to identify those areas of concern. As required by the environmental justice initiative, Section 5.20 identifies potential mitigation measures that DOE could adopt to address the potential environmental justice impacts identified in Section 5.19.

Please refer to the response to Comment numbers 0072.149 and 0072.252 for information regarding consultation with Tribal Nations.

Comment Number 0101.08

Yakama Indian Nation

Comment Requirements-Based Alternative Designs Needed -- The TWRS design alternatives in the EIS that are considered fail to reflect a requirement-based approach in the conceptual design process. This effectively forecloses consideration of Yakama Nation cultural values and associated requirements. Hence, impacts within the realm of socio-economic impacts related to these values and requirements are not addressed in the EIS. For example, the potential economic burden on future generations or the impact of alternative closure designs for waste sites or interim storage facilities on the Indian use of nearby religious sites are not assessed in the subject EIS, although the values affected by these impacts are of prime importance to the Yakama Nation.

Response The TWRS alternatives considered in the EIS reflect a requirement-based approach to the conceptual design, but because of the large number of potential alternatives, a broader range of requirements was taken to develop the full range of reasonable alternatives. As indicated in the Draft EIS Volume One, Section 3.3.1, the alternatives were developed using the following requirements:

- That a No Action alternative be addressed in the analysis (NEPA);
- That the EIS developed representative alternatives for detailed analysis that bound the full range of reasonable alternatives when a wide range of alternatives were available for analysis (NEPA);
- That 99 percent of the waste from the tanks will be retrieved for the ex situ alternatives (except for the ex situ/in situ combination alternatives); and
- That management and disposal practices of radioactive waste, as well as the degree of separations required to facilitate near surface disposal of LAW and offsite disposal of HLW, will be consistent with DOE and Atomic Energy Act regulations.

This process allowed the analysis and consideration of cultural values and other associated issues in the EIS. For each of the alternatives, impacts to the human and natural environment, including impacts to Tribal Nation cultural values, were analyzed in the EIS. A description of the existing environment was provided in Volume One, Section 4.0 and Volume Five, Appendix I and impacts to the environment were provided in Volume One, Section 5.0 and associated appendices. Based on comments submitted by Tribal Nations and consultation with affected Tribal Nations during and following the comment period, the text of the EIS has been modified to reflect comments regarding the affected environment and potential impacts to Tribal Nation cultural values. Please refer to the response to Comment numbers 0037.01, 0072.271, 0072.53, 0072.154, 0072.252, and 0072.268 and 0072.149 for discussions of changes to the EIS based on consultation with Tribal Nations.

Regarding potential burdens to future generations, the EIS addresses potential health impacts to future generations, out to 10,000 years into the future, for a variety of potential future Site users. The Final EIS was modified to include a Native American Subsistence scenario based on consultation with affected Tribal Nations. Please refer to the response to Comment number 0072.198 for a discussion of this scenario. Other potential burdens to future generations are addressed to the extent the impact analysis indicates that a natural resource would be adversely impacted. Other impacts, such as impacts associated with accident risk, are not addressed in detail in the EIS because their small likelihood and potential consequences. Please refer to the response to Comment numbers 0072.26 and 0072.225 for discussions regarding accident impacts.

Impacts associated with alternative closure designs for waste sites were addressed within the context of the scope of the TWRS EIS. Closure is not within the scope of the EIS, hence, the EIS addressed a single closure scenario to provide the public, Tribal Nations, and decision makers with information needed to compare the relative impacts of each alternative. Please refer to the response to Comment number 0072.08 and 0019.03 for a discussion of closure and its relationship to the EIS.

L.5.20 MITIGATION MEASURES

Comment Number 0019.06

WDFW

Comment The Final Environmental Impact Statement Safe Interim Storage (SIS) of Hanford Tank Wastes made a firm commitment to develop a stand alone Mitigation Action Plan. The SIS project should be commended for being consistent with USDOEs Land and Facility Use Plan. The SIS project is part of the TWRS program. However, the TWRS EIS does not make the same explicit commitments as the SIS EIS did for mitigation of Priority Shrub-Steppe Habitat. There appears to be inconsistency within the TWRS program in interpreting and implementing the Land and Facility Use Policy.

The TWRS project will impact from 540 to 690 acres of shrub-steppe habitat. WDFW has several specific comments asking for clarification on acreage (refer to specific comments). WDFW strongly recommends compensatory mitigation for this project. The project should develop a stand alone Mitigation Action Plan, since the Biological Resource Mitigation Strategy has not been completed or reviewed by the natural resource agencies. At this point in time, the Biological Resource Mitigation Strategy may not meet mitigation requirements defined by WDFWs and USFWs mitigation policies. Besides biological arguments, this recommendation is based on USDOEs Land and Facility Use Policy which states "it will sustain the natural resources for which it is steward." By performing compensatory mitigation for this project, USDOE-RL is consistent with its Land and Facility Use Policy.

Response There is no inconsistency within the TWRS program. The EIS explicitly states that a Mitigation Action Plan will be performed as required by NEPA. Like the SIS project, the TWRS EIS program will make commitments for mitigation will be made in the TWRS EIS, the specific requirements will be contained in the Mitigation Action Plan. Under the regulations that implement NEPA (40 CFR 1500-1508), the EIS is not the place to document the specific mitigation measures that will be performed. The mitigation measures for the TWRS EIS may be far more complex than the measures identified by the SIS EIS so it is not feasible to document these in the Final EIS.

The 540 to 690 acres of shrub-steppe habitat mentioned in the comment refer to disturbances during tank farm closure activities, which is outside of the scope of this EIS and will be addressed in a future NEPA analysis. Please refer to the response to Comment number 0019.14 for more information on the potentially affected acreages. The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0019.19

WDFW

Comment Page 5-260, section 5.20.2. Request the word "Potential" be removed from section title. The section includes discussion of mitigation for shrub-steppe habitat, but vague language is used throughout without any firm commitment to doing mitigation. Again, WDFW strongly recommends mitigation for impacts to shrub-steppe.

Response General commitments for mitigation are contained in the TWRS EIS. The Mitigation Action Plan (MAP) will contain the specific requirements for mitigation. The term potential mitigation measures is the correct term because, as explained in Volume One, Section 5.20, page 5-260 of the Draft EIS, the mitigation measures included in this section are not included in the alternatives. One or more of these mitigation measures identified in Volume One, Section 5.20.2 could be included in the alternative selected for implementation. One likely mitigation measure is to mitigate impacts to the shrub-steppe habitat, as DOE has done for numerous other projects at Hanford. Following publication of the Final EIS, a Mitigation Action Plan will be prepared identifying additional mitigation measures DOE intends to implement.

Comment Number 0019.20

WDFW

Comment Page 5-262, section 5.20.2, third paragraph containing bullets. WDFW strongly recommends this idea be developed under its own section and that an explicit commitment be made for development and implementation of mitigation for the loss of shrub-steppe habitat. This would be consistent with Secretary Hazel O'Leary's Land and Facility Use Policy which states "USDOE will sustain the natural resources for which is steward", and would also be consistent with an earlier TWRS program EIS action.

Response Please refer to the response to Comment numbers 0019.06 and 0019.09 for discussions that respond to this issue.

Comment Number 0072.06

CTUIR

Comment Regardless of the proposed final Hanford tank waste retrieval and closure plans developed under the TWRS-EIS process, and prior to permitting of a treatment/disposal facility by the state under RCRA, a CTUIR aboriginal-lands human health and environmental sampling and analysis network must be established in order to help the CTUIR identify and mitigate potential future contamination impacts in a variety of environmental media. Existing environmental networks, albeit fragmentary, in both northeastern Oregon and southwestern Washington long have measurably demonstrated the regional environmental distribution of Hanford-source radionuclide and hazardous contaminants in air, water, soil, vegetation, and wildlife.

Response Cultural and archeological surveys of the areas that might be impacted by the project were performed and are summarized in Volume One, Section 5.5. Future environmental impacts on all environmental media were fully assessed and are presented in Volume One, Section 5.0 and associated appendices. A Native American exposure scenario is included in the Final EIS in Volume One, Section 5.11 and Volume Three, Appendix D. DOE annually samples and reports the regional contaminant levels in all environmental media on and near the Hanford Site in the Annual Hanford Site Environmental Report (PNL 1996), which is made available to the public and is summarized in Volume One, Section 4.0 and Volume Five, Appendix I of the EIS. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.5.21 MISCELLANEOUS

Comment Number 0034.01

Belsey, Richard

Comment Health and safety, the Hanford tanks are the greatest threat to public health and worker safety and the environment in the whole Hanford Site.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0046.02

DiGirolamo, Linda Raye

Comment Scientist and technicians got the DOE into a horrible, life threatening, INDUSTRY in Washington State and they are dancing around the gravity of the "CRUD" this industry creates. This nuclear "CRUD" is not only not biodegradable it is also EXPANDING in its lethal abilities...making it a true, toxic hazard which will not only never degrade but will most probably lead to the cause of the destruction of our whole planet. How? a) Nuclear winters (already experiencing), b) climate changes, c) Atmospheric interruptions d) river poisonings e) well water poisonings f) human and animal mutations...etc. (too many impacts to list on this page).

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0061.02

Longmeyer, Richard

Comment If there are any planned activities which will disturb or destroy these monuments, NGS requires not less than 90 days' notification in advance of such activities in order to plan for their relocation. NGS recommends that funding for this project include the cost of any relocation(s) required.

Response DOE and Ecology acknowledge the comment and the notification requirements. DOE and Ecology intend to comply with all requirements. No change to the text was appropriate based on this comment.

Comment Number 0072.164

CTUIR

Comment P 5-3: PP 2: Please indicate the process of determining which environmental component has uncertainties to be discussed. This is a VALUE laden statement which needs definition and consultation with the CTUIR.

Response The process for determining which environmental component has uncertainties associated with the environmental impacts analysis involved determining whether the methodology used in the impacts analysis involved using data regarding waste characteristics, technologies, or processes that were uncertain due to the level of confidence in the quality of the data or the maturity of performance data regarding the technology or process. In cases where data are incomplete or unavailable, NEPA requires DOE to "make clear that such information is lacking" (40 CFR 1502.22). If the incomplete information is relevant to reasonably foreseeable significant adverse impacts, the agency must: 1) include information in the EIS that informs the decision maker of the status of the information; 2) summarize the existing credible scientific evidence relevant to evaluating the potential impacts; and 3) evaluate the potential impacts "based on theoretical approaches or research methods generally accepted in the scientific community."

For the TWRS Draft EIS, this process was accomplished by including in the analysis of each environmental component a discussion of the assumptions used in the impact analysis, information on the implications of the assumptions used, and information on the uncertainties associated with the data, assumptions, and/or methodologies used in the analysis. Based on this and other comments received on the Draft EIS, a new appendix (Volume Five, Appendix K) has been included in the Final EIS to provide a single-source of information regarding the uncertainties associated with the analysis of the proposed action.

The referenced statement, as well as the entire Draft EIS, has been subject to consultation with the CTUIR, other affected Tribal Nations, and other interested parties. Please refer to the response to Comment number 0072.149. The changes to the EIS mentioned previously were a result of the consultation process, as well as other comments received on this and other related issues. Other comments and consultation input from Tribal Nations resulted in changes to specific assumptions and uncertainties analysis. These changes are documented throughout in this appendix. Please refer to the response to Comment number 0101.08 for a related discussion.

Comment Number 0098.04

Pollet, Gerald

Comment Groundwater data. I find it incredible and I am going to address this, make this personal - Mike Thompson from the Department of Energy - for you to stand in front of the audience and talk about the borehole probably being contaminated when the Department of Energy's own occurrence report conclusively states that, Borehole contamination is not the cause of the contamination found in ... underneath the SX Tank Farm. That the correlation between boreholes, this proves the claim that an individual borehole was contaminated and that would be the source of this cesium finding. Now if that is the official position of the Department of Energy in its occurrence report, I think it is not permissible for you to stand up and without even acknowledging the official position, try to destroy the credibility of the data presented from your contractor.

Response The position stated by Mr. Thompson at the Seattle TWRS EIS Meeting, and in previous meetings with the Hanford Advisory Board was, "although the conceptual model describing cesium-137 in an aerially extensive plume as deep as 125 feet may eventually prove to be correct, there are other conceptual models (involving preferential contaminant flow down the drywells) that can explain the observed data. There is insufficient evidence in hand to conclusively discriminate between the two primary potential conceptual models for cesium-137."

At the time of the TWRS EIS meetings, the SX Tank Farm Report was not written. Only the data reports were available for review. The interpretation, displayed in graphical form, showing a plume of cesium-137 to a depth of 125 feet (and possibly beyond) was not substantiated by published analysis of the full suite of data. It was unknown if there had been adequate consideration of all pertinent data required to discriminate between multiple viable conceptual models that could result in the observed data. The release and distribution of graphical representation of one of several potential conceptual models prior to release and distribution of the data analysis report has prompted considerable debate in the technical community. The debate focuses on the interpretation of the distribution of cesium-137 in the soil. Debate over the potential transport of mobile contaminants (technetium-99, tritium, and chromium) is considerably less polarized. Please refer to the response to Comment number 0012.15.

Cesium-137 has been found in the lower regions of some of the drywells in the SX Tank Farm. The occurrence of gamma-emitting radionuclides (presumably cesium-137) in these drywells has been known for years, and has previously been interpreted to be borehole contamination. The new interpretation that there is an aerially extensive plume of cesium-137 in the soil is not consistent with what is known about cesium-137 transport through the soil as demonstrated by laboratory studies and field observation. Cesium-137 is an alkali element, univalent cation, with properties similar to other alkali elements (lithium, sodium, potassium, and rubidium). Adsorption preference on mineral surfaces behaves according to Coulomb's Law, in the Lyotropic Series (adsorption to mineral surfaces for cesium is greater than rubidium, potassium, sodium, and lithium); cesium-137 adsorbs with higher affinity than other alkali metals. In laboratory studies and in Hanford soil washing tests, it also has been demonstrated that cesium-137 ions absorb into the structure of molecules, specifically to "wedge sites" of micas, where they can substitute for potassium ions, and are hard to displace. Cesium-137 does not complex (interact with common inorganic anions such as ferrocyanide) and has little interaction with most organic chemicals. Ammonium ions may displace cesium-137. Cesium-137 exhibits high adsorption coefficients K_ds (>1,000) in dilute solutions. K_ds decrease with solution strength, but even at a K_d as low as 4.5, the contaminant should move as little as approximately 20 feet through the soil column.

The SX Tank Farm drywells have been drilled through contamination from tank leaks. The drywells are not sealed to prevent the flow of contamination down the annular space between the casing and the soil. A drive shoe is attached to the bottom of the casing, which is larger in diameter than the casing, thus providing for a potential annular space for vertical contaminant transport. When these wells were deepened, the existing (potentially contaminated) casing was driven deeper as new pipe was welded to the top of the casing string and driven downward. Flooding of drywells has been known to occur in other tank farms, providing another transport mechanism for contaminants. There are data showing the two deep drywells are contaminated on the inside of the casing. The data indicate that contamination has entered the boreholes.

The DOE commissioned an expert panel to review the SX Tank Farm drywell logging data and the interpretations to determine which conceptual model for cesium-137 transport is correct: 1) an aerially extensive cesium-137 plume to at least 125 feet or 2) a more shallow soil plume and deeper, localized contamination due to preferential flow down the unsealed drywells. The panel has requested additional field data to make that determination.

There are a number of potential mechanisms that may have caused the contamination recently measured. Until additional data are collected, the mechanism or mechanisms responsible cannot be reliably determined. Volume Five, Appendix K contains a discussion of the levels of contamination measured, potential mechanisms that could have caused the contamination, and how each mechanisms might affect the results presented in the EIS.

L.8.0 LIST OF PREPARERS

No comments were submitted for this topic.

L.9.0 NEPA-RELATED COMMENTS

L.9.1 EIS PRESENTATION AND DISTRIBUTION

Comment Number 0042.02

EPA

Comment EPA has authorized the Washington State Department of Ecology to be the single regulatory authority for Resource Conservation and Recovery Act requirements on the Hanford Site. Although the formal public comment period began on April 12, 1996, copies of the draft EIS were not received by our Environmental Review Program office in Seattle until May 10, 1996, 30 days into the 45-day comment period. Therefore, we will not be conducting a detailed review of this Draft EIS. However, based on our previous endorsement of the single regulatory authority approach and the extensive involvement of Ecology as a co-preparer of this Draft EIS, we do not foresee having any critical environmental objections to the proposed project.

Response DOE submitted five copies of the Draft EIS to EPA headquarters in Washington, D.C. on April 5, 1996. Subsequently, copies were requested by EPA Region X for purposes of review and an additional five copies were sent to EPA Region X on the day the request was received by DOE. After the EIS had been received by EPA, DOE and Ecology met with EPA staff to facilitate the EIS review. DOE and Ecology informed EPA that the agencies would provide whatever support was necessary to ensure a timely and complete review of the EIS. EPA Region X subsequently informed DOE and Ecology that the agency would not be conducting a detailed review of the EIS. Please refer to the responses to Comment numbers 0007.01 and 0044.01 for information related to this comment.

L.9.2 CLOSURE

Comment Number 0012.12

ODOE

Comment This EIS does not govern closure of the tanks and tank farms. This is appropriate. Decisions on closure of tanks and tank farms and what to do about leaked tank waste must be the subject of a separate EIS.

Response DOE and Ecology acknowledge the comment and provide a discussion that supports the comment in Volume One, Section 3.3 on pages 3-18 to 3-20 of the Draft EIS. Please also refer to the response to Comment numbers 0005.17, 0019.03, 0072.08, and 0101.06 for a discussion of the relationship between the TWRS EIS scope and closure of the tanks.

L.9.3 SCOPE

Comment Number 0010.01

*GRAY*STAR*

Comment One page B-25 is the following paragraph:

DOE is pursuing alternative uses for the cesium and strontium capsules, however, no acceptable uses have been found. If no future uses for these capsules are found, the capsules eventually would be designated as HLW and managed and disposed of consistent with the TWRS EIS alternative selected for implementation.

As outlined in the attached "Privatization of Isotope Activities: GRAY*STAR, Inc. Expression of Interest, May 28, 1996", we believe that there is an alternative and driving use for the cesium and ultimately the strontium capsules. Further, we believe that there is an immediate need for ALL of the Cesium-137 at ALL of the government laboratories.

If a plan similar to that outlined in the enclosed Expression of Interest is put into effect, there will be several immediate and long range benefits, which include but are not limited to:

1. No need to "bury" the HLW. This would lead to a cost avoidance by the United States taxpayers in the billions of dollars as outlined in the EIS. It would also avoid overall impact to the environment. Or, at worst, allow more room at a repository for other (perhaps civilian) waste.
2. The immediate savings on the WESF building would be approximately $10,000,000 per year with a total cost savings from $112,000,000 to $697,000,000 as outlined in the EIS.
3. The 100 jobs outlined for the WESF building would be reduced and privatized.
4. The tank Remediation would be simplified (thus savings in both costs and environmental impact), because of the simplification of dealing with the wastes after the HLW is removed. (For example, the HLW could be removed from the tanks prior to full TWRS implementation. This would be similar to the project which produced the existing WESF material.)
5. The process could be sped up which would lead to some cost savings and major savings on environmental damage.
6. There would be no legacy of stored DOE HLW in the future, either in 100 years, 1,000 years or 1,000,000,0000 years.
7. The GRAY*STAR will reduce worldwide food borne disease.
8. The GRAY*STAR will open up phytosanitary restrictions and allow for greater trade between nations.
9. The GRAY*STAR will allow the reduction/elimination of post harvest fumigants which are harmful to both health and the environment.
10. The manufacture of GRAY*STAR units will lead to an expansion in heavy steel fabrication orders, helping the economy.

In summary, there is an immediate use for the existing cesium and perhaps strontium capsules now stored in the WESF building. This use will result in major cost savings, both monetary and environmental. This use extends to all of the cesium, and perhaps strontium, which is still in the 177 tanks as well as the MUSTs. Therefore, the impacts as outlined in the EIS could be further significantly reduced.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on cesium and strontium capsules. The TWRS EIS addresses the management and disposal of the capsules. Analysis of potential beneficial users of the capsules is outside of the scope of the EIS. However, the information will support DOE's decision regarding the designation of the capsules to be available for disposal. Please refer to the response to Comment number 0006.01.

Comment Number 0012.11

ODOE

Comment Treatment of the Hanford tank wastes was the subject of an extensive Tri-Party public involvement process two years ago associated with a proposal by USDOE called Tank Waste Remediation System Rebaselining. The Tri-Parties also formed the Tank Waste Task Force at that time to discuss these issues. The public overwhelmingly rejected USDOE's plans to place the low-activity waste from tanks in a grout waste form in favor of vitrifying the waste. All of the public comment from that process is directly applicable to this EIS and should be included in this EIS.

Response In Volume One, Section 1.1, DOE and Ecology acknowledged the important role of the Tank Waste Task Force in considering the revised technical strategy for TWRS and the extensive public involvement process associated with the renegotiation of the Tri-Party Agreement in January 1994. The Draft EIS also stated that one of the major developments since the 1988 Hanford Defense Waste EIS ROD was the termination of the planned low-activity grout project in response to public concerns. Grout was considered in the EIS as an available immobilization technology and addressed in Volume Two, Appendix B. However, it is important to note that the current TWRS planning basis, the Tri-Party Agreement, and the preferred alternative all specify that the LAW, as well as the HLW, will be immobilized with the assumed waste form being a vitrified glass. Please refer to the responses to Comment numbers 0035.04, 0036.13, 0038.01, 0038.05, 0038.10, 0052.01, 0055.03, and 0072.05.

DOE and Ecology considered the values and recommendations of the Tank Waste Task Force in developing the TWRS EIS alternatives. Within the EIS, DOE and Ecology have incorporated the role of the Tank Waste Task Force into the TWRS program and amended Tri-Party Agreement technical strategy and, ultimately into the identification of the preferred alternative. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0055.03

Martin, Todd

Comment Second, our second bullet is the TWRS EIS is not responsive to public concerns and here primarily we are referring to the Tank Waste Task Force. Two years ago when we finished up the Task Force, we said call this a NEPA equivalent and let us get on with it. Unfortunately, DOE and Ecology decided to do this EIS. We said okay, that is maybe alright, but what you should do is just look at flushing out the impacts of the preferred alternative. That has not happened. What we have got is a behemoth of a document that analyzes every possible alternative.

Response The Tank Waste Task Force identified several "principles" to guide the Tri-Party Agreement negotiations. These principles were defined as "values that should be applied to the overall agreement." During scoping for the TWRS EIS, individual commentors did support the concept that the Tank Waste Task Force and Tri-Party Agreement serve as "NEPA equivalent" activities. However, the Tank Waste Task Force Report specifically states that the Tri-Party Agreement should not be used as a "shield against enforcement of other laws." NEPA and SEPA are both environmental laws that apply to the proposed tank waste action. Neither statute allows the Tank Waste Task Force report to be used as an EIS. Therefore, DOE believes that an EIS was required to support the decisions related to TWRS proposed action, and that the EIS complies with the Task Force value of not using the Tri-Party Agreement to shield enforcement of other laws. Please refer to the response to Comment number 0034.05 for a related discussion.

Prior to initiating the impact analysis in the EIS, DOE and Ecology reviewed the Tank Waste Task Force Report to ensure that the EIS incorporated the issues of concern identified by stakeholders. Ten items were identified in the Tank Waste Task Force Final Report regarding impacts to the environment, including worker and public health safety and protection of the Columbia River. The TWRS EIS incorporates all of the areas of concern identified by the Task Force into its analysis of potential environmental impacts. Please refer to the response to Comment number 0012.11.

The TWRS EIS achieves the value of "getting on with the cleanup" by combining Federal and State environmental impact analyses into one process. DOE and Ecology are co-preparing the EIS to meet NEPA and SEPA requirements, and thereby reducing "paperwork, analytic, and decision-making redundancy."

Finally, in order to comply with NEPA, DOE was required to do more than "flushing out the impacts of the preferred alternative." First, NEPA requires that all EISs compare the impacts of the proposed action to a No Action alternative. Second, NEPA requires that an EIS 1) "rigorously explore and objectively evaluate all reasonable alternatives," 2) "devote substantial treatment to each alternative considered, including the proposed action, so that reviewers may evaluate all comparative merits," and 3) include reasonable alternatives not within the jurisdiction of the lead agency." These requirements can be found in 40 CFR 1502.14.

Comment Number 0063.01

Donovan, Virgil

Comment This is kind of the way the government works, and Hanford is not above this. There are contractors down there that even that you see at that time would get in bed with them a little bit, and like to see those contracts continue and get bigger for the community, and one thing or another. We see the same thing happening now with Doc Hastings. He wants to convert the Fast Flux Test Reactor to a tritium production plant. Then he wants to follow that up with a bigger tritium production plant. Tritium was used in the bomb because it was cheaper than diterium, which was a much safer material we used to use in the bomb in the warhead. It didn't bother them a bit to make that change. In fact is was a good place to hide the fact that we produced tritium in any reactor, and so we have a certain amount of it we have to dispose of. Well that gave us a good reason to have a bigger stockpile. We had lots of military contractors out there who'd like that, and I'd hate to see it happen again. I don't want us to produce tritium.

Response The production of tritium and future uses of the FFTF are not within the scope of this EIS; therefore, no modification to the text is warranted.

Comment Number 0063.02

Donovan, Virgil

Comment And I think we should be very damn careful about how the politicians get into this, and how much we believe, and how much we believe of the government agencies. Let's keep them at the point, what we're supposed to be looking for here. Clean this plant up. And let's not get into the side issues of building more tritium, which is not needed, or something else to continue operations at Hanford.

Response DOE and Ecology acknowledge the preferences expressed in the comment and share the desire to move forward with remediation at the earliest possible date. Because issues associated with the production of tritium are outside the scope of this EIS, no change to the EIS is warranted.

Comment Number 0067.01

Browning, Joe

Comment I think that the public should take into consideration of a new energy system that would bring energy, or nuclear energy to stop radiation leaks into rivers, land, and air would stop. The energy system is not nuclear power of any sort. It will out produce a nuclear facility, and produce a new system of energy sources throughout. The DOE has wanted to only take this into consideration for talks and technical review. In other words, nothing will ever happen. They will tell the public, such as tonight through Hanford cleanup, that we don't need any more Hanford cleanup because we don't need any more nuclear waste coming into Hanford. All nuclear facilities will basically consider, through this new energy system, would be stopped. The public is not made aware of a new system that will out-produce a nuclear facility, and put a halt to nuclear problems.

Response The scope of the EIS is to evaluate alternatives for the remediation of the tank waste and cesium and strontium capsules. The topics identified in the comment are not within the scope of the EIS; therefore, no change to the EIS is warranted.

Comment Number 0072.09

CTUIR

Comment Both of these critical issues (characterization deficiencies and lack of closure coverage) point to a lack of an overarching programmatic structure, linked to long-term goals, that is framed with a single guiding and truly comprehensive decision document. The current EIS focuses on retrieval as an isolated event that excludes critical assumptions and limiting factors that cannot be separated from preceding, subsequent, successive, incremental, and cumulative actions. The CTUIR SSRP must remain informed about each of these factors which have the potential to result in direct impacts to tribal interests.

Response Please refer to the responses to Comment numbers 0012.14 and 0072.07 for discussions regarding characterization of tank waste. Please refer to the response to Comment number 0072.08 for the reasons for not including closure in this EIS. DOE and Ecology remain committed to open communication and consultation with the CTUIR on all issues potentially affecting Tribal Nation interests. The TWRS EIS addresses the cumulative impacts of past tank waste leaks, the TWRS alternatives, and other related, planned and reasonably foreseeable actions at the Hanford Site in Volume One, Section 5.13. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted. Please also refer to the response to Comment numbers 0072.198 and 0072.252.

Comment Number 0072.46

CTUIR

Comment Since the Hanford Barrier is an integral part of this EIS, along with the potentially tremendous adverse ecological and cultural impacts of mining the fill and cap materials, will this EIS be used *post hoc* to claim that this aspect of closure was pre-approved? The CTUIR can not endorse the Hanford Barrier as part of closure; nor can the CTUIR endorse closure of tanks as a landfill.

Response The TWRS EIS or the ROD will not be used as an evaluation of closure alternatives, including use of the Hanford Barriers. Closure, use of the Hanford Barrier, and the selection of sites for earthen borrow material will be addressed in a future NEPA analysis. Please refer to the response to Comment numbers 0019.03, 0019.04, 0072.08, 0089.04, and 0101.06 for discussions of closure and borrow sites.

Comment Number 0072.47

CTUIR

Comment Contaminated soil is not included. Making a statement that contaminated soil and groundwater are not included does not excuse DOE from making decision based on the complete source term. The insertion of subsurface and groundwater data has implications that point to closure decisions.

Response Please refer to the response to Comment numbers 0019.03, 0072.07, 0072.08 and 0101.06 for a discussion of the reasons closure, including releases from past practice activities, are not included in this EIS, but will be addressed in future NEPA analysis. Additional NEPA evaluations of the environmental impacts associated with closure, such as potential impacts to habitat cultural resources, human health, and cumulative impacts, would be analyzed. Volume One, Section 5.13 of this EIS discusses the cumulative impacts associated with TWRS and other Hanford Site projects. A discussion of emerging vadose zone contamination data is provided in Volume One, Section 4.2 and Volume Five, Appendix K. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.48

CTUIR

Comment Contribution of tank waste + soil + gw + all other 200 Area hazardous materials/waste constitute the 200 Area aggregate source term. What apportionment has been considered among these sources relative to the total Hanford long-term and accident risks? The ultimate decision must be based on all sources of risk.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume One, Section 5.13 of the EIS, Cumulative Impacts, assesses the cumulative impacts of TWRS and other Hanford projects. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. However, closure, which includes soil and groundwater contamination from past tank leaks and past-practice sites outside of the tank farms, is beyond the scope of the TWRS EIS. These issues will be addressed in future NEPA analysis for closure, or future CERCLA actions, for past-practice sites in the 200 Areas.

Comment Number 0072.49

CTUIR

Comment The risks are estimated due to *new* groundwater contamination and do not include existing groundwater contamination, new contamination as the contaminated soil leaches, nor any other new source of groundwater contamination (from ERDF, US Ecology, other 200 Area materials). This is a serious flaw in the way that source terms at Hanford are estimated - the Record of Decision must "apportion" the risks among all existing and future sources.

Response Please refer to Volume One, Section 5.13, Cumulative Impacts and Appendix F, which assesses the cumulative impacts of TWRS and other Hanford projects and existing contamination using the best available information. The Environmental Restoration and Disposal Facility (ERDF), US Ecology, other 200 Areas impacts, and TWRS impacts were presented in this section as well. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the responses to Comment numbers 0012.15, 0030.02, 0040.06, 0072.08, 0072.47, 0091.01, 0098.04, and 0101.05 for related discussions.

Comment Number 0074.02

Shims, Lynn

Comment I wanted to formally also offer some kind words to the Department of Energy who have worked very hard on this and working hard to change their image. Because I heard today that to replace the monies lost by the gasoline tax revenues that there had been a proposal again to replace your whole department. And it must be very difficult to work on these gray issues and not get enough respect like that. And I'm also very mad about the fact that here we are smack up against the cold war mortgage legacy to us, given to us by the Department of Defense, who get's more money than they ask for in their budgets, and we're left kind of like the garbage men picking up after them all over the world right here in our own backyards because they have to have enough money to fight a war on two fronts. And I wonder if we're one of the fronts that their fighting against, or that they don't care about our own homeland. And that's a persistent problem.

Response Funding of the DOE and its programs from Congress, the relative merits of funding DOE programs compared to other agencies, or national priorities are not included in the scope of this EIS; therefore, no change to the text of the EIS is warranted. Please refer to the response to Comment 0014.04 for a discussion of funding issues.

Comment Number 0075.02

Wright, Peter

Comment And I just want to thank you very much, and I hope you get all the funding you need because we do need, as that woman said, a lot more money to clean it up than we do to continue making the messes.

Response DOE and Ecology support the desire to obtain the necessary funding to complete the project. Funding of the DOE and its programs is not included in the scope of this EIS. The EIS presents data regarding the potential costs of the alternatives analyzed in the EIS to assist the public and decision makers in the consideration of the alternatives. Please refer to the response to Comment numbers 0014.04 and 0074.02.

Comment Number 0076.04

Blazek, Mary Lou

Comment Although we support the preferred alternative, it will not resolve all the issues related to the high-level waste at Hanford. We believe there will continue to be a need for ongoing monitoring, characterization, and pumping and treating of groundwater contamination caused by waste, which has leaked and migrated from the tanks. We will continue to support fast, speedy, and cost-effective cleanup at Hanford. We believe the preferred alternative is a step in that direction. Thank you.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The monitoring, characterization, and remediation of the groundwater caused by past practice activities is not within the scope of this EIS, but remains a concern of DOE and Ecology and will be addressed in a future NEPA analysis. The TWRS EIS discusses, to the extent practicable, the relationship between the tank waste remediation alternatives and future Hanford Site cleanup decisions. Please refer to responses to Comment numbers 0040.06, 0072.07, and 0101.05 and the Volume One, Section 5.13 discussion of cumulative impacts.

Comment Number 0078.01

ODOE (Exhibit)

Comment A year after this process and negotiations ended USDOE changed course. USDOE began a program to reduce costs and privatize the tank waste program. In the process, they laid off the workers that were key to the program. In the process, they laid off the workers that were key to the program for designing and building the glass plants. The plant was to convince private companies to submit bids for and then build plants to convert the tank waste to glass. That would be cheaper and faster than USDOE could do.

Many stakeholders, including Oregon, expressed reservations about USDOEs ability to succeed at privatization.

Response Privatization is discussed in Volume One, Section 3.3 and is simply a contracting mechanism, which is beyond the scope of this EIS. Under this concept, DOE would competitively bid a portion of the remediation work instead of having the Site Management and Operations contractor perform the work. Equivalent requirements for retrieval, treatment, and disposal of the waste would apply regardless of how DOE contracts to perform the remediation. Please refer to the responses to Comment numbers 0079.06 and 0088.05.

Comment Number 0078.05

ODOE (Exhibit)

Comment This EIS makes no decisions about what to do with the tanks or leaked tank waste. This is deferred to a later Environmental Impact Statement. Decisions about the fate of the tanks and leaked waste must be based on a thorough understanding of the fate of this waste. Modeling alone is insufficient. USDOE must begin now a program to determine the fate of all of the waste leaked from the tanks, cribs, trenches, reverse wells, and other disposal facilities.

Response The remediation of leaks and releases during past practice activities are part of tank farm closure and are not within the scope of this EIS. However, DOE has a program to monitor and characterize these releases and will address remediation of these releases in a future NEPA analysis. Volume One, Section 5.13 and Appendix F contain a description of the potential cumulative impacts of tank waste remediation with other Site activities and past practice releases using the best available data. Please also refer to the responses to Comment numbers 0012.15, 0030.02, 0072.08, 0072.47, 0076.04, 0091.01, and 0098.04.

Comment Number 0078.06

ODOE (Exhibit)

Comment The comprehensive impact of disposed and leaked wastes on the groundwater and future health of the environmental and citizens of the Northwest must not be a guessing game. We do not know enough today to decide what to do about these wastes. In depth analysis of the actual fate of the leak tank waste is needed before decisions can be made about what to do with the leaked tank waste and the tanks themselves.

Response There is currently insufficient information to address remediation of past practice activities for the tank farms. The scope of the EIS is the management and disposal of the tank waste and cesium and strontium capsules. Remediation of past practice tank waste leaks is not within the scope of this EIS, but will be addressed in a future NEPA analysis. Please refer to the responses to Comment numbers 0012.15, 0030.02, 0072.08, 0072.47, 0076.04, 0091.01, and 0098.04.

Comment Number 0079.06

Knight, Paige

Comment If privatization fails, you must start over. Do it quickly, but you must do it. The DOE must not have the sole authority to determine failure in this process.

Response The Draft EIS addresses regulatory compliance for each alternative in Volume One, Section 6.2. However, the relative authority and responsibilities of the agencies under the Tri-Party Agreement are beyond the scope of the EIS. The 1996 Tri-Party Agreement amendment contains a contingency plan in the event that privatization failed to meet established criteria. Therefore, both Ecology and EPA are part of the decision-making process concerning the success of privatization. Please refer to the responses to Comment numbers 0072.73, 0072.74, 0078.01 and 0088.05.

Comment Number 0087.02

Tewksbury, Ross

Comment Now, one of the problem that Hanford has had over the years, which seems to be setting back in here with the problems with the budget and the Congress, is that it's doing things on the cheap, or only taking halfway measures, and it winds up being far more expensive in the long run. And the whole history of Hanford is one of the worst examples of this type of thing.

Response DOE and Ecology share the desire and expectation that Congress will provide the necessary funding to perform the remediation alternative selected. However, funding issues are not within the scope of this EIS.

Comment Number 0088.04

Porter, Lynn

Comment Okay, I would like to see Casey Ruuds' research into the waste migrating through the soil towards the groundwater, I'd like to see that fully funded. As I said earlier, I would be really upset and angry if DOE fires Casey Ruuds, because I think we really need him out there.

Response The emerging information concerning contamination in the soil column from past-practice activities was discussed in Volume One, Section 3.3 of the Draft EIS; and the Final EIS has been modified in Volume One, Section 4.2 and Volume Five, Appendix K to add additional discussion of this information. In Volume One, Section 3.4 and Appendix B, the EIS indicates that characterization and monitoring of the vadose zone and groundwater associated with tank leaks is among the ongoing operations that would continue under all alternatives analyzed in the EIS. DOE has implemented a program to better characterize the leaks from past practice activities. However, closure that would address alternatives for remediating contaminated soil and groundwater, the funding of particular projects and the employment of individuals are beyond the scope of the EIS. Please refer to the responses to Comment numbers 0012.15, 0030.02, 0078.08, 0091.01 and 0098.04.

L.9.4 NEED TO PREPARE THE EIS

Comment Number 0005.07

Swanson, John L.

Comment I do not believe that this EIS will be used to aid decision makers, other than to provide for them as much justification as possible for decisions that they have already made. Shouldn't it really have been written before the Tri-Party Agreement was reached?

Response NEPA does not preclude DOE from identifying a preferred course of action before an EIS is prepared. NEPA does require DOE to provide the decision makers and public with information regarding the potential environmental impacts of any proposed action and reasonable alternatives so that when decisions to irretrievably commit the agency to a specific course of action are made, environmental consequences are considered by the decision makers.

Similarly, the TWRS EIS will provide the decision makers and public with information regarding the potential environmental impacts of the proposed action, which includes the current Tri-Party Agreement approach. The ROD for the TWRS EIS will document the decisions made regarding tank waste management and disposal. DOE and Ecology believe that the EIS will provide one more valuable source of information to be used by the decision maker to reach a final decision on tank waste management and disposal. Please also refer to the response to Comment numbers 0005.09, 0034.05, and 0055.03.

Comment Number 0009.01

Broderick, John L.

Comment I attended the May 2 public hearing in Pasco. One comment that came up several times in the testimony and in discussions in the back of the meeting room was: We should not reopen this issue; we have already decided how to deal with these wastes. My answer to that comment is that it is being reopened because Hanford can not seem to complete projects. We try to clean up Hanford without any health effects, with facilities that take too long to construct, and with project that cost too much money.

Response Please refer to the response to Comment number 0034.05, which addresses a similarly worded comment.

Comment Number 0034.05

Belsey, Richard

Comment And in January of 1994, the agreement was signed. And we thought okay now they are going to get on with it. And the Tank Waste Task Force said get on with it because it is so expensive and it's so unsafe.

Then we found out that they were not going to start with the preferred alternative and go and look at the impact of that, but that because of the size of the program and such they needed to do this full Environmental Impact Statement.

That was not the sentiment of the people of the Northwest who made up their minds and essentially voted with their feet to come and tell us about that in all these meetings.

Response The EIS was initiated because DOE is required by NEPA to complete an EIS when considering an action that could significantly affect the quality of the human environment (40 CFR 1500). Failure to complete an EIS would pose a legal risk to the implementation of tank waste retrieval, treatment, and disposal actions. Also, State law requires preparation of an environmental analysis under the SEPA to support subsequent State actions, such as granting permits for construction and operation of facilities (WAC 197-11).

As indicated in Volume One, Section 1.1, the TWRS EIS is being prepared in response to several important changes since the 1988 Hanford Defense Waste EIS ROD. These changes, which included substantial changes in the actions identified in the 1988 ROD (e.g., signing of the Tri-Party Agreement and changes to the proposed action), required DOE to prepare an EIS. This requirement is based on CEQ regulations (40 CFR 1508.18) that require an EIS when:

- Adopting official policy, such as ... "formal documents establishing an agency's policies which will result in or substantially alter agency programs."
- A Federal action includes "adoption of formal plans, such as official documents prepared or approved by federal agencies which guide or prescribe alternative uses of federal resources, upon which future agency actions will be based."

In this case, the formal document and plan that would alter DOE policies and require alternative uses of Federal actions was the revised approach to tank waste remediation contained in the 1994 amendments to the Tri-Party Agreement. Therefore, DOE initiated the EIS to comply with NEPA.

In preparing the EIS, DOE was required to evaluate the proposed action, a no action alternative, and reasonable alternatives to the proposed action (40 CFR 1502.14). CEQ regulations (40 CFR 1502.14) require an EIS to:

"Rigorously explore and objectively evaluate all reasonable alternatives..."

"Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits."

DOE and Ecology view the TWRS EIS as a necessary step in the continued progress in managing and disposing of the tank waste. This document ensures compliance with NEPA and SEPA and provides the public and decision makers with an analysis of the comparative impacts on human and natural environment and a range of considered alternatives.

In response to these requirements, DOE developed alternatives for evaluation that included the no action alternative, alternatives based on the Tri-Party Agreement approach to tank waste management and disposal, alternatives recommended for consideration during the scoping process, and a range of reasonable alternatives that were representative of the alternatives available on the continuum from no action to full retrieval and disposal of the tank waste. Please refer to the response to Comment numbers 0005.07, 0005.09, 0055.03, and 0072.05 for related discussions.

Comment Number 0055.02

Martin, Todd

Comment The first thing I would like to talk about is a HEAL fact sheet which is on the back table over there. First bullet we have on this fact sheet is something that has been said before that the TWRS EIS is essentially a step backwards. It ignores a widely supported body of documentation that led to the current Tri-Party Agreement plans. Essentially the work in this EIS has been done before and it has been done better. We should rely on that and go forward. Continues to debate the issues that have long been resolved. What waste form are we going to use? Dr. Belsey spoke very elegantly about sticking with glass. Let us get on with it.

Response In preparing the EIS, DOE and Ecology incorporated past documentation that led to the current Tri-Party Agreement plans to the extent that the information was relevant and provided the best and most currently available data on which alternatives could be developed and the applicable alternative impact analyzed. In many cases, the data used during the Tri-Party Agreement renegotiations were the best available data. However, new data were used to address the substantial issues described in the EIS. Please refer to the responses to Comment numbers 0034.05 and

0072.05 for discussion of NEPA requirements relative to analyzing environmental impact of alternatives for management and disposal of tank waste.

Comment Number 0064.02

Roecker, John H.

Comment I guess I would just like to close by emphasizing what some of the gentlemen have already said about getting on with it. And I'll just give you a little bit more history. The first defense waste management plan was written in 1972. 1972. The second one was written in 1983. The third one basically was written in 1988 when the Tri-Party Agreement was first signed. The fourth one was written in 1994 when the Tri-Party Agreement was renegotiated. We have gone through this study at least four times, the history that I know. We have come up with basically the same conclusion every single time. There has been one change in all those 25 years. And that is we've abandoned grout as the low-activity waste form, and gone to vitrification. Every thing else has changed -- has stayed the same. Nothing has changed. And I guess I just urge DOE, the Federal government, to let's get on with cleanup at Hanford. It's way past due. Thank you.

Response As indicated in Volume One, Section 1.1, management and disposal of the Hanford Site high-level tank waste has been a long-term issue of concern and study. As new data have become available, the strategy planned for the management, treatment, and disposal of tank waste has changed. One change noted in the comment was the decision to use vitrification rather than grout as the preferred waste form for LAW. Other substantial changes included terminating the Hanford Waste Vitrification Plant because of insufficient capacity and the decision to include SST waste retrieval and treatment in combination with DST waste. These changes, among others, represented substantial changes in the proposed action, which has potentially significant impacts on the human or natural environment. DOE and Ecology concur with the view that it is important to "get on" with the clean up of the Hanford Site and the tank waste. DOE views this EIS as a necessary step in the continued progress toward tank waste removal and treatment. Please refer to the responses to Comment numbers 0034.05 and 0072.05 for related discussion of NEPA requirements associated with the EIS.

Comment Number 0065.01

Phillips, Thomas

Comment All I want to say is, in 1988 we had a Tri-Party Agreement that said we would clean up this waste in 30 years. That was 8 years ago. We haven't cleaned up any of the tanks at all at this time. The only change is, as this man pointed out, is we renegotiated it for 40 years. Now we're having discussions about privatization and this Environmental Impact Study, which has taken 2 years, and will take approximately 2½ years before it's done. The privatization, the contracts are going to be awarded some time this year, but no one has said exactly when these plants are going to start cranking out waste, and no one has shown us that there is actually going to be any waste cranked out any time soon. It's projections. I, like all the other people here, feel that we need to get on with it, we need to clean this up, we need to quit studying this to death. It looks like to me that the Environment Impact Study, the privatization plan are just smoke screens to delay doing it so the next administration can come up and pick up the buck that this administration, Miss O'Leary and Mr. Clinton, are passing on to our next generation. No one is doing anything. We need to get on with it.

Response DOE and Ecology share the desire to proceed with remediation at the earliest possible date. A decision was made in 1988 concerning methods to remediate the waste, but due to the development of additional technical information and concerns raised by many stakeholders, DOE and Ecology changed the proposed approach to remediating the tank waste.

The following changes affected the planned approach for managing the disposal of Hanford Site tank waste.

B Plant, which was selected in the Hanford Defense Waste ROD as the facility for pretreatment processes to comply with current environmental and safety requirements, was found not to be viable or cost-effective.

The Tri-Party Agreement was signed by DOE, Ecology, and EPA in 1989, establishing an approach for achieving environmental compliance at the Hanford Site, including specific milestones for the retrieval, treatment, and disposal of tank waste.

Safety issues were identified for about 50 DSTs and SSTs, which became classified as Watchlist tanks in response to the 1990 enactment of Public Law 101-510.

The planned grout project was terminated, and a vitrified waste form was adopted as the proposed approach as a result of stakeholders' concerns with the long-term adequacy of near-surface disposal of grouted LAW in vaults.

The construction of the Hanford Waste Vitrification Plant was delayed because of insufficient capacity to vitrify the HLW fraction of all DST and SST waste in the planned time frame.

The planning basis for retrieval of the waste from underground storage tanks was changed to include the SSTs and treating the retrieved SST waste in combination with DST waste.

These changes resulted in an extensive reevaluation of the waste treatment and disposal plan that culminated in adopting a revised strategy to manage and dispose of tank waste and encapsulated cesium and strontium. The reevaluation of the waste treatment and disposal plan began following a December 1991 decision by the Secretary of Energy to reconsider the entire tank safety and treatment and disposal program and to accelerate the retrieval and disposal of SST waste. DOE plans to issue a final decision on remediation in the early Fall of 1996 and move rapidly into the design and construction phases of the project.

L.9.5 ADEQUACY OF THE DRAFT EIS

Comment Number 0005.02

Swanson, John L.

Comment My overall feelings about this draft are really quite mixed. On a superficial basis, it appears to be quite good-but then I see many statements that I know to be misleading if not inaccurate, which make it appear to be not good. In addition, there are many inconsistencies between sections. Perhaps it would have been better to spend more time on getting a few things "right" (and properly qualified) and less time on excessive detail in relatively unimportant areas.

Response Without specific comments that identify statements that are "misleading if not inaccurate" or inconsistent, the specific responses cannot be made. In cases where inaccuracies or inconsistencies were specifically identified, DOE and Ecology have acknowledged the correction required and incorporated revisions to the EIS. In other cases, information in the EIS was perceived as inaccurate or inconsistent. However, on closer examination, the text or analysis contained in the Draft EIS was determined by DOE and Ecology to be accurate and consistent. DOE and Ecology recognize that in a document this size that addresses complex issues, errors and omissions sometimes occur. The agencies value the public comment process because comments that identify errors and omissions contribute to a more accurate Final EIS. The comment process provides an opportunity for many stakeholders, interested State and Federal agencies, and Tribal Nations to review the Draft EIS document and provide comments that contribute to making the Final EIS a better document.

Comment Number 0005.04

Swanson, John L.

Comment I detect an ambivalence in this draft about the status of assumptions. Sometimes it is said that the assumptions are bounding and/or conservative and other times conclusions are drawn as if the assumptions were known to be true, when different assumptions could lead to different conclusions.

Response The approach in the EIS is to identify assumptions for each alternative and area of impact analysis. When differing assumptions would likely substantially change the analysis presented in the EIS, the EIS identifies and discusses this potential. When feasible, an uncertainty analysis is provided to fully inform the public and decision makers of the potential impact. To better communicate the role of assumptions and uncertainty in the EIS, a new appendix has been added to the Final EIS in Volume Five, Appendix K. Please refer to the responses to Comment numbers 0005.03 and 0012.17.

Comment Number 0005.06

Swanson, John L.

Comment Many of my comments, along with most of those made at the May 2 hearing, fall into the "hindsight is better than foresight" category. However, it is also true (I believe) that this EIS effort was not performed very well as far as resource allocation and schedule are concerned. That is water over the dam now, and we'd better get on with the job of cleaning up the waste now that the obligatory EIS is nearing completion.

Response As with any project, cost and schedule enhancements are feasible, especially when viewed after the fact. However, without specific comments regarding how resources could have better utilized or how the schedule could have been optimized, the generalized assertion contained in this comment cannot be addressed.

Comment Number 0014.02

Bullington, Darryl

Comment Past events relating to the storage and transfer of these materials combined with over 30 years of inaction and indecision regarding safe storage of radioactive fuel materials followed by the generation of these reports with which the public is asked to choose between alternatives which do not include even preliminary feasibility studies is unconscionable.

Response The analysis contained in the Draft EIS was based on conceptual designs, which are contained in the TWRS Administrative Record and DOE Reading Rooms and Information Repositories and are summarized in Volume One, Section 3.4 and Volume Two, Appendix B. This approach is consistent with CEQ requirements to consider environmental impacts early in the decision making process (40 CFR 1500).

Comment Number 0035.01

Martin, Todd

Comment Essentially, the Hanford Education Action League thinks that the TWRS EIS is a step backwards.

We think that this work has been done before and has been done better. It ignores all of the documentation that was developed to support the Tri-Party Agreement over a two-year period, and it also ignores the public process that went into that document development.

Response Please refer to the response to Comment numbers 0005.07, 0005.09, 0034.05, and 0055.03 which address similarly worded comments.

Comment Number 0038.02

Reeves, Merilyn

Comment The Tank Waste Treatment and Disposal program has been developed through extensive public involvement, long technical study process that provided a credible and the technical basis for the program.

In essence, many stakeholders believe that the intent of the NEPA process has been met. An if a declaration had been made that NEPA had been satisfied, it would have been made -- it would have been welcomed by the stakeholders.

But stakeholders understood DOE's concern that an EIS must be completed for the purpose of NEPA compliance. And given this, the stakeholders would have supported an expedited EIS that just fleshed out the impacts of the Tri-Party Agreement preferred alternatives, not another whole study of the gamut of options.

Unfortunately this EIS has been a long time in coming and does not analyze the full range of options in detail. This EIS represents to me just another redundant study, and it does not reflect our value of getting on with cleanup.

Response DOE and Ecology view the TWRS EIS as a necessary step in the continued progress in managing and disposing of the tank waste. This document ensures compliance with NEPA and SEPA and provides the public and decision makers with an analysis of the comparative impacts on the human and natural environment and a range of considered alternatives.

During the scoping process for the TWRS EIS, DOE and Ecology approved the following schedule: publish the Draft EIS in August 1995; publish the Final EIS in April 1996; and publish the ROD in May 1996. The agencies stated that by combining these two processes [NEPA and SEPA], the agencies hope as a result to accelerate the TWRS EIS (DOE 1994m). Following the conclusion of the scoping process, DOE and Ecology determined that the accelerated schedule would not be feasible. DOE and Ecology believe that given the technical complexity associated with tank waste remediation, the emergence of new data since January 1994 that needed to be addressed in the EIS, and the need to address a broad range of potential environmental impacts, the EIS has been prepared as expeditiously as could be reasonably expected. Moreover, the EIS has been and will continue to be completed on a schedule that does not adversely affect compliance with Tri-Party Agreement milestones. Please refer to the responses to Comment numbers 0034.05 and 0072.05 for more information.

Comment Number 0038.12

Reeves, Merilyn

Comment In spite of vigorous and discipline re-base lining, the Hanford Advisory Board realizes that the Tri-Party Agreement can always be improved upon, and therefore we strongly support critical reviews of the program within the context of the Tri-Party Agreement requirements.

However, a critical pillar in the Hanford Advisory Board's support for the Tri-Party Agreement is a belief that it is time to go forward. And we hope that the intention of the systems review, which is what we were addressing at that point in time, the systems requirement review team -- we hope that the intention of the systems requirements review team is not to spend an inordinate amount of time challenging the decisions laid out in the Tri-Party Agreement at this late date.

In a skeptical and wary stakeholder community, such re-examination would certainly be viewed at best as a DOE delay tactic or at worst an attempt to circumvent the provisions of the Tri-Party Agreement.

This is not the EIS, but it is applicable to it. The Board holds similar concerns in regards to the TWRS EIS. Our concerns are heightened by the inability of the Agencies to complete the EIS on or even nearly near the critical schedule.

And the EIS was supposed to be completed as of June of '95. And now DOE and Ecology will be very fortunate if this June in '96 it can come out.

In summary, the Board finds that the EIS is largely an unnecessary document, goes directly against the get on with it value that citizens wanted in the Northwest.

Response Please refer to the responses to Comment numbers 0034.05 and 0052.02 for discussions regarding the need to complete the analysis required in an EIS and the role of the EIS in regulatory compliance. Please also refer to the response to Comment number 0038.02 regarding the scoping process and the schedule for the EIS.

Comment Number 0072.01

CTUIR

Comment In any major federal action, it is critical that assumptions, data, interpretations, conclusions, and uncertainties be clearly identified. Such critical and often limiting factors can have profound ramifications to a comprehensive decision process addressing complex issues, such as the safe and effective retrieval, treatment, and isolation of diverse Hanford tank wastes.

These concepts need more emphasis than what is in the current Tank Waste Remediation System (TWRS)-Environmental Impact Statement (EIS). This EIS deals with the retrieval of radioactive and hazardous waste currently stored at the Hanford Nuclear Reservation in southeastern Washington state. Hanford is located in part on the aboriginal lands of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), where the Tribes retain off-reservation treaty-reserved rights and interests.

Response The assumptions, data, interpretations, conclusions, and uncertainties for each discipline were clearly identified in their respective appendix (inventory - Volume Two, Appendix A; engineering - Volume Two, Appendix B; human health risks - Volume Three, Appendix D; accidents - Volume Four, Appendix E; groundwater - Volume Four, Appendix F; air - Volume Five, Appendix G; and socioeconomics - Volume Five, Appendix H) of the Draft EIS. Key assumptions and conclusions also are identified in the respective sections of Volume One, Section 5.0; Environmental Consequences. A more extensive uncertainty section was added to the Final EIS as Volume Five, Appendix K. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the responses to Comment numbers 0005.03 and 0012.17.

Comment Number 0081.08

Pollet, Gerald

Comment The bottom line is throughout this EIS that the policy makers will view an extremely skewed cost versus risk and benefit analyses in this EIS if they look at it today. And everything in the EIS is driven currently towards saying let's leave it behind. The risks aren't so high. Risk of explosion aren't so high. The risk of fatal cancers aren't so high from leaving it behind. The costs are so much lower than retrieval. When in fact the risks are so much higher from leaving it behind, or any delay, and the costs are actually similar for retrieving, as they are for leaving it behind.

Response Cost and human health risks are presented in the Summary, Section S.7 and Volume One, Sections 3.4, 5.11, and 5.12. The cost and human health risk numbers were developed using the best available information and industry- and government-accepted analytical methods. DOE and Ecology

consider this information to be unbiased and the best available information for the public and decision makers to use in evaluating the alternatives. Please refer to the response to Comment 0081.02 for a discussion of how the repository costs were calculated for the Final EIS.

Comment Number 0087.03

Tewksbury, Ross

Comment Now, many of the assumptions and the estimates are faulty or erroneous because of the facts that you know nobody knows just exactly what's in the tanks, and nobody knows just how much the tanks have leaked, and nobody knows where the leaks have gone, or how far, and nobody knows where to put the high-level waste once it even comes to some final condition, and where it can be put permanently. And there's apparently there's so much stuff that's leaking, with the tanks, and the cribs, and the power plants, everything, that you don't even know where it's coming from. As you have said tonight. So with all the things that nobody really knows, then it's really hard to come up with exact costs and estimates and assumptions.

So as some of the previous speakers were saying, I really, it really upsets me if you come up with some of these standard things that you know the costs and things are really low, that the danger from them is really low or nonexistent when nobody really knows anyway.

Response The EIS fully identifies the assumptions made in performing the analysis and presents the uncertainties associated with the implementation of each alternative. This information is presented in Volume Five, Appendix K in the Final EIS. Although there are details that are unknown about certain aspects of the alternatives, DOE and Ecology believe that there is adequate information available to analyze the alternatives, select an alternative, and proceed with remediation. The costs of the alternatives are presented in ranges to account for the uncertainties. The Final EIS will present ranges in human health risk to provide information concerning the uncertainties associated with these calculations. It should be noted that contamination beneath the tanks from past practice activities is outside the scope of this EIS. Please refer to the responses to Comment numbers 0005.03, 0012.17, and 0072.08.

L.9.6 RECORD OF DECISION

Comment Number 0009.14

Broderick, John L.

Comment There has been a lot of effort by a lot of people to decide on the Preferred Alternative. However, it has the appearance of being selected because that is what has been agreed to before the EIS ROD is available. The usual order of decision is NEPA, then other agreements.

Response The final decision on the selection of an alternative will be made no sooner than 30 days after the publication of the Notice of Availability for the Final EIS is published in the Federal Register and it will be identified in the ROD. The efforts made concerning the Phased Implementation alternative have been to establish DOE's proposed action. NEPA requires that an EIS evaluate the

proposed action and alternatives to it as was done for the TWRS EIS. No modification to the EIS is required because the required procedures were followed. Please refer to the responses to Comment number 0005.07, 0027.01, and 0036.15.

Comment Number 0012.10

ODOE

Comment We urge U.S. DOE to analyze the cumulative impacts from previously leaked tank waste, waste disposed to cribs, trenches, reverse wells, drain fields, ponds, burial grounds, and other locations. The record of decision should require the preparation of a peer-reviewed detailed long-term performance and risk assessment, that includes all of the factors above. This risk assessment should be a joint effort of USDOE with the Nuclear Regulatory Commission, EPA and other state, tribal and Federal agencies with regulatory authority or special expertise for resources at Hanford and should be conducted separately from this EIS.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Cumulative impacts of the TWRS alternatives, past leaks, and past-practice sites are addressed in Volume One, Section 5.13 and Appendix F. Although not within the scope of this EIS, DOE will consider the request separately for a peer-reviewed risk assessment. Please refer to the responses to Comment numbers 0005.17, 0012.15, 0040.06, 0072.08, and 0101.05.

Comment Number 0035.03

Martin, Todd

Comment Another concern we have had is schedule. We were concerned, and the agencies were concerned that if this EIS did not meet its schedule, it could throw the TWRS program into a death spiral.

What has happened is the original record of decision was to be had by June 1995. Now we are going to be lucky if we have a record of decision by June of 1996.

Response Please refer to the response to Comment numbers 0034.05, 0038.02, and 0055.03 which address similarly worded comments.

Comment Number 0040.07

Rogers, Gordon J.

Comment I need to add that these comments are my own as a taxpaying citizen who is concerned with the staggering cost estimates for each of the other treatment alternatives, considering the rather low risk provided we have the common sense and optimism in the capacity of humans to manage and solve problems and threats in the future as has been the case through much of human history. I hope these comments generate some serious thought by DOE and the Regulators in deciding how to proceed.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0043.03

Hanford Communities

Comment We call on the Department of Energy, with the support of regulatory agencies to proceed expeditiously to adopt a record of decision and award a contract with a private firm to begin the design and permitting of a vitrification facility.

Response DOE remains committed to pursuing the earliest possible ROD date and implementing the preferred alternative as soon as possible. The EIS will not delay award of privatization contracts for Phase 1a. DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0072.12

CTUIR

Comment This is a retrieval EIS, not a closure EIS, and the ROD should explicitly state that the selection of any of the retrieval options in no way implies that a particular closure method is thereby approved.

Response DOE will incorporate the recommended language into the ROD. Please refer to the responses to Comment numbers 0019.03, 0072.08, 0072.46, and 0101.06.

Comment Number 0072.13

CTUIR

Comment Existing soil and groundwater contamination should be included as part of the Tank farms source term, and the entire tank waste inventory should be considered as part of an overall aggregate 200 Area source term.

Response The scope of the TWRS EIS is the remediation of the tank waste and cesium and strontium capsules. Please refer to the response to Comment number 0072.08 for a discussion of the reasons for not including closure of the tank farms, including past practice releases of contaminants to the soil column, in the TWRS EIS. However, existing soil and groundwater contamination was addressed in the cumulative impacts presented in Volume One, Section 5.13 and Appendix F. Closure will be addressed in a future NEPA analysis. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted. Please refer to the responses to Comment numbers 0012.15 and 0072.08.

L.9.7 OUT-OF-SCOPE ISSUES (Other Than Closure)

Comment Number 0011.01

Gilsdorf, Paul D.

Comment If you have any information that could help me find a job I will be eternally grateful. I am a carpenter with a degree in biochem. What does that mean, well I do not know either but I still need a job. Hope you have a great day.

Response Facilitation of employment for individuals, as well as identification of contractors to perform tasks identified in the EIS, are beyond the scope of the EIS.

Comment Number 0014.05

Bullington, Darryl C.

Comment I pray daily that existing governments will find a way to prevent the release of radioactive toxic materials into the air, water, and food by continuing to invent increasingly clever ways to disperse such materials over the planet.

Response The EIS evaluates alternatives to manage and dispose of tank waste and cesium and strontium capsules, in a manner which will protect human health and the environment from the future releases from the tank wastes and capsules.

Comment Number 0014.06

Bullington, Darryl C.

Comment I pray, too, that the diversion of sporting events and political elections will not divert the public's attention from demanding solutions to these most critical decisions of our time. Should action be taken I pray that the government does not attempt to absolve itself from responsibility by giving the cleanup to unproven, unmonitored contractors that win cost-plus-fixed-fee contracts by submitting least cost proposals.

Response The qualifications of potential remediation contractors and the contracting strategies associated with implementation of the actions considered in the EIS are outside of the scope of the EIS. However, in both cases, DOE is required by Federal procurement rules to select qualified contractors to perform all work contracted by a Federal agency. All work contracted must be performed in compliance with applicable Federal, State, and local laws and regulations.

Comment Number 0016.01

J.L. Shepherd and Assoc.

Comment The purpose of this report is to encourage the U.S. Department of Energy (DOE), the Washington State Department of Ecology and other interested parties to reconsider a proposed program for long-term storage and eventual disposal of the WESF cesium-137 source capsules at Hanford, under the Cesium Legacy Project EM30-ADS-84900-00-SA. In our opinion, the contents of these WESF capsules are a national resource and are vital to U.S. interests. To support this position, included in this report is a brief history of previous USDOE encapsulation programs of the WESF contents. We believe that the DOE could restart a cost-effective and waste reducing source encapsulation program, perhaps including the cesium-137 retrieved from the waste tank remediation project. The primary focus of this response is on medical and health related uses of cesium-137 sealed sources. A secondary focus is on cesium-137 source user's commitments to environmental concerns, especially non-burial (source recycling) programs and regulatory constraints and regulation by the U.S. Nuclear Regulatory Commission and Agreement States.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The TWRS EIS addresses alternatives for disposal of tank waste and encapsulated cesium and strontium. The encapsulated cesium and strontium are included in the EIS primarily because they were originally extracted from the stored high-level tank waste to reduce the thermal heat generation in the tanks and would be considered HLW for purposes of disposal. DOE and Ecology have identified the No Action alternative as the preferred alternative. The EIS has been modified in the Summary and in Volume One, Section 1.3 to reflect that No Action is the preferred alternative. DOE is actively seeking commercial interest in the beneficial applications for the encapsulated cesium and strontium, and DOE and Ecology remain committed to pursuing any viable commercial or other beneficial uses. However, that analysis is outside the scope of this EIS. These uses would not be without substantial cost for reprocessing and repackaging because the current encapsulation was designed principally for storage purposes. If viable commercial or beneficial uses are not implemented, the capsules would be designated as waste at some point in the future and would be disposed of using methods consistent with the alternatives identified in the EIS. Also, it is unlikely that DOE would pursue any course of action to remove and encapsulate additional amounts of cesium, strontium, or other radionuclides unless viable use is made of the current capsule inventory or there is a clear, viable commercial or beneficial interest in the additional amounts. Please refer to the responses to Comment numbers 0006.01 and 0010.01 for more information on this topic.

Comment Number 0016.02

J.L. Shepherd and Assoc.

Comment We have tried to present information which will lead to reconsideration of the burial/disposal proposal for the WESF capsules. The contents of these capsules, besides the cesium in the waste tanks, are the only domestic supply of cesium which can be used in the sources for the many critical and beneficial applications described in this written comment. We have tried to make the point that cesium is a strategic U.S. product, that currently the sole world supplier of this material is Myak, Russia and that the same preliminary techniques used for vitrification can be used in making special form source capsules. We invite anyone reading this comment to contact us with any inquiries, questions, or requests for further information concerning its contents to contact us.

Response Please refer to the responses to Comment numbers 0006.01 and 0010.01 for discussions related to consideration of beneficial uses of cesium and strontium capsules.

Comment Number 0031.01

Billett, John

Comment Even though I have a sheaf of paper in my hands, it will only be a few minutes. I just want to summarize some comments, particularly on the issue of the recycling of the cesium which is the subject I want to put some comments on the record about.

The market for cesium-137 has progressively increased worldwide particularly over the past 27 years due to an increase in medical research and our knowledge of medicine as well as the knowledge in the areas of personnel radiation protection.

The only current supplier of large cesium-137 sources is located in Russia. In the interest of public health and safety we are suggesting that the U.S. should consider domestic cesium-137 extraction from the capsules or tank waste as a strategic material viable to national interest.

Response Please refer to the response to Comment numbers 0006.01 and 0010.01 for discussions related to consideration of beneficial uses of cesium and strontium capsules.

Comment Number 0031.02

Billett, John

Comment Without the use of these special form cesium-137 sources in medical research we would not have many of the lifesaving technologies we enjoy today.

And there are many potential breakthroughs in cancer research and prevention which will not be possible without large cesium-137 sources.

People from all walks of life are affected, including the nurses and patients in nuclear medicine departments.

And we are talking here about x-rays, mammography, cat scan, MRI, oncology, blood banks, the technicians in a dental office, the emergency response personnel for transportation, reactor or nuclear accidents and incidents, and the public teachers and students at university research laboratories and in the biomedical field.

Response Please refer to the responses to Comment numbers 0006.01 and 0010.01 which address similarly worded comments.

Comment Number 0037.02

Eldredge, Maureen

Comment The funding for the entire cleanup program is continually at risk. Last year was a particularly difficult one in the appropriations cycle.

We continually heard and had to deal with allegations of problems, waste, fraud, and abuse in the program. And the fingers kept pointing at Hanford.

We need to start seeing progress. We need to see action. We need to get moving, or we are going to continually face that slideward -- downward trend of funding.

Response The data prepared for each alternative were presented as objectively as possible, including the potential costs (listed in 1995 dollars) associated with implementation. Forecasting Congressional funding is beyond the scope of the EIS and was not included in the implementability discussion sections. DOE is committed to pursuing remediation at the earliest practicable date.

Comment Number 0037.04

Eldredge, Maureen

Comment Which also leads me to the old concept of the big picture. The Department of Energy seems to have a problem with it.

The Waste Management Programmatic Environment Impact Statement which the draft was recently released, and quite seriously panned by everyone, was supposed to look at programmatic impacts of all the waste in the Department of Energy's nuclear weapons complex.

I assume that might include waste coming out of Hanford tanks, but it does not. And there is no cross-linkages between all of the EIS actions. That needs to happen. We need to start looking at the high level, low level, mixed waste in the Department of Energy nuclear weapons complex as a comprehensive total, not as piecemeal efforts.

Response The scope of the TWRS EIS includes management and disposal of tank waste and cesium and strontium capsules. The cumulative impact section addresses the impact of TWRS alternatives within the context of related actions at the Hanford Site and within the DOE complex. The TWRS action is being conducted within the framework of DOE's responsibility to manage and dispose of HLW and to comply with applicable local, State, and Federal laws and regulations.

Comment Number 0043.04

Hanford Communities

Comment The Department of Energy must make very effort to assure the success of the tank waste vitrification program. Adequate funding must be provided for both the privatization initiative as well as the DOE tasks associated with characterization, tank safety and the steps necessary to deliver liquid waste to the vitrification facility. We are concerned about the proposal to take funds out of the Hanford cleanup budget to finance a liability reserve. The impact of taking this money out of the budget will seriously jeopardize the existing TWRS program as well as other programs. We encourage the Department of Energy to establish a liability reserve fund for this initiative. Funds for this reserve should not come from the Hanford cleanup budget.

Response Privatization and Congressional funding issues are not within the scope of the EIS. The purpose of the privatization reserve funding is not to cover 100 percent of all potential liabilities for the privatization contractor's construction and operation of the immobilization facilities. There are two primary reasons to have the reserve funding pool: 1) to cover the contractor capitalization cost during design and construction in the event of Termination for Convenience on the part of DOE; and 2) to level the DOE budgetary requirements during operation of the contractor facilities.

Before issuance of the RFP, there were a series of conversations with vendors that might be interested in providing immobilization services to DOE. These vendors expressed concern with the potential financial risk associated with project starts and stops. Under privatization, contractors would make a significant capital investment for an extended period of time before receiving any return on the investment. To protect themselves and their stockholders against the possibility of a change in direction and project starts and stops leaving the contractors with a large capital investment, the vendors wanted to ensure that they could be reimbursed for their investment if the change in direction or starts and stops were the responsibility of DOE and not the vendors.

When treatment services are initiated in 2002, the reserve funds would be "drawn-down" to pay for waste treatment services. Rather than being an insurance fund, the reserve is a "bank account" in which funds are saved over a period of time so that DOE can assure private industry that money will be available, when needed, to "pay the bills." Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0093.01

Devoy, Tiffany

Comment I think when you are talking about 200 plus billion dollars a year going to defense, then 200 billion dollars total to take care of what will be with us for hundreds of thousands of years is not that high of a price tag.

Response DOE and Ecology acknowledge the opinion expressed in the comment. Please refer to the response to Comment number 0075.02.

L.9.8 HEARINGS

Comment Number 0022.01

Shims, Lynn

Comment Thank you very much for the opportunity to comment. Thank you also for holding a TWRS public meeting in the Portland area. In my opinion meetings such as these are not only useful educational methods but also important for clarification dialog, expansion of perspective for all parties and significant value input.

Response Dialogue with stakeholders at public meetings provides valuable information regarding the proposed action, alternatives to the proposed action, and the potential environmental consequences of the alternatives considered in the EIS. Further, dialogue at meetings is critical to informing the agencies of the values, concerns, and issues important to the public. NEPA and SEPA were adopted to ensure that information is exchanged between the government and the public. Under NEPA, the government actively incorporates public involvement in government decisions potentially affecting human health and the environment. The government also must provide decision makers and the public with information that would aid in making informed decisions regarding the alternatives and the impact of each alternative. Public meetings are an important aspect of ensuring that NEPA and SEPA are implemented to the maximum extent possible. Please refer to the response to Comment number 0020.01 for more information of TWRS EIS public involvement.

Comment Number 0022.05

Shims, Lynn

Comment It is appreciated that an attempt was made at the Portland meeting to change the usual design of the meeting to enhance public participation. I believe that the strong opinions of the public were due to the fact that the subject of tank wastes as related to public health and safety are of great importance to us.

Response DOE and Ecology are committed to continually improving public participation in the decision making process. For the TWRS EIS public hearings, the agencies worked closely with the stakeholders to provide alternative formats for meetings that would improve the opportunity for dialogue between the public and agency representatives.

Comment Number 0046.01

DiGirolamo, Linda Raye

Comment With the exception of the speaker for the HEAL group this discussion was far too "technical" for the average citizen.

Response The DOE and Ecology objective was to use to the extent possible in the EIS, language that was appropriate and understandable by the average citizen. One reason for holding a question and answer session at the hearing was to provide an opportunity for the public to present clarifying questions to the agency representatives. Both agencies are committed to continued efforts to improve communication with the public. Your comment will assist the agencies to improve the process, especially where communication was not as effective as preferred.

Comment Number 0062.06

Longmeyer, Richard

Comment Just a final comment. The advertisement for this meeting was a little bit more than it had been in the past. I've attended other meetings, and I get information from Hanford all the time, but I'm glad to see that we have a little better representation here in Spokane this time. Unfortunately it was HEAL that did that advertising. I really feel it's the responsibility of the DOE to do that, instead of HEAL. Now whether the DOE needs to hire an advertising agency to help them to put a better face on the meeting, or whatever, I don't know. But I do appreciate HEAL's effort in that regard, but I do feel it's the DOE's responsibility. Thank you.

Response DOE and Ecology acknowledge the role of HEAL and others in making the Spokane-area public aware of the public meeting. The public meeting was coordinated with HEAL and other stakeholders because the outreach efforts of these groups has proven to be helpful. DOE and Ecology worked closely with HEAL representatives to ensure that the location, date, and format of the meeting maximized public participation. Further, DOE advertised the meeting in the local newspaper and distributed four separate mailings to interested area residents on the Tri-Party Agreement mailing list. These efforts, in conjunction with the efforts of HEAL and other Hanford Site stakeholders were instrumental in ensuring that the public was provided with an opportunity to participate in the decision making process, as required by NEPA. Please refer to the responses to Comment numbers 0066.01 and 0087.01 for more information on TWRS EIS public involvement.

Comment Number 0075.01

Wright, Peter

Comment My only comment is with respect to DOE, and I guess Ecology. I find that I'm really saddened by the fact that there's not a lot more people here. It's the first time I've gone to a government meeting, which may be characterized more by bureaucrats, than by human beings, and found that it's mostly human beings who recognize that we're all in this together. And I really feel that your average is a sign, at least to me, that there's a recognition that all of our kids are going to suffer from this.

Response Participation at the five public meetings on the TWRS EIS varied substantially; however, in total more than 400 individuals attended the meetings and more than 350 individuals provided oral or written comments on the Draft EIS. DOE and Ecology are committed to the public involvement process and continue to strive to ensure the public has access to the decision making process. Please refer to the responses to Comment numbers 0087.01 and 0066.01 for more information on TWRS EIS public involvement.

Comment Number 0087.01

Tewksbury, Ross

Comment And I, first I want to say that it's good that your having a meeting here in Portland, and I want to encourage you to keep having them here regarding each issue as it comes up, and not just in Seattle and Tri-Cities. And I also want to say I hope you don't have any more video meetings. And as I was saying earlier, if you want more people here there's lots of things that you can do, as opposed to doing just the legal bare minimum. You can try and have an article in the paper, rather than just ad's. You can have an ad in the paper every day for two weeks in a row, you know, prior to the meeting. You can have announcements on the radio stations and TV, especially OPB and KBOL. And send letters to everybody on the mailing list to arrive just a few days before the meeting. And there's other stuff too, but that's.

Response Public meetings on the TWRS Draft EIS were held in five cities, including Portland, Oregon. For each issue under consideration at Hanford, the number and location of meetings was carefully considered by DOE, in consultation with the Hanford Advisory Board, Ecology, EPA, and the stakeholders.

DOE and Ecology exceeded the legal requirements for public participation in the public meetings held for the Draft EIS. For example, for the Portland, Oregon meeting, two advertisements were published in the largest daily newspaper in the Portland area; two press releases were distributed to area newspaper, radio, and television stations; and the meeting location was provided in a mailing distributed to more than 4,500 interested parties and in two other mailings to 1,500 interested parties. Oregon Department of Energy mailed a letter to community leaders and stakeholders announcing the meeting and information on the meeting was provided on the Hanford Site Home Page. DOE and Ecology will continue to implement more effective means to communicate to the public and to inform the public of opportunities to participate in meetings on important issues relative to the Hanford Site. However, the TWRS public participation program met or exceeded all requirements under State and Federal regulations and used many innovate methods designed to enhance public involvement.

DOE will consider suggestions regarding publicizing meetings when planning future public participation opportunities. Regarding video meetings, DOE believes that such a format may occasionally be an effective method to expand public participation opportunities, particularly when lack of resources might otherwise preclude them. DOE welcomes any additional suggestions.

Please refer to the response to Comment number 0066.01 for more information on TWRS EIS public involvement.

Comment Number 0088.02

Porter, Lynn

Comment I have a lot of questions that I wish we could have gotten into tonight, I felt like there wasn't enough time for discussion.

Response An inherent limitation to the public hearing format is the time available for interaction between the agencies and the public. To address this concern, DOE and Ecology scheduled a one-hour informal session at the beginning of this hearings. During this time, DOE and Ecology representatives were available to interact one-on-one with the public. Further, once the meeting began, the public was encouraged to ask questions during the discussion of the EIS. This portion of the meeting lasted approximately two hours. The meeting concluded with a one-hour session during which a forum was provided for the public to submit additional formal comments on the EIS. Before the meeting ended, the moderator asked the attendees for additional comments. When no one responded, the meeting was adjourned. After the meeting was adjourned, several agency representatives remained in the meeting room to meet informally with the attendees. The information packets distributed at the meeting contained the names and phone numbers for agency contacts. The public was encouraged to contact the listed individuals for more information or to submit additional comments.

L.9.9 COMMENT PERIOD

Comment Number 0002.01

Roecker, John H.

Comment You are making a mockery out of the public comment period for the TWRS EIS. Forty-five days is entirely too short a period for public review of such a lengthy and important document. If you are truly interested in receiving public input the comment period should be extended to at least 90 days. I know this does not fit with your political agenda of announcing the selection of the privatization contractors before the November election, but the EIS process should be driven by what is technically right not by politics. This is just another example of DOE being driven by political agendas rather than technically sound programs.

Response After consultation with relevant Federal and State agencies, affected Tribal Nations, and stakeholders, DOE and Ecology determined that an extension of the comment period for the Draft EIS would not materially facilitate improved public participation in decision making regarding the proposed action. Please refer to the responses to Comment numbers 0020.01 and 0036.07 for related information.

Comment Number 0003.01

CTUIR

Comment Technical staff of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Special Sciences and Resources Program (SSRP) are currently reviewing the TWRS Draft EIS (DOE/EIS-0189D). We have already developed numerous draft comments on Volume One, and anticipate that we will identify additional issues in the remaining volumes. As a result, the CTUIR-SSRP requests a 45 day extension to the public comment period in order to be able to address this EIS in a manner that truly reflects the time and effort the U.S. Department of Energy (DOE) and Washington Department of Ecology (Ecology) have put into producing it.

Response Subsequent to the receipt of this request for an extension of the comment period, the CTUIR formally withdrew their request for an extension of the comment period. Please refer to the response to Comment number 0013.01.

Comment Number 0005.01

Swanson, John L.

Comment I have the feeling that many of my comments might be dismissed as being "unimportant" because they might not impact the gross comparison of the alternatives. My response to that might be along the lines of (a) if only gross comparisons are desired/needed, why present all the detail, and (b) if the information is important enough to present, it should be presented as accurately and unambiguously as possible.

Response No comment has been dismissed as "unimportant." DOE and Ecology believe that the comments submitted on all issues, including those not involving the "gross comparison of the alternatives," contributed to improving the TWRS EIS and all comments were included in preparing the Final EIS. NEPA and SEPA require the agencies to consider all comments provided during the public comment period, to give equal weight to oral and written comments, and to consider all comments prior to completing the Final EIS. All comments have been reproduced verbatim and responded to individually in this appendix. Copies of the documents from which comments were extracted are provided in DOE Reading Rooms and Information Repositories to permit each comment provider to easily understand how the agency addressed the comment and to ensure that all comments submitted were considered by the agencies.

Comment Number 0007.01

EPA

Comment Pursuant to its responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the Environmental Protection Agency (EPA) is mandated to review environmental impact statements (EIS's).

Unfortunately, our office did not receive copies of the Hanford Tank Remediation Draft EIS until yesterday. As you noted, a copy was sent to another staff member, but he does not have responsibility for NEPA review. We are therefore requesting an extension of the comment period from May 28 to June 28. This gives us adequate time to assemble a review team from other offices within EPA and perform a quality review for this very important EIS.

Response DOE submitted five copies of the Draft EIS to EPA on April 5, 1996. These copies were provided to the EPA headquarters in Washington, D.C. Subsequently, copies were requested by the Region X EPA and an additional five copies were provided. After the EIS had been received, DOE and Ecology met with EPA staff to facilitate the EIS review. EPA subsequently withdrew their request for an extension of the comment period and decided not to conduct a detailed review the EIS. Please refer to the responses to Comment numbers 0044.01 and 0042.02, which address related comments.

Comment Number 0013.01

CTUIR

Comment Since making our original extension request, CTUIR SSRP staff have become aware of critical timing considerations for the TWRS project which provide us with significant reasons why the review of the TWRS project should not be delayed, even though the lack of an extension may reduce the quality and quantity of public scrutiny that the text of the Draft EIS receives. As a result, CTUIR SSRP hereby retract our previous request for an extension of the public comment period for the TWRS Draft EIS.

Response DOE and Ecology acknowledge the withdrawal of the request for an extension of the comment period. Please refer to the responses to Comment numbers 0003.01 and 0013.02, which address related comments.

Comment Number 0013.02

CTUIR

Comment Finally, as a sovereign, the CTUIR enjoys a government-to-government relationship with federal and state governments, including their departments, such as DOE and Ecology. This relationship means that our consultation with the DOE is not limited to the comment periods designated for the public under National Environmental Policy Act and the State Environmental Policy Act. While we are retracting our request for an extension of the public comment period for this Draft EIS, CTUIR staff will be availing ourselves of our right to submit comments outside of the public comment period. While our review of the TWRS Draft EIS will not take the forty-five additional days we had originally requested, CTUIR staff are planning to submit our comments on Friday, May 31, 1996--three days after the close of the public comment period. We expect that Ecology and DOE will give full consideration to our comments despite their delivery outside the bounds of the public comment period.

Response DOE and Ecology are committed to ongoing consultation with affected Tribal Nations throughout the NEPA and SEPA process for the TWRS EIS. This commitment has resulted in numerous meetings with Tribal Nations and the TWRS EIS project team, as well as formal and informal consultations regarding the EIS. The formal comments on the EIS were received by the Agencies and have been given full consideration. Several issues identified in the comments have resulted in subsequent meeting and communication between the CTUIR and the Agencies to address methods by which issues could be resolved. DOE and Ecology value this consultation process and believe it has enhanced the quality of the EIS and the NEPA process. Please refer to the responses to Comment numbers 0013.01, 0072.149, and 0036.07, which address related comments.

Comment Number 0018.01

Mannion, Don

Comment This document is very long and complex. The conduct of proper review seems to be requiring a lot more time than I initially anticipated.

I respectfully request that the review period be extended in order to assure an adequate review by such concerned citizens as myself. Thank you, in advance, for any consideration that you can give this request.

Response After consultation with relevant Federal and State agencies, affected Tribal Nations, and stakeholders, DOE and Ecology determined that an extension of the comment period for the Draft EIS would not materially facilitate public participation in decision making regarding the proposed action. Please refer to the response to Comment number 0020.01, which address related comments.

Comment Number 0020.01

Waite, Corey N.

Comment In my opinion the public comment period for the Tank Waste Remediation System Environmental Impact Statement is far too short. While I am sure that someone from the scientific community could review and comprehend this long, complex report in a short amount of time, this is a difficult task for the average reader. From my college studies in environmental science, I know that it is my right as a citizen to express my concerns, reservations, and questions regarding the actions proposed in this document as they could affect me, my family, my livelihood, and my community. For these reasons, I believe that the public should be given more time and more opportunity to review and disseminate the information contained in this very long, complex, technical report.

Response Dialogue with stakeholders at public meetings provides valuable information to the stakeholders regarding the proposed action and alternatives to the proposed action, as well as the potential environmental consequences of the alternatives considered in the EIS. Further, dialogue at meetings is critical to exchanging information with the agencies regarding values, concerns, and issues that are important to the public. NEPA and SEPA contain provisions that require public involvement in government decisions that potentially affect the quality of the natural and human environment. These regulations also require that information be provided to decision makers and the public so that decisions that potentially impact environmental quality can be made in as open a manner as possible. Public meetings are an important aspect in ensuring that NEPA and SEPA are useful decision making tools for the public and decision makers.

After consultation with relevant Federal and State agencies, affected Tribal Nations, and stakeholders, DOE and Ecology determined that an extension of the comment period for the Draft EIS would not materially facilitate improved public participation in decision making regarding the proposed action. Please refer to the response to Comment number

0036.07, which addresses a related comment.

Comment Number 0024.01

Jordan, James

Comment

1. The Draft EIS for the Hanford Site TWRS was received this date at about 2 p.m. Washington D.C. time. The transmittal letter states that written comments should be postmarked no later than this date, May 28, 1996. Obviously, there is insufficient time to review this report and make responsible comments. Therefore, we respectfully request that the Public Comment Period be extended to the end of June.
2. JJA, a Science and Technology Consulting firm, is in the process of forming a consortium of qualified contractors to develop, fabricate and install a vitrification technology that is much safer and more technically reliable than any of the alternatives discussed to date. It is the consortium's intention to license this technology invented by Drs. James Powell, Morris Reich, and Robert Barletta to Brookhaven National Lab for development and manufacture.
3. Our analysis of the health, safety and environmental risks and our analysis of the costs of conducting the TWRS campaign show that the BNL concept is substantially superior to the other concepts for removing HLW from the Hanford reservation. Accordingly, we would appreciate additional time and your assistance in including the BNL concept in your consideration of alternatives for Hanford. Specifically, we would appreciate your assistance in running our factors in the same model that you used for the other alternatives.

Response After consultation with relevant Federal and State agencies, affected Tribal Nations, and stakeholders, DOE and Ecology determined that an extension of the comment period for the Draft EIS would not necessarily increase public participation in decision making regarding the proposed action. Please refer to the response to Comment number 0020.01.

The plan to form a consortium to develop the proposed vitrification technology was not included in the scope of this EIS, and therefore is not a factor in determining whether the comment period should be extended. The Draft EIS does not address the agency procurement strategy nor does the EIS limit the agency from considering technology options that may emerge following the completion of the NEPA process. During the procurement process following the publication of the ROD, DOE would be able to consider any available technology bounded by the EIS analysis. For options not bounded by the EIS analysis, in terms of potential impacts to the environment, DOE would be required to complete a supplemental NEPA analysis of the TWRS EIS.

Because of the conceptual nature of all technologies considered in the EIS, DOE adopted a bounding approach when developing the EIS alternatives. Therefore, if during the procurement process, a technology is proposed that demonstrates lower costs and impacts to the environment than those presented in the EIS, DOE would be able to procure and implement the proposed technology. Because of this approach, and because the process described in this comment does not represent a new alternative, DOE and Ecology do not view the delay in the EIS that would be required to develop and evaluate an alternative based on this technology as necessary to improve the decision making process under NEPA.

Comment Number 0036.07

HEAL (Exhibit)

Comment The TWRS EIS has been in development for years. DOE has delayed the release of the EIS. The difficulties the agencies have had in producing the EIS are evidenced by how long it has taken to release the Draft EIS. However, the public is expected to review and comment in only 45 days -- on a document that is over 2,000 pages long.

Because HEAL has consistently held that moving the program forward is paramount, we will not protest what is an insufficient amount of time to substantively comment on the document.

Response DOE and Ecology co-prepared the Draft EIS and concurred on the scope, areas of analysis, and schedule for the EIS following consideration of public comments received during the scoping period for the EIS from January 28, 1994 through March 15, 1994. The time required to prepare the EIS was a function of the complexity of the issues addressed in the EIS.

During the past eight years, DOE has facilitated extensive public participation relative to tank waste in the following policy areas:

- Public participation in the Hanford Defense Waste EIS (1987 to 1988);
- Tank Waste Task Force (1993);
- Public comment on the renegotiation of the Tri-Party Agreement to include the revised approach to tank waste management (1993 to 1994);
- Scoping for the TWRS EIS (1994);
- Public comment on the SIS EIS (1994 to 1995);
- Privatization and related public involvement on the proposed amendments to the Tri-Party Agreement (1995 to 1996); and
- Interaction with the Hanford Advisory Board and its committees (1994 to 1996).

This public involvement has provided DOE with a strong understanding of the values and perspectives of Northwestern stakeholders regarding tank waste management and disposal. Moreover, HEAL, among others, provided comments during the scoping and comment period on the Draft EIS that encouraged DOE and Ecology to expedite the completion of the EIS, whenever feasible.

In response to comments requesting expedited completion of the EIS and in recognition of the extensive past public involvement associated with tank waste, DOE and Ecology concurred on the 45-day comment period. A 45-day comment period is the minimum time that an agency must schedule for receipt of public comments on an EIS. DOE and Ecology also recognized that public review would be limited by the 45-day comment period. To assist the public review, DOE and Ecology held five public meetings during the comment period. For these meetings, the agencies worked closely with stakeholders to provide meeting formats that would maximize interaction with the public. The EIS also was widely distributed to reading rooms and information repositories, as well as made available on the Hanford Home Page on the World Wide Web.

Finally, DOE and Ecology carefully considered all requests to extend the length of the comment period. Of the six requests for extensions received by the Agencies, two were formally withdrawn, two submitted written and/or oral comments during the 45-day period, and the remaining two requests represented general requests for more time on behalf of the public and not the individual commentor. Given that more than 1,400 interested parties received direct mailings, more than 850 copies of all or part of the EIS were distributed to interested parties, and more than 350 individuals submitted oral or written comments, the agencies concluded that sufficient time had been given and no extension of comment period was warranted. Please refer to the response to Comment number 0066.01, which provides more information regarding TWRS EIS public involvement.

Comment Number 0036.08

HEAL (Exhibit)

Comment However, we do want to state for the record the difficulties encountered in obtaining the supporting information on the EIS.

First and foremost is the difficulty in reviewing the EIS's references and supporting information. Many are missing from the information repositories. The most important references are the data packages

that support the various alternatives in the EIS. Some of these data packages were approved for public release in July of 1995 -- nine months is ample time to deliver documents to the information repositories.

Response DOE and Ecology acknowledge the concern expressed in the comment. The agencies remain firmly committed to executing the public involvement requirement mandated by NEPA. This process includes providing all referenced documents in a readable format and timely manner.

All references and supporting documents cited in the Draft EIS were available through the following sources:

Publicly (e.g., regulations and laws)

In DOE reading rooms or information repositories in Richland, Spokane, Seattle, and Portland

By contacting the Hanford Site Tri-Party Agreement information repository.

These documents were available throughout the public comment period to support the public review of the Draft EIS. Due to the volume of the documents supporting the Draft EIS, microfilm was used to save space and resources. One reading room was not familiar with the indexing system used for the microfilm and was provided copies of the paper documents. In several isolated incidences, individuals requesting supporting documents were mistakenly told that certain documents were unavailable in the reading room. To correct this situation, several supporting documents that were used as the data basis for the Draft EIS were provided in hard copy to the reading room and directly to the individuals requesting copies.

Comment Number 0044.01

EPA

Comment We are hereby withdrawing our request for an extension of the comment period.

Response DOE and Ecology acknowledge the withdrawal of the request by EPA for an extension of the comment period. Please refer to the responses to Comment numbers 0007.01 and 0042.02.

Comment Number 0055.01

Martin, Todd

Comment But my first point has to do with problems with the informational repositories. I spent yesterday morning hammering my head against a brick wall out at the informational repository trying to get the data packages that support the EIS. Some of them are there and some of them are not. I get paid to do this although not nearly enough but I can not imagine an interested citizen actually being able to find any of that information if they were so motivated. It was particularly troubling in that there is a very competent and professional staff at this informational repository where at the others it is difficult to find a staff person who actually knows where the Hanford documents are. So that was somewhat troubling to me and I understand that DOE and Ecology and Jacobs are working to fix that

problem and I hope it is fixed by now. Given to that I had those problems I want to thank DOE, and Ecology, and Jacobs for facilitating my getting a hold of these packages yesterday. That was very helpful.

Response Please refer to the response to Comment number 0036.08 for a related discussion.

L.9.10 MISCELLANEOUS

Comment Number 0005.03

Swanson, John L.

Comment At the May 2 hearing in Pasco, I did a poor job of expressing myself regarding the fact that "The assumptions drive the conclusions." This draft is based on MANY assumptions, which is all you could do at this point in time, but I think you could do a better job of making that clear. There generally seems to be places where the proper qualifying statements regarding assumptions are made, but those qualifying statements do not generally follow throughout the text (what is properly qualified early on, or in an appendix, is often stated as an absolute fact later in the text). Yes, it would take more words to do it right, but that should not prevent it from happening. I wonder if some of the writers do not in fact believe that some of the assumptions are really facts.

Response For each area of environmental impacts analysis in the EIS (e.g., groundwater, health, accidents) assumptions were clearly identified in the relevant appendix. Where uncertainties associated with an assumption would potentially result in significant variations in the data or conclusions presented in the EIS, an uncertainties discussion or analysis was included in the appendix. For each area of impact analysis, the assumptions and uncertainties were summarized in the relevant portions of Volume One, Section 5.0.

For the description and comparison of the alternatives, a similar process was used to inform the decision maker and public regarding assumptions and uncertainties. For the alternatives, the detailed analysis was presented in Volume Two, Appendix B, and the summary information in Volume One, Section 3.0. To enhance the decision maker and public understanding, all assumptions and uncertainties addressed in the EIS, as well as the associated calculated relative uncertainties, are now presented in Volume Five, Appendix K. This new format for addressing these issues should improve accessibility to the information and clearly communicate important interrelationships between assumptions and uncertainties. A general review of the EIS was completed to ensure that all assumptions are clearly identified and communicated to the extent practical. Please refer to the response to Comment number 0012.17 for a related discussion.

Comment Number 0027.01

Roecker, John H.

Comment TWRS Alternative Decision Making Process

DOE makes the following statement right up front in the EIS (page 1-3 to be exact), "NEPA and SEPA provide decision makers with an analysis of environmental impacts (both positive and negative) of proposed actions for consideration in decision making." Anyone following the TWRS program during the last couple of years fully realizes that the alternative selection decision has already been made. Before the ink was dry on the January 1994 re-negotiated Tri-Party Agreement, DOE was already canceling engineering and technology development work to support any alternative except the privatization effort (i.e., the Phased Implementation alternative). If DOE had truly not made a defect and unilateral (without State or Public involvement) alternative selection decision, funding for all alternatives would have been continued at an equal level. DOE has just received proposals for Phase 1 of the Phased Implementation alternative and is due award contracts before September. How can DOE possibly say the decision hasn't been made? How can DOE expect to gain public confidence and credibility when it continues to function in such a misleading manner. This EIS is nothing more than an attempt to backfit and justify a decision that has already been made on a political rather than technical basis. That kind of action continues to result in poor DOE credibility. DOE would do much better in the public confidence and credibility arena if it would simply state the truthful facts as they are and let the public judge on that basis rather than continuing to manipulate the information.

Response DOE and Ecology have presented the facts concerning the alternatives for remediation in this EIS and have solicited public comments concerning the EIS. The renegotiation of the Tri-Party Agreement and the planning for the Phased Implementation alternative has been an effort to develop the DOE and Ecology proposed plan. It is frequently the case that agencies have a proposed action developed prior to initiating the preparation of an EIS. The EIS provides an analysis of the environmental impacts of the proposed action and alternatives to it. The EIS is not prepared to justify the selection of any alternative but rather, as required by NEPA, is prepared to provide the public and the decision makers an assessment of the proposed action and its alternatives so they may take environmental issues into account where decisions are made. Because the information contained in the Draft EIS is correct, no change to the text was made. Please refer to the response to Comment number 0005.07.

Comment Number 0066.01

Stilger, Bob

Comment My main comments are about the lack of citizen participation over the past 2½ years. From what, from the answer I got to my question earlier, it sounds like the last major participation that was conducted on this was in late 1970, excuse me 1994, which came at the direction of the Nuclear Waste Advisory Council before it was disbanded. So we've gone through as 2-year period, in which what I regard as substantial changes have been made in the current plans. When I hear that the amount of waste that's due to be cleaned up by 2010 is now at 16 percent, rather than 30 percent. Almost a 50 percent reduction. I regard that as a major change. I regard the plans for privatization as a major change. The fact that these plans have been developed primarily in private, behind closed doors, once again gives me great concern. When I come to a meeting like this and have, what, maybe a 2-hour period to examine what's going on, and have contrary information, or contradictory information presented by on the one hand DOE and Ecology, and on the other hand by HEAL and Heart of American Northwest. I must say, based on past experience, my inclination is to believe HEAL and Heart of American Northwest. Jerry may have long figures, but they're frequently more accurate, and more accessible than the others that are presented. My concern is that over the past 2 years work that was done in the late 80's, and early 1990's to begin to develop more of a relationship between the public and DOE, between the public and Department of Ecology, seem to have been substantially eroded. I don't believe that people know what's going on right now. I think these changes need to be discussed more publicly, in a more accessible manner. Frankly, I can't tell from the limited amount of information that's been available tonight, whether the new plans really are the best plans since sliced bread, or are another example of backsliding and more paper work. Whichever the case is, we're not going to know until there is a more active, and more aggressive, and more thoughtful citizen participation process. Thanks.

Response Since 1994, there have been extensive opportunities for public involvement in the decision making regarding the TWRS program. The public has participated in the TWRS decision making process on the following occasions:

Scoping for the TWRS EIS in early 1994 (five public meetings), consultation with Tribal Nations, and briefings of the Hanford Advisory Board.

A public comment period on the SIS EIS and the Final EIS in late 1995 (five public meetings) and briefings for Tribal Nations, the Hanford Advisory Board, and the Natural Resources Trustee Council.

Privatization and related public involvement on the proposed amendments to the Tri-Party Agreement from late 1995 through early 1996.

Interaction with the Hanford Advisory Board and its committees from 1994 to the present on a variety of issues associated with the TWRS program. The EIS was discussed during public forums held in Richland, Washington, in Fall 1995.

Extensive mailings and public notifications have been provided by the Agencies to encourage public involvement in the NEPA process and to provide the public with information regarding the alternatives and analysis in the EIS.

Substantial changes have occurred in the TWRS program during the past two years. However, these changes have been subject to extensive public participation and have all been undertaken within the context of the Tri-Party Agreement. Because of these changes and changes that preceded the signing of the amended Tri-Party Agreement in 1994, DOE was required by NEPA to prepare this EIS. NEPA requires public participation in the decision making process for actions by an agency that could have significant impacts on the human and natural environment. The NEPA process for the TWRS program provides the public with an opportunity to comment on the proposed action and alternatives to the proposed action.

To facilitate public participation in the NEPA process, DOE and Ecology widely advertised the opening of the comment period and the availability of the Draft EIS for review and comment.

In newspapers throughout the region.

In mailings to more than 4,500 individuals on Hanford Site mailing lists.

Two separate press releases were distributed to media outlets in the regions.

Indirect mailings to more than 1,400 interested parties.

In distribution of more than 600 copies of the EIS.

Additionally, the EIS and supporting documents were available at four public reading rooms or information repositories in the Northwest. The entire EIS was available on the Hanford Internet Homepage (http:\www.Hanford.gov.). DOE and Ecology have taken all steps possible to ensure that the complete information was provided, information was provided in as many locations as possible, and that the public had access to the level of information they needed to effectively participate in the decision making process. While more active, aggressive, or thoughtful public participation is an important goal to which both Agencies are committed, the TWRS public participation program met or exceeded all requirements and expectations under Federal and State regulations. The TWRS public participation program implemented many innovative techniques that were designed to improve public involvement.

Comment Number 0081.10

Pollet, Gerald

Comment Secondly, lastly, we are concerned that the joint state U.S. DOE EIS effort was a noble effort at saving costs and streamlining. And we feel that DOE, U.S. DOE, excuse me, has jeopardized the success of this experiment. Jeopardized it by failing to provide all relevant access, all data, excuse, me, data access for all relevant data to its partner in this EIS. The Department of Energy has been sitting on data about tank leaks. It has been sitting on data and has known that it has evidence about additional types of wastes, radionuclides, not just cesium that have moved from tanks. It hasn't shared that data, and seems to be sitting on that data in such a manner as to try to prevent it from coming out during the public hearing and comment period on this EIS. That would be extremely bad faith. It has to release that data, and maybe even do a supplemental mailing to the public, and share it immediately with its partner if it expects to ever be able to go ahead and do a joint EIS again. And we're very concerned that Ecology can't be a full partner in an EIS when its co-partner has control over all the data, and attempts to sit on it and evade public disclosure. Thank you.

Response All data used in the development of the EIS are available to the public by accessing the TWRS EIS Administrative Record. The emerging data concerning tank leaks and the depth into the soil column the contaminants have moved were identified in Volume One, Section 3.3 on page 3-4 of the Draft EIS. The mechanism for how this contamination may have moved into the soil column at a greater depth than previously believed has not yet been determined. It may have leaked down unsealed bore holes, caused by hydraulic pressure of large leaks, caused by chemical reactions that could change the rate at which the contaminants might move in the soil column, or a combination of these and other factors. Additional information analysis has been performed since the publication of the Draft EIS and the last available information was included in Volume One, Section 4.2 and Volume Five, Appendix K of the Final EIS. DOE and Ecology know of no information that has been withheld from the public.

Comment Number 0085.06

Klein, Robin

Comment It is important that a plan be implemented immediately to retrieve the tank wastes. Oh, and on behalf of a number of individuals here, we'd also like to know what your going to do with these comments, and what the response mechanisms will be. How will you be responding to our comments?

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology agree with the need to move forward with remediation of the waste at the earliest possible date.

All oral and written comments have been entered into the public record for the EIS. Transcripts of meetings and written comments have been placed in the Administrative Record for the EIS and made available for public review at DOE Reading Rooms and Information Repositories. Each comment received was also logged, categorized by topic, and responded to individually. A copy of the comment and response has been published in this comment/response document (Volume Six, Appendix L). Based on the response to the comment, appropriate changes have been incorporated into the text. The Final EIS will be provided to the decision makers to support the Agency decision.

Comment Number 0098.07

Pollet, Gerald

Comment Everyone has to get together to fight to get first of all full disclosure, secondly, to make sure that tanks are not left behind, and thirdly, that no decision makers are lulled into thinking it is safe to leave wastes behind because of this EIS and because the Department of Energy does not give its partner, the State of Washington, the data. I think this was a failed experiment in terms of the state collaborating with the Department of Energy. The U.S. Department of Energy blew it and we will oppose joint EISs in the future unless the state really puts down its foot and insists on some truth and changes here.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The DOE and State of Washington were jointly involved throughout all aspects of the preparation and approval of the Draft EIS and they concur in its results. Co-preparing this EIS instead of preparing two, one by DOE and one by the State of Washington, allowed the overall approval process to be accelerated and saved taxpayers money. All information concerning the EIS was shared between the State and DOE. Please refer to the response to Comment number 0081.10 for a related discussion.

L.10.0 POLICY ISSUES

L.10.1 MISSION

No comments were submitted for this topic.

L.10.2 AUTHORITY AND RESPONSIBILITY

No comments were submitted for this topic.

L.10.3 CREDIBILITY

Comment Number 0053.01

Carpenter, Tom

Comment Workers were often heavily criticized or publicly ridiculed in the press for being wrong. Hazards that today are publicly accepted and even embraced enthusiastically by regulators and it is hard to come here and listen and read the documents and have a whole lot of trust in the same set of folks who created the situation to now go out and propose scenarios for cleaning it up. I have a real problem with the same group of people who denied that there was ever a problem about ten years and five years and even three years ago now telling us that the risks for such and such a scenario was so much that explaining to us this alternative means this much money or that alternative means this many lives and I guess what I am trying to get to is I think the problem at the Hanford Site is not one of science, I think it is one of management.

Response An independent contractor was selected to assist DOE and Ecology in preparing this EIS and several independent assessments of the EIS have been performed to validate its results. The scope of the EIS is the remediation of the tank waste and cesium and strontium capsules, and the items mentioned in the comment are outside of this scope of the EIS; therefore, no change in the text of the document is warranted.

Comment Number 0053.04

Carpenter, Tom

Comment Why did it take over a month and a half for folks to be informed about these findings (regarding cesium on nearing toward the groundwater). So, again we have whistle blowers bringing information out about problems in the tank farms, about problems in management and I guess my bottom line is that I would like to see some meaningful management reform, some ethical folks with integrity in charge of doing whatever it is you're going to do out there, with whatever scenario you choose because the best laid plans can not be effectively implemented by incompetent folks. You can have a great plan but it won't work if your not honest, if your not accountable. So that is my concern and that is my comment for tonight.

Response DOE and Ecology know of no delay in informing the public of verified information concerning the cesium in the soil column. DOE and Ecology are continuously working to improve methods used to distribute information to the public.

Comment Number 0057.01

Garfield, John

Comment I would like to express appreciation for Ecology's involvement in this process over the last several years. Also, the other stakeholders for their influence. For the last 3 to 4 years, there has been an unfortunate headquarters involvement that skewed this process and made it much more complex than it needs to be.

Response DOE and Ecology acknowledge the comment. The extensive involvement of Ecology and the stakeholders helped provide a higher quality document that addresses the concerns of the stakeholders.

Comment Number 0095.01

Stock, Sidney

Comment May be possible and so I would urge again those who work there to remember that your first responsibility is as a human being to yourself, to your families, to all of humanity and secondly to your job and so when it comes to making a judgement on my part with limited information I will continue, hopefully not forever, to trust what part of American and Physicians for Social Responsibility and the other public interest groups say in criticism of what goes on rather than the information that I am receiving from the government.

Response DOE and Ecology believe that the TWRS EIS was prepared using the best available data and methods of analysis. An important part of the NEPA process is the review of the Draft EIS by stakeholders, agencies, and Tribal Nations during the comment period. This review period provided interested parties with the opportunity to examine the assumptions, analyses, and conclusions in the draft document and the opportunity to provide input on how these issues and other concerns should be addressed in the Final EIS. This process improves the quality of the Final EIS and is crucial to the NEPA decision-making process.

Comment Number 0096.01

Zepetta, Barbara

Comment And for people in this room, not to have the actual documents, not to have the actual data in and, I mean, in an objective way, not a subjective way, it should not be a different consultant every time you do not get the right answer you get a different consultant. This is not a PR game and until we stop doing this as a PR game we are not going to reach any ... we are not going to get the facts to begin to get the solutions on them.

Response The purpose of the public comment period is to provide the public, agencies, and Tribal Nations with the documents and data. The Draft EIS and its supporting documents were released for public review and comment on April 12, 1996. During the 45-day public comment period which ended on May 28, 1996, these documents were available in the DOE Reading Rooms and Repositories in five cities in the Northwest. Among the documents available were the raw data and calculations used to describe the alternatives and assess impacts. This information was provided to allow any interested party with the documents necessary to assess the quality of the information that served as the basis of the EIS. Individuals requesting the EIS and supporting appendices were provided a copy. The document also was available on the Hanford Internet Homepage.

Volume One, Section 8.0 contains the names and qualifications of each individual author who was responsible for analysis presented in the EIS.

L.10.4 GOVERNMENT POLICY

No comments were submitted for this topic.

L.10.5 MISCELLANEOUS

Comment Number 0008.07

Evett, Donald E.

Comment In closing, you have prepared an excellent impact statement. It pleases me to know that progress is in the making to begin resolving the Tank Waste Remediation System at Hanford. I believe it is ever so important to place high value program actions on this system without unnecessary delays. I wish everyone in the Department of Energy success in this difficult venture.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0015.01

NRC

Comment The Nuclear Regulatory Commission currently does not have budgeted resources to do a proper review of the EIS at this time. Because incomplete EIS comments from NRC could set an improper precedence for any future licensing of the solidification operations, NRC will not issue comments on the TWRS EIS. NRC will, however, use the EIS, as appropriate, to support future reviews of TWRS solidification operations.

Response DOE and Ecology acknowledge the receipt of the comment.

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L.2.0 PURPOSE AND NEED FOR ACTION

Comment Number 0005.36

Swanson, John L.

Comment The term "low-activity waste" is used incorrectly on page 2-1: at least the usage there does not agree with the distinction drawn on pages 1-3 and 6-18 that LAW is tank waste remaining after the removal of the practicable amount of HLW. By this distinction, how can there be any LAW in the tanks now? As I understand it, all of the tank wastes except for the NCRW and PFP tanks are HLW by definition; they will be pretreated to divide them into HLW and LAW fractions, but LAW does not exist until after pretreatment has happened. If this understanding is not correct, you had better revise your definition of LAW so that it is consistent with whatever it is that you mean. (I would be happy to try to assist in such a revision if it were explained to me what is really meant).

Response The use of the term LAW on page 2-1 is consistent with the definition of LAW provided in Volume One, Section 1.0. LAW is the waste remaining after the removal of as much of the radioactivity as is practicable from HLW. As indicated in Volume One, Section 1.1, during the 1950's and 1960's uranium, cesium, and strontium were separated from the waste in some of the SSTs. Based on this earlier waste separations, some of the SSTs may be able to be classified as containing LAW. However, due to incomplete tank-by-tank waste characterization, it is not possible at this time to conclude how many or which tanks could potentially be considered for classification as LAW tanks.

As discussed in Volume One, Section 6.2, the correct classification of the waste from each tank will be required to determine which regulations are applicable to the disposition of the waste in each tank. Thus, it is possible that when tank waste characterization is complete, some of the tanks may be classified as LAW tanks. The waste from these tanks then could be processed accordingly. For example, under the preferred alternative, Phased Implementation, the waste from tanks determined to contain only LAW could be directly treated at the low-activity vitrification facility without requiring pretreatment. Please refer to the responses to Comment numbers 0005.25, 0041.01, and 0072.41.

Comment Number 0019.02

WDFW

Comment WDFW has reviewed, the purpose and need for action, and requests additional language be incorporated for clarification. Specifically, the need for action should state 67 SSTs are known or are assumed to have leaked 2.3 million to 3.4 million liters of hazardous waste to the groundwater, thus the need to remediate the source (tank waste) to prevent further contamination of groundwater. As long as an uncontained liquid waste source exists, it will continue to contribute to groundwater contamination and ultimately end up in the Columbia River.

Response The transfer of the liquid waste from the SSTs, many of which have leaked or could leak in the future, into the DSTs greatly reduces the potential for additional leaks into the soil column. A separate NEPA analysis was performed for this action, referred to as saltwell pumping. The purpose and need does identify the need to manage and dispose of tank waste to reduce existing and potential future risks to the public, Site workers, and environment. The analyses provided in the EIS include a No Action alternative and the impacts analyzed for the alternative include potential future migration of waste to groundwater. Because DOE and Ecology believe the purpose and need for action is accurately presented in the Draft EIS, no modification to the document is warranted.

Comment Number 0043.01

Hanford Communities

Comment Radioactive tank waste is one of the most serious environmental risks on the Hanford site. The tanks continue to pose imminent safety risks to workers and the environment. These risks include the potential for catastrophic release through hydrogen gas flammability and groundwater contamination from leaking tanks. Our communities are frustrated with the lack of progress in getting the wastes out of the tanks and safely stored.

Response DOE and Ecology share the desire to move forward with remediation of the tanks at the earliest possible date and are implementing plans to accelerate remediation. In the mean time, DOE is performing numerous activities to place the tank farms in a controlled and stable condition and upgrade the regulatory compliance status of the tank farm system. (See Volume One, Section 3.4 and Appendix B for discussions of current and planned programs to manage the tank waste.)

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L.3.0 DESCRIPTION AND COMPARISON OF ALTERNATIVES

L.3.1 INTRODUCTION

L.3.2 SITE AND WASTE DESCRIPTION

L.3.2.1 Tank Waste

Comment Number 0005.10

Swanson, John L.

Comment On another matter related to tank-by-tank inventory, on page A-2 it is said that "...tank farms were grouped together based on tank contents (inventory)..." Again, what data were used to perform such groupings? The inventory data presented in the EIS, and represented to be used therein, do not allow such groupings to be made. We thus have no way of knowing (or estimating) how valid these groupings are. I detect no special bias here, as I do in the consideration of the combined ex situ/in situ alternatives cases, but the story presented in the EIS should be complete and consistent.

Response DOE and Ecology acknowledge the concern expressed in the comment. The text has been modified to show that the tanks were grouped according to configuration, not according to content. This text modification appears in Volume Two, Appendix A, Section A.2.1.1.

Comment Number 0005.22

Swanson, John L.

Comment On page A-3, it appears to be stated as a fact that the K Basins sludges will be added to the tanks. This is news to me, and I do not believe that it is reflected in other portions of the EIS.

Response One proposed option for disposition of K Basin sludge identified by the 1996 K Basins EIS ROD is to remove and transfer the sludge to the DSTs. If implemented, the final disposition of this waste would be in accordance with the alternative implemented for tank waste management and disposal under the TWRS EIS. The Draft EIS included, in Appendix A, the K Basin sludge inventory as a potential source of new waste to be added to DSTs. K Basin sludges are discussed in Volume One, Section 3.4.1 and Volume Two, Appendix A, Section A.2.4.

Comment Number 0005.37

Swanson, John L.

Comment On page 3-11 it is said that "--new leaks are developing in these tanks at a rate of more than one a year." Are data available to support this statement, or is it an assumption that is stated as fact?

Response At the time the Safe Interim Storage (SIS) EIS was published, 67 SSTs were assumed to have leaked over the past 50 years. This number was used to support the statement that leaks would develop at a rate of more than one a year in the future. The saltwell pumping program, which involves removing liquids from the tanks, is expected to slow the rate of corrosion and substantially reduce future leaks (see Volume One, Section 3.4). Data are not available to accurately predict the number of new leaking tanks that will develop. The data identified above provide the best estimate available at the current time. Based on the saltwell pumping program to stabilize the SSTs and for the purposes of analysis in the TWRS EIS, no new leaks are assumed to occur during the 100-year administrative control period. The text of the EIS in Volume One, Section 3.2 has been modified to state that, "... new leaks are developing at a rate of one new tank known or assumed to have leaked per year."

Please refer to the response to Comment numbers 0072.70 (leak detection methods), and 0072.85 (predicted and anticipated future leaks).

Comment Number 0012.14

ODOE

Comment Tank Waste Characterization

The tank wastes are complex and poorly understood. The complex operating history of Hanford tanks has created a situation where the contents and character of the waste in every tank varies significantly from every other tank.

USDOE is working to characterize tank wastes. This should allow USDOE to narrow the uncertainties and mitigate severe hazards such as flammable gas generation. But, the data will not be detailed or accurate enough to ensure the risk assessments can accurately predict the fate of these wastes if they are left in the tanks.

Response The tank wastes are not well characterized on an individual tank basis, but an estimate of overall tank contents can be made. As noted in the EIS in Volume One, Section 3.2 and Volume Two, Appendix A, DOE has implemented a program to characterize tank waste on a tank-by-tank basis, which will be instrumental for resolving tank safety issues and final design activities for waste treatment. This program will aid in narrowing uncertainties regarding the waste in the tanks. However, DOE and Ecology believe that the existing historical data, laboratory data, and characterization reports provide an approximate estimate of tank contents from which the analysis of the tanks alternative can be completed to support the analysis and comparison of potential environmental and human health impact under National Environmental Protection Act (NEPA). The EIS acknowledges the uncertainties involved with the level of knowledge of the tank waste inventory and uses a conservative approach to assessing impacts based on the available data. This approach, known as bounding, provides an inventory of tank wastes that supports a risk assessment that DOE and Ecology believe fairly and objectively informs the decision makers and the public of the potential impacts associated with each alternative and support a comparative analysis of the alternatives. Tank-by-tank characterization will be needed to implement detailed design and operation of the TWRS action. If characterization data become available that are not bounded by the EIS analysis, DOE would complete an appropriate NEPA analysis to support analysis of environmental impacts and, if appropriate, alternatives that address the new data. See Volume Two, Appendix A for a discussion of tank inventory and Volume Five, Appendix K for a discussion of uncertainties.

Comment Number 0072.07

CTUIR

Comment In particular, two aspects are deficient within the TWRS-EIS. First, thorough characterization of the natura and composition of Hanford's chemically and physically ckmplex tank wastes is in its infancy. It is clear that not enough information exists about these wastes within this EIS to adequately support retrieval and treatment needs, let alone facility design(s). If overall planning goals are not well understood in advance, the CTUIR SSRP asks, how will it be possible to design retrieval, treatment, and disposition systems that will meet protective waste management endstate and Tri-Party Agreement goals? This EIS should fit hand in hand with the Hanford sites overall guiding, framework document.

Response Though the characterization program for the tank waste is not complete, the EIS functions primarily as an environmental planning document, not as an engineering design document, and as such, will not include the complete details of programs like tank inventory and characterization or retrieval. As required by the Tri-Party Agreement, the tank waste characterization program will be completed September 1999. Assuming the tank waste characterization sample collection, analysis, and data interpretation must be finalized well in advance of the program, in addition to the reservoir of existing information, sufficient data would be available to support the detailed design of the transfer and retrieval systems, as well as of the treatment facilities. Where appropriate, the EIS incorporates such information by referencing the publicly available information on relevant topics. The locations of DOE Reading Rooms and information repositories containing publicly available information are given in the Summary, Section S.8. For example, the EIS contains references WHC 1995b, WHC 1995o, WHC 1994f, and WHC 1994g pertaining to tank contents and WHC 1994h pertaining to the characterization program. Tank retrieval and blending strategy is the subject of reference WHC 1995p. DOE and Ecology agree that it is necessary to ensure that tank waste remediation decisions are based on this EIS and are consistent with overall goals or designed endstates for the Hanford Site. To this end, the EIS describes the relationships among the alternatives and broader goals and policies, both nationwide and for the Hanford Site. For example, the relationship between the alternatives and tank closure is discussed in Volume One, Sections 3.3, 5.1-5.10, and 6.0. Further, Volume One, Section 6.0 describes the policy and regulatory background, including the Tri-Party Agreement, in relationship to the proposed action. Please refer to the response to Comment number 0012.14.

Comment Number 0072.14

CTUIR

Comment Considering the controversy surrounding the characterization of tank waste, the documentation of the contents of individual tanks and development of the "supertank" inventory should be better.

The entire tank waste characterization strategy needs to be examined and improved.

Response More complete knowledge of the tank contents would be preferable. At present, there is a program of tank characterization which, when completed, will provide information on the contents of each tank. Because that program of characterization is not completed, estimates of tank components were used in the EIS. The documentation of the inventory estimates that were used in the EIS is discussed in Volume Two, Section A.3.0 and in Volume Four, Appendix E (Section E.1.1.3.1). The use of the super tank inventory is specifically discussed in Appendix A (Section A.3.3). The super tank inventory is intended to present the most conservative impacts from an accident so that the effects of accidents will not be underestimated. The super tank concentration of a chemical or radionuclide is the highest reported value that has been measured or calculated for that substance. This means that for assessing the impacts of an accident, a uniform inventory will be used for every accident scenario. For assessment of impacts, the use of this inventory data provides an equitable comparison of impacts. For the Final EIS, Appendix K (Volume Five) has been added to provide expanded information regarding uncertainties including inventory and accident. Please refer to the response to Comment numbers 0012.14 and 0072.07.

Comment Number 0072.67

CTUIR

Comment P 3-2: Sect. 3.2.1.2: Tank farm description: It is indicated here that 67 SSTs have leaked 2.3 million -3.4 million liters of liquids, it would be useful if there were a description on how this was calculated.

Response The estimate for the volume of waste that has leaked from the 67 known or assumed leaking SSTs was taken from the cited reference (Hanlon 1995). The referenced document, titled Tank Farm Surveillance and Waste Status Summary Report is one of a series of periodic reports that contains tank volume data as well as estimates and data for leak volumes from each of the known or assumed leaking SSTs. The methods used to estimate the volume of waste to have leaked varied by tank. The estimating method and the other parameters that impacted the assessment are contained in the footnotes to Table H-1 in the Waste Tank Summary Report for the month ending February 29, 1996 (Hanlon 1996).

Comment Number 0072.68

CTUIR

Comment P 3-4: PP 1: A vadose zone baseline characterization program could not possibly have determined the structure of the region underneath the tank farms given the amount of liquids presumed to have leaked and the large number of unknowns associated with the vadose zone points to an enormous amount of error in the ground water assumptions changing the future predictions on the rate of contaminate transport through the vadose zone will necessarily change the risk.

Response There are uncertainties and unknowns associated with the vadose zone modeling of rate and transport of contaminants from the tanks. Many of the uncertainties were addressed in Volume Four, Sections F.4.3.5 and F.3.4. The impact assessment modeling in Appendix F only addresses impacts from releases associated with TWRS remediation, not past leaks. Additional modeling was performed with evaluations provided in Volume Five, Appendix K that address potential transport mechanisms that may have been active during past leaks. Together, these evaluations and assessments provide the basis for developing appropriate mitigating measures. The response to Comment number 0012.15 contains an extensive discussion of vadose zone contamination issues, particularly uncertainty and subsurface geology.

Comment Number 0072.69

CTUIR

Comment P 3-7: PP 3: S 5: what is the precipitation process for the metal-salt compounds indicated here.

Response The sentence cited in the comment refers to the sludges in the tanks. Sludge is contained in a layer of water-insoluble chemicals that precipitated and settled to the bottom of the tank when the waste liquid from the processing plants was made basic by the addition of sodium hydroxide. Because of their reaction with sodium hydroxide, the sludge compounds are composed of primarily of metal hydroxides. Because the sludge composition may vary and other compounds may precipitate, the precipitate also is termed hydrous metal oxides.

Comment Number 0072.70

CTUIR

Comment P 3-11: PP 3: Bullet 1: How was the rate of leakage determined? Please explain how the control wells or the leak sensors are strategically placed.

Response The statement cited in this comment, taken from the SIS EIS, is as follows: "Removing saltwell liquid from older SSTs to reduce the likelihood of liquid waste escaping from corroded tanks into the environment. Many of these tanks have leaked, and new leaks are developing in these tanks at a rate of more than one per year" (DOE 1995i). This statement was intended to reflect the age, condition, and historical perspective of the SSTs. This statement also reflected the thinking at the time that since 67 SSTs were assumed or confirmed to leak, the leakage rate would continue at more than one per year in the future.

Several methods are used to find leaks. Starting in the early 1960's, vertical monitoring wells, called drywells, were drilled around the SSTs. These wells are called drywells because they do not reach the water table. Approximately 760 drywells, located around the SSTs, are used to measure increases in radiation in the ground caused by tank leakage. Multiple drywells are located around the perimeter of the tanks in order to monitor around the tanks. A second way to detect leaks is to use a lateral drywell. This is a drywell drilled horizontally underneath a tank where the radiation in the soil can be measured by a detection probe. A third way to detect leaks is to lower radiation probes into liquid observation wells inside the tank and measure the radiation as a way to identify the level of liquid. By comparing the current liquid level with the last recorded level, a large leak can be detected. Detecting leaks in SSTs is an imprecise activity. As all tanks continue to age, the number of leaking tanks will likely increase. Please refer to the response to Comment number 0005.37.

Comment Number 0072.71

CTUIR

Comment P 3-11: PP 5: Bullet 3: In the event of loss of institutional control, and the loss of the mixer pump in 101-SY, could the microcrystalline mat reform much stronger and thicker, resulting in greater entrapment of hydrogen and other flammable gases?

Response The loss of institutional control, as an assumed event, would result in the termination of continuing operations at the tank farms. The loss of institutional control would mean that the day-to-day activities concerned with management of the tank wastes would no longer continue. This would mean that the mitigative measures currently being applied to the tank wastes would no longer be performed including the use of the mixer pump in tank 101-SY. The tank would revert to its condition before the mixer pump was installed. Whether the sludge layer would reform much stronger and thicker is unknown; however, this possibility cannot be ruled out. A discussion of potential remediation and post-remediation accidents is contained in Volume One, Section 5.12 and Volume Three, Appendix E. Please also refer to the response to Comment numbers 0040.02 and 0040.03 for more information related to administrative controls and the response to Comment number 0072.80 for discussions of the reason and basis for assuming a 100-year administrative control period.

Hydrogen and other flammable gas deflagration accidents were analyzed in the EIS. For post-remediation accidents, an analysis of the flammable gas deflagration accident, among others, determined that a seismic event would result in bounding case accident conditions and therefore the post-remediation accident presented in Volume One, Section 5.12 is the seismic event.

Comment Number 0072.72

CTUIR

Comment P 3-13: PP 1: This is the first notation on complexing of tank waste, please include a discussion on exactly what is meant by complexing waste.

Response The subject discussion regarding the SIS EIS ROD is provided in the EIS to inform the reader of planned activities to address urgent safety or regulatory compliance issues. The discussion of complexed and noncomplexed waste with respect to tank 102-SY was presented in the SIS EIS (DOE 1995i). A definition of complexed and noncomplexed waste is also provided in the glossary of the TWRS EIS. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please also see the response to Comment number 0072.170 for more information about complexed waste.

Comment Number 0072.73

CTUIR

Comment P 3-13: PP 2: S 3: What part if any has the DOE done to insure that the affected tribes are involved and kept up to date with the transfer of responsibility, accountability, and liability?

Response The phased approach to implementation of the alternatives is discussed in Volume One, Section 3.3. Contracting strategy is not an issue addressed in the EIS. However, DOE recognizes the importance of maintaining an interactive relationship with the affected Tribes. Informal discussions as well as meaningful consultation and cooperation result in better understanding of important cleanup issues.

In the developing months of the privatization effort (Spring/Summer 1995), invitations were issued to the affected Tribes to present the initially envisioned concept. Letters and follow-up communiqués were issued to J.R. Wilkinson, Hanford Program, Confederated Tribes of the Umatilla Indian Reservation (CTUIR); Donna Powaukee, Environmental Restoration and Waste Management (ERWM) Manager, Nez Perce Tribe; and Russell Jim, Confederated Tribes and Bands of the Yakima Indian Nation. Of the invitations, only the Nez Perce requested and participated in a discussion of the project with a DOE representative and staff. Follow up correspondence addressing questions and concerns was issued August 1995.

Following issuance of the TWRS Request for Proposals (RFP) (February 1996), a request was made for a copy by Joseph H. Richards, Environmental Compliance Auditor, CTUIR on February 23. The following day, the document was forwarded to him.

Progress reports and status updates are routinely provided to the Hanford Advisory Board, which has Tribal representation. This is not to suggest that interactions with the Board substitutes, or may be conducted in lieu of, both formal and informal interactions with the Tribes. DOE encourages such interactions and welcomes opportunities to discuss important cleanup activities with the Tribes. An in-depth discussion of the Tribal consultation process for the TWRS EIS is presented in the response to Comment number 0072.252.

Comment Number 0072.74

CTUIR

Comment P 3-13: PP 2: S 7: The CTUIR agrees that the plan for privatization is subject to the final record of decision of the TWRS EIS.

Response The TWRS EIS ROD will document the decision for how to remediate the tank waste. DOE intent in preparing the schedules for the TWRS EIS and the award of Phase 1a contracts was to have the EIS ROD completed prior to the contract award. To ensure that the award of contract could proceed in the event of a schedule disruption to the EIS ROD, DOE clarified in the final RFP that action under the contract would be contingent on the outcome of the TWRS EIS ROD, a decision which would be considering other alternatives and, if chosen, might necessitate renegotiating or voiding the contract award.

DOE NEPA Implementing Procedures (10 CFR 1021) require DOE to "complete its NEPA review for each DOE proposal before making a decision on the proposal (e.g., normally in advance of, and for use in reaching, a decision to proceed with detailed design)" (10 CFR 1021.210 [b]). The November 1995 draft RFP indicates that Phase 1a is intended as a "development period to establish the technical, operations, regulatory, and financial elements required in privatized facilities." It is only in Phase 1b that the selected contractors will provide detailed, complete design, and be authorized to proceed with construction and operations. These circumstances and requirements comply with NEPA procedures that provide for submittal of environmental data and analysis by offerors and incorporation of an environmental synopsis of that data and analysis in any NEPA document prepared (10 CFR 1021.216 [h]), as long as the actions taken prior to beginning detailed design do not "have an adverse environmental impact" or "limit the choice of reasonable alternatives." Based on the planned Phase 1 approach of splitting the action into two subphases, DOE would be able to proceed with Phase 1a (conceptual design) prior to completion of the TWRS EIS ROD and be within the intent of NEPA. However, the TWRS EIS ROD would be required prior to the anticipated April 1998 award of Phase 1b contracts.

Comment Number 0072.80

CTUIR

Comment P 3-21/22: while it is acknowledged that NEPA requires that an EIS includes a no-action alternative, it should also be acknowledged that leaving leaking tanks violates several laws, regulations, and statutes. Also, no-action would not necessarily be a "continue the current waste 'management' program." It would more likely be a walk-away situation where institutional controls fail.

Response The No Action alternative would result in failure to comply with Federal and State laws and regulations. This information is presented in Volume One, Section 6.2 and in the Summary, Section S.7. EIS Sections S.7, 3.4, and 6.2 describe the Federal and State compliance issues applicable to the No Action alternative. DOE guidance on NEPA requires that EIS alternatives be addressed regardless of "conflict with lawfully established requirements" (DOE 1993d). DOE is required to identify the laws and regulations that apply to each alternative and indicate whether the alternative, if selected, would comply with applicable laws and regulations (40 CFR 1502.2d). Please refer to the response to Comment numbers 0093.02 and 0072.52.

Guidance on the implementation of NEPA Council on Environmental Quality (CEQ) Memorandum to Agencies: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations states the following.

Section 1502.14(d) requires the alternatives analysis in the EIS to "include the alternative of no action." There are two distinct interpretations of "no action" that must be considered, depending on the nature of the proposal being evaluated. The first situation might involve an action such as updating a land management plan where ongoing programs initiated under existing legislation and regulations will continue, even as new plans are developed. In these cases "no action" is "no change" from current management direction or level of management intensity. To construct an alternative that is based on no management at all would be useless academic exercise. Therefore, the "no action" alternative may be thought of in terms of continuing with the present course of action until that action is changed.

In the case of the TWRS program, there is an ongoing program to safely manage the tank waste that would continue under any reasonable scenario for the 100-year administrative control period. For this EIS, no action is assumed to be no effort other than the safe management practices currently conducted. The "walk-away" alternative was not evaluated, because it would present an imminent danger to human health and the environment and would be a useless academic exercise.

Comment Number 0072.81

CTUIR

Comment P 3-24: last paragraph: exactly what does "enough waste would be remediated"? Does this mean that the characterization of the tanks, tank farms, intra-tank, tank mixtures, solubility mixtures would be done on a pilot scale in ten years on an order of magnitude to justify 1.6 billion dollars of set-aside moneys. Is this amount of money justified in terms of removal of tank waste, lowering of risk, characterization, and achieving Tri-Party Agreement milestones.

Response The referenced language means that a sufficient quantity of waste would be remediated during Phase 1 to prove that remediation would be effective for the entire remediation program. The sentence was modified in Volume One, Section 3.3 as follows for clarification. "A sufficient quantity of a variety of tank waste types would be processed to demonstrate the effectiveness of the process and to provide the necessary data to design a full-scale facility." Please refer to the response to Comment number 0005.38.

Comment Number 0072.168

CTUIR

Comment P A-1: Sect. A.2.1: It is appropriate to list the estimated radionuclide and non-radionuclide inventory for each tank or tank farm for comparison.

Response Please refer to the response to Comment numbers 0012.14 and 0072.07. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.169

CTUIR

Comment P B-8: What is actually in the miscellaneous underground storage tanks? The characteristics of an expected waste indicates a need for a comprehensive characterization, even if the total combined inventory of MUSTs volumes is less than one half of one percent of the total tank inventory.

Response Please refer to the response to Comment numbers 0012.14 and 0072.07 for issues related to tank waste characterization. Please also refer to Comment number 0072.99 for MUST content information. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.170

CTUIR

Comment P B-10: What are the characteristics of concentrated complexant waste?

Response Concentrated complexant waste is the concentrated aqueous raffinate from strontium-90 liquid-liquid extraction operations performed in the 1960's and 1970's. This waste is a component of the wastes in the AN and SY tank farms, although some is in the DSTs because of saltwell pumping. It is characterized by a high organic content including the complexants ethylenediaminetetraacetic acid (EDTA), citric acid, and hydroxyethylenediaminetriacetic acid (HEDTA).

Comment Number 0072.171

CTUIR

Comment P B-12: PP3: Please explain what is meant by 'have or may have' greater than 50,000 gal of drainable liquid.

Response The section describes the installation of liquid observation wells in the tanks. The criteria for installation is the presence, or suggested presence, of at least 50,000 gallons of drainable liquid. The criteria retains the provisional phrase 'have or may have' because the exact quantity of liquid remaining in the saltcake will not be known until the liquid has been removed and its volume is measured.

Comment Number 0072.172

CTUIR

Comment P B-12: PP4: How many and how often are radiation measurements taken in the drywells?

Response Radiation measurements taken in the drywells are included in the discussion of ongoing tank monitoring and maintenance activities and are one of the methods used to monitor for tank leaks in Volume One, Section 3.2 and Volume Two, Appendix B. Two drywells at two SSTs (tanks 241-C-105 and 241-C-106) are currently monitored monthly by gamma radiation sensors. The remaining tanks are monitored by the TWRS program periodically based on the need to detect potential new leaks and/or to document the extent and nature of past leaks.

Comment Number 0072.173

CTUIR

Comment P B-16: PP5: Please re-do this paragraph. It is confusing and could be better written. For example, the description of the majority of radioactive elements in the sludges needs to be expanded and an indication needs to be made whether the sludges are at the bottom of the tanks or elsewhere.

Response The referenced paragraph provides a generic description or overview of the waste in numerous tanks rather than in individual tanks. The three types of waste (i.e., liquid, sludges, and saltcake) are present in the individual tanks in varying combinations and proportions. For example, sludges may be located at the bottom of the tank, caked along the side of the tank, or both. Although there is a considerable amount of tank waste inventory available from process records and past sampling activities, this information is not considered adequate to characterize the waste in individual tanks. However, DOE is actively involved in an ongoing waste characterization program that is using waste sampling and analysis, in situ measurements, monitoring, surveillance, and waste behavior modeling to provide more detailed and accurate characterization data for the content of individual tanks. Current agreements among DOE, Ecology, and EPA require that all characterization reports be issued by September 1999. Volume Two, Sections A.2 and A.3 present additional information on the tank inventory data including the estimated radionuclide inventory for SSTs and DSTs, ongoing tank characterization programs, and tank inventory data accuracy and its effect on the EIS. Please refer to the response to Comment numbers 0012.14 and 0072.07. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.174

CTUIR

Comment P B-18: PP3: The statement, "upgrade the regulatory compliance status" implies that the DOE may not be in compliance even after they complete the SIS EIS activities.

Response In the context of the TWRS EIS alternatives, the referenced statement regarding the SIS EIS refers only to the compliance status of the cross-site transfer portion of TWRS. Installing the cross-site transfer pipeline would comply with applicable regulations whereas the existing cross-site transfer pipeline does not. It is DOE policy to conduct its operations in an environmentally safe and sound manner in compliance with applicable environmental statutes, regulations, standards, and the Tri-Party Agreement. Routine operations at the tank farms include monitoring and maintaining the regulatory status, and operations and maintenance of facilities and equipment. However, upgrading the regulatory compliance status as part of the process of placing the tank farms in a controlled, stable condition involves multiple and continuing activities, particularly as facilities age. The EIS addresses upgrades specific to the waste transfer system (Volume Two, Section B.3). The cross-site transfer system and upgrades under the TWRS EIS are actions identified in the Tri-Party Agreement Resource Conservation and Recovery Act (RCRA) compliance provisions. Volume One, Sections 1.1 and 3.2 provide additional information regarding how the SIS EIS and TWRS are interrelated. Volume One, Section 6.0 describes the statutory and regulatory requirements potentially applicable to TWRS.

Comment Number 0072.175

CTUIR

Comment P B-20: PP1: If the goal of privatization has a component that transfers a share of accountability and liability to industry, have the affected Tribes been properly notified and consulted regarding this? If so, when and with whom were the notifications and consultations addressed to?

Response Please refer to the response to Comment number 0072.73.

Comment Number 0072.176

CTUIR

Comment P B-20: PP2: Once again the statement "upgrade the regulatory compliance status" indicates that even after the current planned upgrades the tank farms may not be in compliance. The planned upgrades listed including instrumentation, ventilation, and electricity is supposed to place the tank farms in a controlled stable condition. Please bring forth a discussion on how these three upgrades will accomplish this.

Response DOE and Ecology acknowledge that even after the current planned upgrades, the tank farms may not be in full compliance. However the upgrades are required by the Tri-Party Agreement which is the RCRA enforcement agreement among DOE, Ecology, and EPA. The upgrades when completed along with other projects such as the saltwell pumping program will result in the attainment of controlled onsite conditions for the SSTs. Upgrades to the instrumentation, ventilation, and electrical systems are not included in the scope of this EIS; however, these activities are the subject of other NEPA documents. Please refer to the response to Comment number 0072.174. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0077.01

ODOE

Comment More than a million gallons of high-level wastes have already leaked from these tanks, threatening the aquifer and the groundwater. Plutonium and americium from one tank leak at Hanford have migrated over 100 feet through the soil and may have reached the groundwater. A third of the tanks have been placed on a "watch" list because of the danger of explosions.

Response DOE and Ecology concur the magnitude and complexity of the tank waste issues that constitute the purposes and need for the TWRS action. DOE must implement decisions to manage and dispose of tank waste to reduce existing and potential future risk to the public, Site workers, and the environment. The EIS includes an analysis of alternatives to manage and dispose of tank waste. The analysis of impacts includes potential impacts to groundwater in Volume One, Section 5.2 and Volume Four, Appendix F; remediation and post remediation health impacts in Volume One, Section 5.11 and Volume Three, Appendix D; and remediation and post-remediation accidents, including the risk of explosions, in Volume One, Section 5.11 and Volume Four, Appendix E. The cumulative impacts of past leaks and TWRS actions are presented in Volume One, Section 5.13. Please refer to the response to Comment numbers 0072.61 (estimates of tank volume thought not to have leaked), 0072.63 (leak volume thought to be cooling water) and 0072.67 (leak volume estimating methods) for more information about tank leaks. Current methods used to detect leaks are discussed in the response to Comment number 0072.70.

Comment Number 0089.10

Nez Perce Tribe ERWM

Comment Page A-13, Table A.2.1.2

The Table delineates the soluble and insoluble portions of chemical species. This information is useful, but it would be helpful to see a listing of the chemical compounds rather than just anions and cations listed separately. A better understanding of tank chemical processes is possible with a listing of chemical compounds.

Response DOE and Ecology concur that more complete knowledge of the tank contents, including the exact nature of the chemical compounds would be advantageous. At present, there is a program of tank characterization which, when completed, will provide greater depth of knowledge as to the contents of each tank. Because that program of characterization is not yet completed, estimates of tank components were used in the EIS. Information on the chemical compounds within the tanks is limited. The inventory estimate provided for use in the EIS (WHC 1995d) gives the chemical species in their ionic form. For purposes of assessing impacts from the release of the tank contents, the use of the ionic forms was sufficient. Please refer to the response to Comment numbers 0012.14 and 0072.07. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

L.3.2.2 Cesium and Strontium Capsules

No comments were submitted for this topic.

L.3.3 DEVELOPMENT OF ALTERNATIVES

L.3.3.1 Tank Waste

Comment Number 0005.17

Swanson, John L.

Comment The fact that tank closure is not included in the analysis seems to me to be a serious deficiency. The statement on S-15 that "Closure is not within the scope of this EIS because there is insufficient information available concerning the amount of contamination to be remediated." seems to me to be a cop-out. You go on to base the analysis that you do on an assumed 1 percent left in the tanks; data given on page S-7 indicate that 0.5 percent of the waste activity has been released or leaked to the ground. Isn't an estimate of 1.5 percent of the contamination to be remediated during closure sufficient information on which to base an analysis? (It is certainly as close an estimate as many of those used in the analyses that were done in this draft).

Response Closure is not within the scope of this EIS because information, such as the nature and extent of vadose zone and groundwater contamination to identify and analyze reasonable closure alternatives is insufficient to support an evaluation of closure alternatives. The Notice of Intent to prepare the TWRS EIS stated, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future" (59 FR 4052). However, some of the decisions to be made concerning how to dispose of tank waste may impact future decisions on closure, so the EIS provides information on how tank waste remediation and closure are interrelated. A single and consistent method of closure was assumed for all alternatives to allow for a meaningful comparison of the alternatives. The closure method used for purposes of analysis was closure as a landfill, which includes filling the tanks and placing an earthen surface barrier over the tanks after remediation is complete. For a discussion of how closure was addressed within the EIS, see Volume One, Section 3.3.

Specific and detailed information on the distribution of contaminants from tank leaks and past practice activities is not available in sufficient detail to provide a meaningful comparison of impacts. When sufficient information is available to evaluate the closure options, DOE will submit a final closure plan to Ecology for review and approval, and an appropriate NEPA analysis will be completed. An extensive discussion of closure and issues related to closure is presented in Comment number 0072.08.

Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0005.18

Swanson, John L.

Comment The assumptions of a) 1 percent of the contaminants (including the water soluble ones) left in the tanks and b) no attempt to immobilize this residual, lead to a lack of discrimination risk is dominated (by a factor of 100) by the risk of the non-immobilized 1 percent assumed to be left in the tanks. This is a classic case of "assumption driving the conclusion." For the purposes of this EIS, wouldn't it be better to assume a closure approach that would allow differences in the considered alternatives to apparent? It would be strange to me if the same "public" that drove out grout as a LLW form because of perceived contaminant release problems would be willing to accept a situation where the overall release is 100 times greater than that from their preferred waste form because something was not done to immobilize the waste left in the tanks (or to rinse out more than 99 percent of the water-soluble contaminants).

Response As stated in Volume One, Section 3.4, the calculations in the EIS are based on the assumption that the waste residual would be composed of the average tank contents, which is a very conservative assumption because the liquids used to retrieve the waste would remove a high percentage of water-soluble contaminants. The water-soluble contaminants are those that contribute to long-term risks because they can be transported over the long term into the groundwater. In response to the issue raised in this comment and others, calculations have been performed and presented in the Final EIS based on a less conservative content of the residuals where most of the water-soluble contaminants are removed. This provides both a bounding and nominal calculation of risks and provides the public and decision makers with greater information concerning long-term risks. This new information is contained in Section 3.4, 5.2 and Appendix F of the Final EIS. For more information regarding closure assumptions and how closure was addressed in the EIS, please refer to the response to Comment numbers 0005.17 and 0072.08 and Volume One, Section 3.3.

Comment Number 0005.26

Swanson, John L.

Comment Page A-7 contains a statement that conservative values of distribution coefficients"--would ensure that travel times of contaminants were at the upper bound--." Shouldn't that be LOWER bound?

Response The distribution coefficient is defined in such a manner that the constituents with the lowest distribution coefficients are those that travel with a greater velocity. The higher the distribution coefficient, the greater the resistance to movement. Therefore, the text is correct as written.

Comment Number 0005.38

Swanson, John L.

Comment At the bottom of page 3-24 and top of page 3-25, it is said that the Phased Implementation approach Phase 1 would remediate enough waste to prove that the many waste types in the tanks could be remediated effectively. This sounds good, but for it to be true you must have a different Phase 1 in mind that the Privatization Phase 1, which will prove essentially nothing about the pretreatment of SST sludges. (On page 3-92 I find "The waste processed during Phase 1 COULD (emphasis added) also include selected SST waste." This is a much different slant than the statement on page 3-24,-25).

Response The referenced text in Volume One, Section 3.3 has been revised to be less encompassing. It is DOE's intent to process enough different feedstocks (e.g., waste types and compositions) during Phase 1 to demonstrate the treatment processes before implementing Phase 2. Different feedstocks processed during Phase 1 would be expected to demonstrate maximum facility thruput, treatment of high cesium level waste, and treatment of organically complexed TRU and Strontium-90 waste. It is believed that by treating the different waste feedstocks identified during Phase 1, the majority of the waste types present in the tanks, including the SST sludges, would be adequately demonstrated to proceed with Phase 2. As explained in Volume One, Section 3.3, the contracting strategy known as privatization is not within the scope of the EIS. Please refer to the response to Comment number 0072.81.

Comment Number 0022.02

Sims, Lynn

Comment In terms of all human history we are treading on unchartered ground. Here we are confronted with a terrible cold war legacy which threatens our lives and environment. We are engaged in a monumentally serious and expensive undertaking which projects itself far into the future. Our current technology is not totally adequate, but we are morally obligated to do the very best we can NOW and not pass this dilemma to future generations.

We do know we are in this situation because of poor management and inadequate long-term planning during the production years. We do not wish to repeat these mistakes and impose disastrous results upon future generations by shortcomings in clean up decision making now.

Response The magnitude and potential impact of the tank waste are among the most extensive of the Cold War legacies. Moreover, the type and volume of waste and the scale of the technologies required for retrieval, treatment, and disposal are unprecedented. The waste poses substantial potential risks to human health and the environment. The costs for implementing any of the alternatives are substantial, and all alternatives would involve tasks that would continue for many years into the future.

It is for these reasons, among others, the Federal agencies are required to complete an EIS before decisions are made and before actions are taken. This allows decision makers and the public to be aware of the potential environmental consequences of the proposed action and ways to mitigate those impacts and for the public to be involved in decisions that affect the quality of the human environment.

Comment Number 0072.05

CTUIR

Comment The idea of NEPA is to identify and assess the full range of available options and technologies to address an issue -- in this case, the safe, effective, and protective treatment and disposition of dangerous Hanford high-level radioactive and hazardous mixed tank wastes. The current TWRS-EIS focuses only on retrieval of wastes and the explicit thermal treatment option of vitrification. Moreover, although 'closure' is not within the scope of the TWRS-EIS, a number of identified alternatives and considerable discussion throughout the EIS either pre-determine or limit ultimate closure options. The CTUIR SSRP, as a result of their interactions with other federal agencies, have noted that other potentially applicable technologies for tank waste treatment exist. A more broad range of applicable and feasible alternative treatment/disposal technologies needs to be systematically assessed with our consultation.

Additionally, NEPA requires a thorough scoping and assessment of key issues, a systematic set of screening or decision criteria, and a comprehensive consideration of a range of technological (or other) approaches to reach the desired endstate. The current TWRS-EIS examines only a limited set of treatment/disposal options and therefore cannot possibly compare the full spectrum of risks, costs, and benefits of alternative treatment/disposal options.

The Tank Waste Task Force (TWTF) identified that a "portfolio" of options for tank waste treatment and disposition should actively be explored, analyzed, and maintained for contingency planning purposes. The sheer complexity, diversity, and volume of Hanford tank wastes should intuitively mandate such an option-as-necessary-and-available approach.

Response A wide range of potentially applicable technologies exists for treating tank waste. One challenge was to eliminate from consideration technologies that were not viable and develop a range of reasonable alternatives for detailed analysis and presentation in the TWRS EIS. This discussion describes how the alternatives were developed.

There is a distinction between technologies and alternatives. Technologies are specific processes (e.g., cesium ion exchange) that relate to a component (e.g., retrieval or treatment) of an alternative. Alternatives include a set of technologies, or building blocks, that have been engineered to work together, forming complete systems for accomplishing the purpose and need for action. Alternatives are made up of a number of technologies linked together.

The evaluation of potential technologies for inclusion in the TWRS EIS began with a review of available technologies from a variety of sources including the Tank Waste Technical Options Report (Boomer et al. 1993), the Tri-Party Agreement (Ecology et al. 1994), Hanford Defense Waste EIS (DOE 1987), and the engineering data packages prepared by the Site Management and Operations contractor (WHC 1995a, c, e, f, g, h, i, j, and h).

The first step in developing alternatives was to screen out technologies that were not viable. The full range of available technologies for each component of the proposed action was evaluated, and technologies that were not viable were eliminated from further consideration. The technologies eliminated by this screening process are described in Volume One, Section 3.8 and Volume Two, Appendix C.

After rejecting technologies that were not viable, a large number of potential technologies remained for inclusion in the EIS. It would not be practicable to develop alternatives that include all of the potential combinations of technologies. In accordance with NEPA, representative alternatives were developed for detailed analysis to bound the full range of reasonable alternatives (DOE 1993d). Upper, lower, and intermediate bounding alternatives were developed in terms of cost, risk, and technologies for the two primary decisions that affect environmental impacts: the amount of waste to be retrieved from the tanks and the degree of separations of retrieved waste into HLW and LAW. The full range of applicable technologies and alternatives therefore is included in the EIS.

Similar to the approach used by the Tank Waste Task Force, representative alternatives were developed for detailed analysis in the EIS. There are many other viable technologies for individual components of the alternatives that could not be included. These technologies are included in Volume Two, Appendix B and constitute the "portfolio" of options that could be substituted for one of the technologies that is included in an alternative without a substantial change in the impacts of that alternative. An evaluation was performed for each of the technologies identified in

Appendix B. Where there would be changes in impacts, the changes are discussed in Appendix B. The level of analysis was dependent on the magnitude of the change on impacts.

The alternatives developed for presentation in the EIS were chosen to be representative of many of the possible variations of the alternative. The design information for all alternatives is at an early planning stage, and the details of the alternative that ultimately is selected and implemented may change as the design process matures. Therefore, the alternatives are intended to represent an overall plan for remediation at a level of detail sufficient for impact analysis and alternative comparisons.

DOE and Ecology are not aware of any other viable technology EIS for tank waste treatment. Please refer to the response to Comment numbers 0005.17 and 0072.08 for a discussion of the reasons closure was not addressed in the EIS.

Comment Number 0072.08

CTUIR

Comment The second major deficient factor is closure, both of waste treatment/disposal facilities and the tank farms themselves. The resolution of the tank waste issues are complex, time-transgressive, and fundamentally impact life-cycle costs. Closure issues, while not within the scope of this EIS, are essential to comprehensive planning for both waste retrieval and treatment from the tank farms. Additionally, closure will significantly impact long-term waste management and land consumption requirements on Hanford's Central Plateau -- a directly connected action which must be specifically assessed and coordinated with the CTUIR SSRP. A specific and incremental plan must be developed to accomplish safe and effective long-term waste management, and this necessarily requires a known endstate goal.

Response The final disposition of the tanks and associated equipment and the remediation of contaminated soil and groundwater associated with leaks from the tanks is a process called closure. Closure is not within the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. The amount and type of waste that ultimately remains in the tanks after remediation may also affect closure decisions. The Notice of Intent to prepare the TWRS EIS stated that: "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS to support tank closure, in the future (59 FR 4052)." However, some of the decisions made concerning how to treat and dispose of tank waste may impact future decisions on closure, so the tank waste alternatives provide information on how tank waste remediation and closure are interrelated. Closure options and assumptions are discussed in Volume One, Section 3.3.1 of the EIS.

Under the Tri-Party Agreement, the tanks are classified as hazardous waste management units that eventually would be closed under the State Dangerous Waste Regulations (WAC 173-303) and the requirements of the Tri-Party Agreement. Three options exist for closure of the tanks. The first option is clean closure, which would involve the removal of all contaminants from the tanks and associated equipment, soil, and groundwater until natural background levels or health-based standards are achieved. The second option is modified closure, which would involve a variety of closure methods and would require periodic (at least once after 5 years) assessments to determine if the modified closure requirements were met. If modified closure requirements were not being met, additional remediation would be performed. Modified closure is a method specific to the Hanford Site Permit under the State Dangerous Waste Regulations (WAC 173-303). The third option is closure as a landfill, which would involve leaving some waste in place with corrective action taken for contaminated soil and groundwater performed under postclosure requirements. This type of closure usually involves the construction of a low permeability cover over the contaminated media to reduce water infiltration and prevent inadvertent human intrusion. When sufficient information is available to evaluate the closure options, DOE will submit a final closure plan to Ecology for review and approval and an appropriate NEPA analysis will be completed.

Although sufficient information is not available to make final decisions on closure, some of the alternatives affect future closure decisions, so information is provided to allow the public and decision makers to understand how the alternatives would be interrelated with future closure of the tank farm system. For example, some of the alternatives addressed in the EIS involve removing most of the waste from the tanks (the ex situ alternatives) and would not substantially affect options for future closure decisions. Conversely, some of the alternatives do not involve removing the waste from the tanks (the in situ alternatives) but rather, would treat and dispose of the waste in the tanks. These alternatives include placing a low permeability cover over the tank farms to reduce water infiltration and prevent inadvertent human intrusion (e.g., Hanford Barrier). This would be considered closure as a landfill. Clean closure would be precluded by implementing one of the in situ alternatives. However, this would not address remediation of the soil and groundwater previously contaminated, so it would not represent complete closure of the tank farms. Therefore, the in situ alternatives would preclude clean closure of the tanks. The ex situ alternatives would not preclude any closure alternative. The decisions on closure will be made in the future when sufficient information is available.

For purposes of comparing the alternatives, a single and consistent method of closure was assumed for all of the alternatives. Closure as a landfill was chosen as the representative closure method for purposes of analysis and is included in all of the alternatives (except the No Action and Long-Term Management alternatives). This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. It is included to allow a meaningful comparison of the in situ and ex situ alternatives and to provide information to the public and the decision makers of the total cost and impacts of final restoration of the Site.

Because decisions on closure cannot be made at this time but are interrelated with decisions to be made on remediation of the tank waste, the EIS presents an analysis of impacts with and without closure in Section 5.0. In each applicable subsection of Section 5.0, the impacts of the activities associated with remediating the waste are presented first. This is followed by the presentation of the combined impacts of remediating the tank waste and closing the tank farms by closure as a landfill. This provides the public and the decision makers with information on the impacts of the issues that are ripe for decision making (remediation of the tank waste) and information on the total project impacts (remediation and closure) as well as how they may be interrelated with the decisions on remediation of the tank waste.

A comprehensive land-use plan (CLUP) is being developed for the Hanford Site, and another NEPA analysis will be prepared on the tank farm closure. The CTUIR will be consulted during the preparation of both documents.

Comment Number 0072.50

CTUIR

Comment It is not clear whether any of the alternatives will allow clean closure, and none of the alternatives include removal of tanks (or support structures).

Response Please refer to Comment number 0072.08 for a discussion of the relationship between the TWRS EIS and future closure decisions. Selection of the No Action, Long-Term Management, In Situ Fill and Cap, In Situ Vitrification (ISV), or Ex Situ/In Situ Combination alternatives would preclude clean closure. The extensive retrieval alternatives would not preclude any closure option. The discussion of closure in Volume One, Section 3.3 was modified to identify which alternatives would preclude clean closure.

Comment Number 0072.51

CTUIR

Comment There is an ongoing problem with failure to define retrieval and closure goals before retrieval is begun. At present, the action plan is to attempt retrieval, and then determine how well we did and therefore whether the tank farms will be closed as a landfill or clean closed.

Response DOE has plans to perform retrieval tests. The project is called The Hanford Tank Initiative and is discussed in Volume One, Section 3.2 of the Final EIS. The information gained from this program will provide data on the effectiveness of a variety of retrieval techniques. The waste retrieval goal is discussed in Volume One, Section 3.4 of the EIS. Please refer to the response to Comment number 0072.08 for a discussion of the relationship between NEPA requirements, the TWRS EIS alternatives, and closure. If an ex situ alternative is selected, the success of retrieval would be a factor in determining the type of closure performed.

Comment Number 0072.75

CTUIR

Comment P 3-18: PP 6: Because closure is not in the scope of this EIS, the CTUIR feels that this EIS is incomplete and actions to correct this should be taken, for example, by designing how a closure plan should be incorporated into this EIS.

Response Please refer to the response Comment number 0005.18 for a discussion of the reasons why tank farm closure alternatives cannot be analyzed at this time. The response to Comment number 0072.08 discusses the relationship between this EIS and future closure options. This response contains a discussion of the relationship between NEPA requirements, the tank waste remedial alternatives

evaluated, and related closure issues. DOE, in the Notice of Intent to propose this TWRS EIS, has committed to complete the appropriate NEPA analysis when data become available to support the analysis. The Tri-Party Agreement contains milestones relative to the preparation and approval of a closure plan for the SSTs.

Comment Number 0072.76

CTUIR

Comment P 3-20: PP 1: The CTUIR SSRP technical staff states that anything less than clean closure would result in excess risk to tribal members.

Response DOE and Ecology acknowledge the preference expressed in the comment and will consider this and other concerns when selecting the final action for TWRS waste. Closure will be addressed in a future NEPA analysis when sufficient data are available to provide a meaningful comparison of closure alternatives. Please refer to the response to Comment numbers 0072.08 and 0072.50.

Comment Number 0072.77

CTUIR

Comment P 3-20: PP 2: For the purposes of comparing the alternatives and as not to preclude ruling out any closure alternatives, the clean closure is, should, and will be replaced in all the following alternatives sections. Additionally it is impossible to do a meaningful comparison between in situ and ex situ alternatives.

Response Tank farm closure was presented in the EIS as a hypothetical closure scenario to demonstrate the relationship between remediation and closure to the public and the decision makers and so in situ and ex situ alternatives could be equitably compared. Using closure as a landfill as the hypothetical closure scenario does not mean that it has been or will be selected for implementation. Tank farm closure will be addressed in a future NEPA analysis when sufficient data are available to provide a meaningful comparison of closure alternatives. Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives are not appropriate for inclusion in the EIS.

Comment Number 0072.78

CTUIR

Comment P 3-20: PP 3: S 4 : Environmental restoration, waste management, and remediation together which define clean-up have been and are ripe for tank farm decision making. You can not separate a removal process from a closure process and plan for privatization without truly considering the future. This process has to be fair, open, meaningful and involve the complete integration of the affected tribes in order to insure true tank farm closure.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives are not appropriate for inclusion in the EIS. Volume One, Section 5.13 of the EIS presents an analysis of the cumulative effects of tank farm remediation and other projects at the Hanford Site. Section 5.13 has been updated to include emerging information concerning the environmental remediation program.

Comment Number 0072.79

CTUIR

Comment P 3-21: PP 4: S 2: Why is it not practical to compare the potential acceptable technologies with the alternatives considering the time and effort used to produce this document? It would seem at the very least to be a reasonable thing to do. If you could not include all of the potential combinations of technologies, how can a reader be sure you have included a full range of applicable technologies?

Response In accordance with the regulations (40 CFR 1500 to 1508) that implement NEPA, the full range of reasonable alternatives were developed and analyzed in the EIS. All other viable technologies and their impacts were also addressed in Volume Two, Appendix B. The purpose of the TWRS EIS was to evaluate reasonable methods or processes (i.e., alternatives) of removing, treating, and disposing of tank waste at the Hanford Site. Including all of the potential combinations of technologies in full alternatives would result in dozens of alternatives to be addressed in the EIS. This would be unmanageable and confusing to the public and the decision makers. Specific removal, treatment, and disposal technologies will be evaluated during the detailed design phase following approval of the Final EIS. Selected technologies will be tested against specific effectiveness and efficiency criteria during the Phase I demonstration (preferred alternative). Please also refer to the response to Comment number 0072.05 and Volume One, Section 3.3 for a detailed explanation of the process used to determine the range of technologies to include in the evaluation.

The Draft EIS addressed the full range of reasonable alternatives. The alternative identified in the comment (i.e., evaluate all potential technologies) is bounded by the alternatives addressed in the Draft EIS, and therefore, DOE and Ecology believe that including the analysis of all the potential combinations of technologies would not provide valuable additional information to the public or decision makers.

Comment Number 0072.177

CTUIR

Comment P B-29: PP2: The in situ alternative may be required by NEPA, but it violates the Tri-Party Agreement. Please insert language regarding this with all in situ alternatives for clarification purposes.

Response The in situ alternatives would not meet the requirements of the Tri-Party Agreement. The Summary, Section S.7 and Volume One, Section 6.2 discuss whether the alternatives meet all applicable laws, regulations, and agreements (including the Tri-Party Agreement). As required by CEQ, the TWRS Draft EIS identifies and analyzes the range of reasonable alternatives for the proposed action. Potential violation of existing laws, regulations, or agreements (any of which may be revised) is not considered basis for eliminating an otherwise reasonable alternative from consideration. Please refer to the response to Comment numbers 0072.80 and 0072.52.

Comment Number 0089.07

Nez Perce Tribe ERWM

Comment Page 3-32, Paragraph 1

The EIS assumed that 99 percent recovery of the tank wastes would be achieved. The remaining 1 percent of tank waste volume left in the tanks will leave a sizable volume of contamination in the tanks to continue to contaminate the vadose zone and groundwater. Future tank closure and soil remediation will not be possible without removal of all tank wastes.

Response The residual waste would likely contain a very low concentration of soluble contaminants because the large volume of liquids used to retrieve the waste would leach the soluble contaminants from the residual waste. The Final EIS presents human health risks based on two scenarios: 1) that the residual waste would contain the average tank contents; and 2) that the residual waste would have been leached to reduce the concentration of soluble contaminants that could be leached into the groundwater. Closure of the tank farms is not within the scope of the EIS. Please refer to the response to Comment number 0072.08 for a discussion of the reasons why closure of the tank farms will be addressed in a future NEPA analysis and 0005.18 for a discussion of the waste retrieval assumption.

Comment Number 0094.01

Moore, Jennifer

Comment I just want to say the thing I find the most disturbing about this EIS, well one of the things I find the most disturbing about this EIS, is the fact that they list not one, not two, but quite a few alternatives which violate the Tri-Party Agreement and other laws and standards. We are dealing with a ... laws which were put so that the public would be protected and that this clean up would keep going at a standard that eventually can ensure that people can live around this area and use the drinking water and basically not live in fear of dying of fatal cancer from being exposed to nuclear waste. The fact the Department of Energy is listing these as viable alternatives, viable options indicates that they do not seem to take the public safety into account very much and somewhat see themselves as above the law which they themselves entered into.

Response The NEPA regulations (40 CFR Parts 1500 to 1508 and 10 CFR 1021) require DOE to evaluate reasonable alternatives even if they do not comply with laws and regulations, so it was necessary to include such alternatives in the EIS. The response to Comment number 0072.80 contains an extensive explanation of NEPA requirements and the criteria used in this EIS to analyze the tank waste alternatives. Please refer to the response to Comment number 0072.05 and Volume One, Section 3.3 for a discussion of how DOE and Ecology identified the alternatives to be analyzed in the EIS. DOE and Ecology's preferred alternative would meet all applicable laws and regulations. Please also refer to the response to Comment numbers 0072.52 and 0072.177.

Comment Number 0097.01

Perry, Henry

Comment Considering that the DOE is representing us, the public, and is playing with more than fire in this situation with the possibility of placing the environment of the entire Pacific Northwest at risk, can there be any question that the EIS, that it prepares, should be prepared on the basis of the worst-case scenario and certainly in accordance with the Tri-Party Agreement previously agreed to.

Response The EIS presents a bounding analysis of the reasonable alternatives. Conservative assumptions and calculation methods are used to provide the public and decision makers with an assessment of the reasonable upper limit of the potential impacts of each alternative if implemented. These assumptions and calculation methods are fully presented in the appendices. The preferred alternative is in full accordance with the Tri-Party Agreement, and in the EIS, the Summary and Volume One, Section 6.2 identify regulatory compliance issues for each alternative. The regulations (40 CFR 1500 to 1508) which implement NEPA and other NEPA implementation guidance discourage the use of "worst case" analyses because these scenarios become unrealistic and blur the differences in impacts between alternatives. The EIS was modified to include an expanded consideration of uncertainties associated with the assumptions and analysis of environmental and human health impacts. The information is presented in Volume Five, Appendix K.

Comment Number 0098.02

Pollet, Gerald

Comment Secondly, in regards to the cost issues, the EIS should clearly compare the cost of the Phased Implementation Tri-Party Agreement path against the risks and costs of the prior Tri-Party Agreement path that were in place for a short period of time before 1994. Under the prior Tri-Party Agreement path, we would retrieve and process approximately twice as much waste by the year 2010 as we will under so-called Phased Implementation. As part of that clear analysis and depiction, the State and the U.S. Department of Energy owe the public and decision makers a clear presentation of the risk each year from delay. In other words, every year you leave more waste in a tank, you have a set of risks. That is why we are hear tonight. You can not deny it. That is ... we all agree that is why we are here. So the question is, does the public deserve to see what is the risk every year from delay. What is the risk from going forward with a path that the General Accounting Office has said may fail. That the State has said is likely to fail. Because of the Department of Energy's contracting decisions which are outside scope of this EIS, but the risks of failure are in the scope of this EIS and need to be disclosed because decision makers for the next decade sitting 3,000 miles away or in the State capital are going to look at this EIS and say, Ah, the risk of another change in the Tri-Party Agreement and another delay in vitrification of 2, 3, 4, 5, 10 years is not so great and we can not let them say that the risks are not so great.

Response The costs of the prior Tri-Party Agreement path are shown in the EIS as the Ex Situ Intermediate Separations alternative costs and the costs of the revised Tri-Party Agreement path are shown as the Phased Implementation alternative costs (without any adjustments for privatization). This information is presented in Volume One, Section 3.4 and Volume Two, Appendix B.

The Phased Implementation alternative would result in less waste being treated during the first 10 years of the project but also would result in all of the waste being treated 4 years earlier than previously required. These two factors would offset each other in terms of releases to the vadose zone before treatment. In any case, the leaks prior to completion are expected to be greatly reduced by the salt-well pumping program, which is currently underway. The Phased Implementation alternative also would decrease the potential for construction of a facility that does not function effectively and thereby reduce the potential for long program delays.

Comment Number 0101.06

Yakama Indian Nation

Comment Invalid Constraints on Scope of EIS Reflecting Lack of Systems Engineering Integration -- The lack of consideration of the impacts associated with the closure of the tank farms following removal of the bulk of the wastes and remediation of the hazardous vadose zone around the tanks is unreasonable, since an integrated systems approach to develop low impact alternatives for tank waste retrieval and tank farm decontamination and decommissioning is warranted to save financial resources and reduce worker exposure. For example, actions required to remediate vadose zones at the tank farms as part of the closure actions may greatly simplify tank waste retrieval actions, reducing costs and expediting retrieval. Cumulative impacts can only be attained when related/integrated actions are evaluated.

Response DOE and Ecology believe that there is sufficient information available to analyze alternatives for remediation of the tank waste even though a number of uncertainties exist for various aspects of the action. These uncertainties are identified in the EIS. DOE is implementing a systems engineering approach to remediation of the tank waste. The integration of tank waste remediation with tank farm closure has been difficult because there is insufficient information available on contamination in the vadose zone and past practice releases. The Notice of Intent to prepare this EIS stated that, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS to support closure, in the future" (59 FR 4052).

There is a relationship between closure and tank waste remediation because certain alternatives for tank waste remediation would preclude clean closure of the tank farms. This relationship was discussed in the Draft EIS in Volume One, Section 3.3 on pages 3-18 to 3-20. In addition, a representative closure option, closure as a landfill, was included in all of the remediation alternatives to demonstrate the relationship of closure to remediation and to allow an equitable comparison of the alternatives. This does not mean that closure as a landfill will be selected as the closure alternative, but it provides an assessment of the total potential impacts for the environment. Consistent with NEPA regulations (40 CFR 1500 to 1508), the EIS has been prepared with the most current available information.

The emerging information concerning contamination in the vadose zone was mentioned in the Draft EIS in Volume One, Section 3.4, and the Final EIS has been modified to address the data, as appropriate, in Volume One, Section 4.2 and Volume Five, Appendix K. A systems engineering approach also will be taken to the development of data and engineering when DOE performs a NEPA analysis for closure.

L.3.3.2 Cesium and Strontium Capsules

No comments were submitted for this topic.

L.3.4 TANK WASTE ALTERNATIVES

L.3.4.1 Preferences for Tank Waste Alternatives

L.3.4.1.1 Specific Preferences

Comment Number 0008.06

Evett, Donald E.

Comment I consider the No Action and Long-Term Management alternatives to be unsuitable for consideration. I believe the impact study reveals significant rationale making this alternative too high of a risk, especially for many years into the future.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please also refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives, and the response to Comment number 0072.80 for issues related to the CEQ, NEPA and the 100-year administrative control period.

Comment Number 0009.07

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) has acceptable risks to workers and offsite public. The other alternatives do not have a significant reduction in fatalities. (About 75 in 10,000 years.) It should be kept in mind that even though statistics indicate a certain level of health effects will be experienced, Hanford will continue to reduce them. The current safety record of Hanford is much better than the national average. We must assume that the good record will continue, and in fact, we must ensure it.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. As noted, the Hanford Site does have a safety record that exceeds the national average, and DOE is committed to continuing improvement of its safety performances. Please refer to Volume One, Section 5.12 and Volume Four, Appendix E, which discuss accident risk during and after remediation. Please also refer to the response to Comment number 0009.06.

Comment Number 0009.08

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) is one of the lowest cost to perform. In addition, it minimizes repository costs. We do not know what the repository costs will be, but it is unlikely that they will be lower than the current estimates.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. A discussion of factors influencing the evaluation of alternatives is provided in the Summary (Section S.6), a comparison among the alternatives is provided in the Summary (Section S.7), and a summary of the environmental impacts is presented in Volume One, Section 5.14.

A reevaluation of repository costs, which accounted for the use of larger canisters in the geologic repository, led to a reduction in repository costs for some alternatives. These revised costs have been presented in the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B. The response to Comment numbers 0081.02, 0004.01, and 0008.01 extensively discuss the issues related to repository costs.

Comment Number 0009.09

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will have the facilities constructed by 2007. This is faster than most of the alternatives. Speed is very important because it seems that Hanford, as time goes on loses its concentration and wants to do something else. The number of canceled projects is very large, and very expensive.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of project completion is but one of many factors that influence the evaluation of alternatives. Other factors analyzed include short- and long-term risk to human health and the environment, technical uncertainty, cost, and regulatory compliance. Please refer to the response to Comment numbers 0009.08 and 0009.10.

Comment Number 0009.11

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) does not meet all of the regulations; however, they can be negotiated to be modified to assure that the public is adequately protected. The Tri-Party Agreement is a good place to document the negotiations.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The ability of the alternatives analyzed in the EIS to comply with Federal and State regulations is presented in the Summary (Section S.7) and discussed in detail in Volume One, Section 5.7.

Comment Number 0009.16

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the cost (for the Preferred Alternative) is not the lowest that provides adequate protection of the public.

Response DOE and Ecology acknowledge the objection to selection of the Phased Implementation alternative as the preferred alternative, and this comment and other public comments will be taken into consideration when making a final decision on remediating TWRS waste. Please refer to the response to Comment number 0009.15. As discussed in the Summary (Section S.6), there are a number of factors that influence the evaluation of the alternatives. Cost was one factor analyzed for each alternative. The results of the impacts analysis are presented in the EIS in an objective, nonvalue-laden (e.g., less or more cost is preferable) manner for careful consideration by the public and decision makers. Cost comparison of the alternatives was never conducted in the absence of all other factors, which included risk to human health and the environment, long-term land use restrictions, and regulatory compliance. Furthermore, for the final EIS cost impacts associated with HLW storage at the proposed geologic repository have been presented separate from costs associated with the waste management, retrieval, treatment, and disposal or disposal onsite. For example in comparing the Ex Situ/In Situ Combination 1 alternative to the Phased Implementation alternative, the cost of long-term land use restrictions and risk to human health and the environment, as well as cost, monetary or other, of not complying with current regulatory requirements were analyzed equally. Please refer to the response to Comment number 0081.02 for discussions of cost issues related to the alternatives.

Miscellaneous Preferences

Comment Number 0001.01

Bell, Robert C.

Comment There currently exists containment technology that could completely seal off the leaking nuclear contaminants from migrating through the earth and contaminating the groundwater. However, it appears that no monies have been budgeted for the containment of the leaking nuclear waste. By containing the leaking storage tanks the public along with all life would be protected from the most toxic and deadly nuclear waste. I urge you to actively support the request to the United States Congress for funds to pay for the containment of the leaking tanks at Hanford.

Response Subsurface barriers are addressed in the EIS as a containment technology that could be applied to control tank leakage. The function of the subsurface barriers would be to prevent leakage of tank waste from migrating beyond the barrier into the vadose zone, which would help minimize the volume of contaminated soil. The possible use of subsurface barriers was derived from concerns about using hydraulic sluicing for retrieval, and because some of the SSTs either are confirmed or assumed leakers. Also, a study titled Feasibility Study of Tank Leakage Mitigation Using Subsurface Barrier (Treat et al. 1995) was completed in support of a Tri-Party Agreement milestone and was one of the references used during preparation of this EIS. The feasibility study assessed the application of existing

subsurface barrier technologies and the potential of existing technologies to meet functional requirements for SST waste storage and retrieval activities. Information on subsurface barriers is included in Volume Two, Section B.9.

In addition, the current TWRS program involves a wide variety of ongoing activities that include monitoring the integrity of tanks and characterizing the vadose zone around the tank farms to detect leaks. DOE also conducts numerous activities to provide continued safe storage of the tank waste, such as the saltwell pumping program, which involves removing retrievable liquids from SSTs to minimize potential future leaks. These ongoing programs are described in Volume One, Section 3.2.

This EIS addresses the full range of reasonable alternatives. This includes 10 tank waste alternatives ranging from no action to extensive retrieval. Risk to human health and the environment was among the factors considered by DOE and Ecology in identifying the preferred alternative, Phased Implementation (a discussion of factors that influence the evaluation of alternatives is presented in the Summary, Section S.6). Volume One, Section 5.13 (Cumulative Impacts) addresses actions at other DOE sites, programmatic actions, and actions at the Hanford Site that could impact the TWRS actions, including the Hanford Remedial Action Program. The proposed TWRS activities would be carried out against the baseline of overall Hanford Site operations. Volume One, Section 5.11 and Volume Three, Appendix D detail the anticipated risk for each alternative.

DOE and Ecology acknowledge the recommendation expressed in the comment regarding funding. However, Congressional funding issues are not included in the scope of this EIS.

Comment Number 0040.01

Rogers, Gordon J.

Comment The In Situ Fill and Cap alternative is clearly the best choice. The cost is low enough to have some real chance of being funded by Congress. It reaches a reasonable stage of completion in the shortest time. The short-term impacts are trivial. The long-term impacts appear likely to be small and acceptable providing that onsite use of groundwater is prohibited; and further than onsite farming and irrigation is prohibited.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Short- and long-term environmental impacts, uncertainties, and regulatory compliance are among the factors influencing the evaluation of alternatives. A discussion of these and other factors influencing the evaluation of alternatives is provided in the Summary, Section S.6, a comparison among the alternatives is presented in the Summary, Section S.7, and a summary of environmental impacts is provided in Volume One, Section 5.14.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, although Congressional funding issues associated with implementation of the alternatives were not included in the scope of the EIS. Please refer to the discussion contained in the response to cost concerns related to a comparison of the alternatives contained in Comment number 0081.02.

Comment Number 0072.11

CTUIR

Comment Of the alternatives presented, the CTUIR SSRP technical staff prefers Ex Situ with Extensive Separations because the cost is comparable, the volume of waste is comparable, the technical uncertainty is no higher than the other ex situ alternatives, and the activity of the LAW would be substantially lower than with less extensive separations. The phased approach will not be practical since substantially more land is required for two sets of vitrification facilities rather than the one set required for the non-phased options.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Multiple factors, including land-use commitments, influence the evaluation of alternatives. Among the factors are short- and long-term environmental impacts, regulatory compliance and uncertainties. These factors are addressed in the EIS in the Summary, Section S.6. In the Summary, Section S.7 contains a comparison of the alternatives based on various evaluation factors and Volume One, Section 5.14 provides a summary comparison of all of the environmental impacts addressed in the various sections of Volume One, Section 5.0 and the supporting appendices. The response to Comment number 0081.02 contains a discussion of the comparison impact of separating repository costs from retrieval and treatment costs of the ex situ alternatives.

Land use commitment impacts were analyzed in detail in Volume One, Section 5.7. Based on that analysis, Volume One, Section 5.19 identifies potential land use restrictions as a potential environmental justice concern for affected Tribal Nations. Volume One, Section 5.20 identifies potential mitigation measures that could be implemented to address the land use impacts identified in Section 5.19. For the Final EIS, these sections of the Draft EIS were revised to reflect technical information unavailable at the time the Draft EIS was published.

Comment Number 0085.02

Klein, Robin

Comment While it is true that a clearly proven, good solution does not exist, it is also true that the liquid wastes must not remain in these tanks. The leaking tanks are the greatest source of waste contaminations to the soils. Contaminated waste originating from the tanks are moving toward groundwater. Groundwater contaminated with Hanford pollutants already in the soils is now in communication with the Columbia River. Cleaning up waste once in the soils will take heroic efforts. Once they get into the river, the long lived contaminants are practically irretrievable. The single most affective measure we can take to protect the river in the long run is to stop the driving force that enables rapid migration of the wastes offsite, get the waste out of the leaking tanks soon. So it is important to have an aggressive plan in place.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology are committed to protecting the Columbia River. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0088.03

Porter, Lynn

Comment There's an article in the Oregonian Sunday March 17th, that raised a whole lot of questions. This was a large article beginning on the front page quoting a panel of scientists from the National Research Council, whoever that is, I probably should know, but I don't. And they're saying just leave the stuff in the tanks. They quote some DOE engineers saying yes we can do it. And one of the points that puzzled me was they're saying in this article, the National Research Council says that before you can sluice out these tanks you have to seal the ground underneath them. I didn't find anything about that in the summary of the Draft EIS, except for the ISV option. So I don't know where this comes from, but their point seems to be that if you're going to have to seal the ground anyway, you might as well leave the stuff in the tanks. That's something I would have like to of heard discussed.

I think the problem is that this kind of thing keeps coming up. And so of course we wonder where's it coming from. There seems to be a lot of energy behind this idea we'll just leave the stuff in the tanks and put it cap on it and walk away. I'm glad to hear that isn't the feeling at the top. But since it keeps coming up in such volume, we wonder what's going on, like is this a trial balloon. If it is, I'd like to shoot it down. I just think leaving the stuff in the tanks is a completely unacceptable alternative. And I wish someone would take this idea out and bury it and drive a stake through it's heart.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The National Research Council, in the cited article, advocated an alternative that evaluated the impact of not removing waste from selected tanks. This alternative, which corresponds to the Ex Situ/In Situ Combination 1 and Ex Situ/In Situ Combination 2 alternatives evaluated in the EIS, is not the preferred approach endorsed by DOE and Ecology. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and Comment number 0001.01, which discusses subsurface barriers as this issue relates to leak containment.

Specific Preference for Ex Situ/In Situ Combination Alternative

Comment Number 0009.05

Broderick, John J.

Comment The above reasoning has lead me to recommend you select the following remediation alternative: Ex Situ/In Situ Combination. I believe the Preferred Alternative is doomed to be not completed because it is trying to avoid leaving waste in place, will take too long to construct, and will cost too much. In addition, there is a possibility that the whole issue will again be revisited at the beginning of the second phase. This will be another opportunity to change the remediation approach.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0009.06 for a description of revisions to the alternatives in the Final EIS, 0009.08 for a description of the factors considered when evaluating alternatives, and 0009.09 for a description of the time required to implement alternatives.

Comment Number 0009.06

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) selects the actions based on long term health effects, rather than a "one size fits all" approach.

Response The ex situ/in situ combination alternatives are based on reduction of human health risk and different tanks having much different contents, therefore representing differing potential long-term impacts to human health. For the Final EIS, two ex situ/in situ combination alternatives are analyzed in detail. Volume One, Section 3.4 and Volume Two, Appendix B provide a description of the two alternatives and the potential impacts associated with each alternative are analyzed in Volume One, Section 5.0 and associated appendices.

Comment Number 0009.10

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will deal with more waste faster than other, more extensive alternatives. Thus there will be less effort expended in just managing the waste.

Response DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of completion of the project was one of many factors that influence the evaluation of alternatives (please refer to the response to Comment number 0009.08). Duration of construction and remediation is directly proportional to the nature and volume of tank waste, as well as the complexity of the tank farms as a whole (i.e., vadose zone contamination, groundwater migration, and closure). The preferred alternative, using a phased approach, would allow evaluation and optimization of the technologies used to treat the waste form and nature to be retrieved, which would enable the Agencies to apply "best fit" for the waste type. A summary of the environmental impacts of all alternatives analyzed in the EIS is presented in Volume One, Section 5.14 and a comparison of the alternatives is presented in the Summary (Section S.7).

Comment Number 0009.12

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will provide means so the waste will not migrate from its disposal location. Still, there will be waste present, so there must be a continuing program to restrict farming, groundwater use, and intrusion. This program will be much less expensive and less complicated than removing all waste from Hanford.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. For purposes of analysis in the EIS, institutional controls for this and other alternatives would end 100 years following the end of remediation. Thus, the long-term impacts assume unrestricted use of the Site for farming and potential use of groundwater as well as intrusion into the waste disposal onsite. Therefore, while the cost, technical complexity, and short-term impacts of the combination alternatives are less than that of the ex situ alternative; long-term impacts tend to be higher. For a comparison of the alternatives, please refer to the Summary, Section in 5.7.

Comment Number 0009.15

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the extra effort (for the Preferred Alternative) does not significantly reduce the fatalities expected, even though all the waste is removed.

Response DOE and Ecology acknowledge the preference expressed in the comment, but have identified the Phased Implementation alternative as the preferred alternative for the reasons described in the Summary (Section S.7). As discussed in Section S.6, there are a number of factors that influence the evaluation of the alternatives including short-term and long-term impacts, uncertainties, and compliance with laws and regulations. Please also refer to the response to Comment number 0098.06 for more information about risk calculation. Reduction in fatalities is one method of comparing alternatives; however, other issues such as regulatory compliance, long-term reduction in potential risks to human health and the environment, and implementability in light of technical uncertainty must also be considered.

Comment Number 0009.17

Broderick, John J.

Comment The Preferred Alternative is not acceptable because there will be significant repository costs (for the Preferred Alternative). The costs are uncertain now because we do not have a repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The repository cost for each alternative was calculated to provide the public and decision makers with information associated with the total potential costs of the various alternatives. Based on new information made available since the publication of the Draft EIS, repository costs have been substantially revised for the Final EIS (Volume One, Section 3.4 and Volume Two, Appendix B). A discussion of the methodology used to calculate repository costs, the cost associated with each alternative, cost formulas, and canister size issues, is contained in the response to Comment numbers 0081.02, 0004.01, and 0008.01.

Comment Number 0009.18

Broderick, John J.

Comment The preferred alternative is not acceptable because the construction of facilities will not be completed until 2012 (for the preferred alternative). This is way too long, our experience is that long duration projects often do not reach the operational phase.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Phase 1 of this alternative (construction and operations) would be completed in 2007. Phase 2 construction would be completed in approximately 2011. DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of completion of the project is but one of many factors that influence the evaluation of alternatives. Please refer to response to Comment numbers 0009.09, 0009.10, and 0098.02, which discusses issues related to construction starts and duration and the impact of the phased approach on the volume of waste treated.

Comment Number 0009.19

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the phased approach is not needed. We can build the facilities with existing technology. As our knowledge and experience increase over the next 45 years, we can modify the facilities. We will need to do that anyway to keep up with technology and safety requirements.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The preferred alternative, Phased Implementation, represents near-term use of currently available technologies to the extent possible. Phase 1, also known as the demonstration period, will assess the capability and effectiveness of existing technologies to retrieve and treat the waste and provide DOE with information on retrieval efficiencies, blending practices, separation efficiencies, vitrification techniques, and costs prior to constructing and operating full-scale facilities. This will result in more efficiently designed and operated facilities for Phase 2. The implementation schedule for the preferred alternative is consistent with Tri-Party Agreement milestones, as well as concurrent with other programmatic and systems activities currently conducted at the Site. Because the phased approach is designed to implement "learn as you go" improvements, system optimization and cost savings are expected. This approach and resulting benefits may be less likely with a fixed, less flexible technology or implementation of full-scale facilities without a demonstration phase. For a discussion of the phased approach to alternative implementation, see Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to the response to Comment number 0098.02 for a discussion of schedule and treatment volume estimates associated with the preferred alternative.

Comment Number 0029.01

Bartholomew, Dale C.

Comment I believe that the Ex Situ/In Situ Combination alternative offers the best balance between risk and benefit of the proposed alternatives and should be selected as the preferred alternative for the following reasons:

It offers the highest real value. It provides a level of safety to the public commensurate with other sub-surface contamination immediately adjacent to some of the tanks, adjacent to the 242-S evaporator, and sites such as cribs throughout the 200 Areas as well as other contaminated areas adjacent to the 200 Areas such as BC Crib. If my understanding is correct, no further action is planned on these other sites. Therefore, totally uncontrolled access by the public would be unacceptable, and I recommend that a waiver be obtained for relief for tank wastes from the regulations. This may be politically incorrect, but makes the most sense in the context of a balanced total system.

Retrieval of wastes from all SSTs, DSTs, and MUSTs is a huge waste of money if the soil contamination sites outside the tanks are not also ameliorated.

I also believe retrieval of wastes from all tanks creates a higher-than-projected exposure of working personnel to both occupational and radiological accidents and injuries. I have no data to support this. However, my experience suggests that the input data for the calculations may not be realistic.

The Summary Table indicates that the Ex Situ/In Situ Combination alternative and the preferred alternative are both rated "moderate" with respect to Technical Uncertainty. I believe the degree of technical uncertainty associated with the Ex Situ/In Situ Combination is less than the preferred alternative because only one-half of the waste volumes would be vitrified and sent to the repository with the Ex Situ/In Situ Combination alternative, (50 percent of the tanks would be filled and capped). It should have received a lower Technical Uncertainty rating because of scaled-down throughput requirements.

I suspect when wastes from all of the tanks are retrieved, there will be several SSTs thought to be non-leakers that will be found to be leakers. That will only add to existing soil contamination during sluicing.

I noticed where the U-238, Tc-99, C-14, and I-129 isotopes were to be retrieved. I fully support this action. I may have read the document too quickly, but I did not notice any reference to TRU wastes. Obviously, these must also be removed and vitrified.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The following responses are in the same order as the comments.

Short-term and long-term impacts to human health and the environment, managing the uncertainties associated with the waste characteristics and treatment technologies, cost, and compliance with laws, regulations, and policies are among the factors considered when evaluating the alternatives (please refer to the response to Comment number 0009.08). No decision has been made regarding remediation of subsurface contamination adjacent to the tanks or in the other areas referred to in the comment. Contamination from past tank leaks is beyond the scope of this EIS (see Volume One, Section 3.3 and the response to Comment number 0072.08). Other contamination of soils in the 200 Areas is the subject of the Hanford Remedial Action EIS and subsequent Comprehensive Environmental Response, Comprehensive Environmental Response Compensation and Liability Act (CERCLA) decisions. The TWRS EIS presents the cumulative impacts of the tank waste alternatives and the 200 Areas contamination in Volume One, Section 5.3).

The retrieval of wastes from the SSTs, DSTs, and MUSTs and their subsequent remediation is considered in this EIS. Tank waste retrieval and treatment is the first step in remediation of the tank farms. The remediation of soil contaminated sites outside the tanks will be considered in other environmental documentation, such as the Hanford Remedial Action EIS. The EIS analyzes a range of alternatives from no waste retrieval to extensive waste retrieval.

Each of the alternatives presents differing trade-offs among short-term and long-term environmental impacts, technical uncertainty, and regulating compliance. Additionally, alternatives that involve no retrieval or partial retrieval, such as the ex situ/in situ combination alternatives would influence the closure actions that could be implemented, as discussed in Volume One, Section 3.3. Implementation of these alternatives would limit or potentially increase the cost and complexity of the future closure actions such as remediation of contaminated soils. Extensive retrieval alternatives would provide the least complications and cost impacts on future closure actions.

The risks to the workers during construction and operation of the retrieval and transfer facilities for the ex situ alternatives have been analyzed for all the alternatives. The results of this analysis are given in Volume Four, Appendix E and in Volume One, Section 5.12. In general, risks to the workers are less when less retrieval and transfer are conducted. Regardless of the alternative selected, DOE would complete a detailed safety analysis of the alternative to determine additional safety measures for implementation. Please refer to the response to Comment number 0098.06 for risk calculation information.

The technical uncertainty of an alternative is a compilation of numerous factors, such as similarity to other like operations, the history of demonstrated performance of the technology, the ability to construct and operate the alternative given the conditions at the Site, and others. However, if two technologies are operating at roughly the same scale and production rate, the technical uncertainty is not a direct function of the throughput requirement. The ability to design, construct, and operate the Phased Implementation alternative and the ex situ/in situ combination alternatives are approximately the same. Both alternatives have approximately the same degree of process development, consequently, the two processes will be rated about equal in their technical uncertainty.

To account for leakage from the SSTs during retrieval, the EIS assumes an average of 4,000 gallons of leakage from each tank (see Volume One, Section 5.2 and Volume Four, Appendix F). It is not expected that all SSTs will leak this amount. Some SSTs will not leak during retrieval, and as the comment suggests, some SSTs will develop unexpected leaks. It has been assumed in the EIS that the total leakage divided by the number of tanks will be bounded by the 4,000-gallon figure. For tanks that are known leakers or that develop leaks during retrieval, the EIS presents technology options to sluicing, such as robotic arm-based retrieval, that would involve substantially lower volumes of liquids (see Volume One, Section 3.4 and Volume Two, Appendix B).

The purpose is to retrieve the radionuclides that are the chief contributors to long-term risk (i.e., uranium-238, technetium-99, carbon-14, and iodine-129). Neptunium-237, a TRU isotope, is also a contributor to long-term risk, and this alternative shows a calculated retrieval of approximately 93 percent for this isotope. There is a large calculated proportion of other TRU elements that would be retrieved, but do not move quickly enough in the vadose zone and groundwater to contribute to risk within 10,000 years.

Specific Preference for the Phased Implementation Alternative

Comment Number 0012.01

ODOE

Comment Governor Kitzhaber and Oregon strongly support the preferred alternative in the environmental impact statement (EIS). This alternative calls for a retrieval of all of the tank wastes technically possible (estimated at 99 percent of the wastes) and vitrifying the wastes. While the vitrified wastes will still be radioactive, they will be safer to store and not susceptible to leakage pending ultimate disposal.

Although we support the preferred alternative, it will not resolve all the issues related to the high-level wastes at Hanford. We believe there will continue to be the need for ongoing monitoring, characterization, and pumping and treating of groundwater contamination caused by waste which has leaked and migrated from the tanks.

Response DOE and Ecology acknowledge the preference of the State of Oregon for the preferred alternative, and will take this preference and other public comments into consideration when selecting the final action for TWRS waste. The issues identified were among the factors considered by DOE and Ecology in identifying the preferred alternative.

The Hanford Site will require ongoing monitoring and characterization relative to past tank leaks and the migration resulting from those leaks into the surrounding environment. The characterization and monitoring programs are discussed in the response to Comment numbers 0072.61, 0072.63, 0072.67, and 0072.70. Each of the alternatives includes continuation of existing programs to characterize vadose zone and groundwater contamination and long-term monitoring programs that extend beyond the completion of the tank waste action (Volume One, Section 3.4 and Volume Two, Appendix B). As more information becomes available regarding the environmental consequences of past leaks and the nature of residual waste remaining in the tanks following retrieval, DOE will be able to address actions associated with tank farm closure, including the potential for pumping and treating groundwater contamination beneath the 200 Areas (see Volume One, Section 3.3 for a discussion of closure). It is because of the lack of adequate data regarding these issues that the closure of the tank farms is not included in the scope of this EIS. Please refer to the response to Comment number 0072.08.

Comment Number 0012.03

ODOE

Comment Leaving wastes in the tanks poses huge risks. The tanks are corroding and failing. As they fail, the radioactive waste is released to the soil and ultimately to the groundwater and to the Columbia River. Vitrifying the tank waste makes it far more stable and greatly reduces the threat to the public and the environment. While the cost of the preferred alternative is substantial, it is the only alternative which satisfactorily deals with the dangers presented by these wastes as quickly as practical. The phased approach allows USDOE to get on with cleanup while allowing for possible development of better approaches which remove all tank wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The issues identified were among the factors considered by DOE and Ecology in identifying the preferred alternative, Phased Implementation. Please refer to the response to Comment number 0009.19 for reasons the Phased Implementation was identified as the preferred alternative.

Comment Number 0012.07

ODOE

Comment The preferred alternative relies on proven technology and a phased approach. This allows a "learn as you go approach" which should identify problems earlier and at a smaller economic and environmental cost.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The issues identified were among the factors that influence the evaluation of alternatives. Please refer to the Summary, Section S.6 and S.7 and the response to Comment numbers 0009.08 and 0009.19.

Comment Number 0012.09

ODOE

Comment The current risk modeling and analysis are too simplistic to allow detailed decisions which call for leaving part of the wastes in place and still protect human health and the environment. We believe the risk assessment in this EIS is sufficient to support the proposed alternative and to conclude that the risks are too large to allow any of the tank waste to remain in the tanks at the end of cleanup.

Response The risk modeling and assessment performed for this EIS used the best available data, state-of-the-art models, and industry standard approaches and techniques and is both comprehensive and detailed. The data generated by the modeling and assessment provided for a balanced and equitable comparison among the alternatives and as such, provided results that were useful in comparing the potential short-term and long-term human health and environmental impacts. To the extent that the risk assessment provided sufficient data to evaluate the preferred alternative, it also provided equally valid data to support the evaluation of all alternatives, including alternatives involving leaving some or all of the waste in place. For the Final EIS, an appendix (Volume Five, Appendix K) was added to the EIS to provide a basis for understanding uncertainties associated with the risk assessment, as well as other areas of uncertainties.

Comment Number 0022.03

Sims, Lynn

Comment We know millions of gallons of waste have already leaked from the tanks and migrated towards groundwater. This relentless assault upon the environment will not cease without intervention. We are not certain of the environmental and human health damage which has and will result from leaking tanks, but forecasts are ominous. The only responsible alternative is the preferred alternative which removes as much waste as possible and isolates them from the environment by vitrification.

Response DOE and Ecology acknowledge the preference expressed in this comment and will take into consideration this preference and other public comments when selecting the final action for TWRS waste. DOE has implemented a program to remove as much of the liquids as practicable from the SSTs to reduce the likelihood of future leaks. A discussion of this program is provided in Volume One, Section 3.4 and Volume Two, Appendix B. An analysis of potential cumulative impacts, including past leaks is presented in Volume One, Section 5.13 and new information regarding the extent of migration of past leaks to the vadose zone and groundwater has been included in Volume Five, Appendix K. The ongoing characterization and monitoring program is discussed in the response to Comment numbers 0072.61, 0072.63, 0072.67, and 0072.70.

Comment Number 0032.04

Heacock, Harold

Comment We support the Department's preferred alternative of phased implementation of an ex situ intermediate separations process, which provides for the greatest protection of the environment, including protection of the groundwater consistent with a reasonable projected cost, the disposal of the vitrified high-level waste at a national waste repository, and an acceptable degree of risk.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Pleaser refer to the response to Comment number 0009.19 for a discussion of the reasons Phased Implementation is the preferred alternative.

Comment Number 0035.08

Martin, Todd

Comment I would like to address what I think is good in the EIS. We support the pretreatment selection in the preferred alternative.

Intermediate separations is appropriate. HEAL would vigorously oppose any movement towards extensive separations pretreatment process.

The stakeholder community in the Northwest has made it very clear that intermediate separations is responsive to our values. It is available relatively, and it will reduce the waste volume by a satisfactory amount.

Secondly I support the assumption that 99 percent of the waste will be retrieved. The risks in the EIS show very clearly that the only responsible alternative is to retrieve all of the waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0005.38 for a discussion of issues related to pretreatment. The response to Comment number 0012.19 contains a detailed discussion of the extent to which the public has made a positive impact on this document.

Comment Number 0036.10

HEAL

Comment HEAL supports the full retrieval of Hanford's tank wastes. The preferred alternative's retrieval scenario is responsive to the stakeholder values. It has always been assumed that Hanford's tank wastes post a great risk to future generations. This EIS confirms the assumption. The EIS shows that future risk is directly correlated to the amount of waste left behind. The impact of leaving only a small portion of contamination behind is evidenced by the difference in long-term risk for the preferred alternative where 1 percent of the waste is left and the Ex Situ/In Situ alternative where 10 percent of the waste is left behind. By leaving 9 percent more waste behind, the risk for residential farmer at 5,000 years would increase by a factor of 10. These high risks clearly show that the only responsible solution is to retrieve all of the waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Impact to the public welfare, including residential farmers, was a factor analyzed for all alternatives. Please refer to the response to Comment number 0009.05. The environmental impacts of all the alternatives analyzed in the EIS are summarized in Volume One, Section 5.14. Potential long-term health effects are summarized for each alternative in the Summary, Section S.7.

Comment Number 0038.03

Reeves, Merilyn

Comment Now, the board supports the full retrieval from Hanford tank waste. The preferred alternative retrieval scenario is responsive to the board's value.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0009.19 for a discussion of the reasons the Phased Implementation alternative is the preferred alternative.

Comment Number 0038.05

Reeves, Merilyn

Comment The Board supports the preferred alternative's pretreatment process. And again, we go back to the Tank Waste Task Force, which stated the high cost and uncertainty of high tech pretreatment and R and D threatens funding for higher performance low level waste form vitrification and cleanup.

Use the more practical, timely, available technology while leaving room for future innovations. Keep a folio of technology options and make strategic investments over time to support the limited number of promising options. Give up further research on unlikely options. Again a statement from 1993.

The intermediate separations case is responsive to this value although the difficult challenge of technetium removal in the Phased Implementation alternative is a concern to the Board.

And the Board would strongly oppose any movement towards extensive separations pretreatment technology.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.05 for a description of how the alternatives analyzed in the EIS were identified and methods for analyzing technology options in the EIS.

Implementing Phase 1 of the preferred alternative would allow evaluation of existing technologies while moving forward on retrieval and treatment goals. As the demonstration phase progresses, the efficiencies and effectiveness of the retrieval and treatment technologies, including technetium separation, can be evaluated and optimized. Technetium removal could be implemented during Phase 1 using established separations technology or emerging technologies that show promise in keeping with recommendations of the board. One way of removing technetium-99 from alkaline waste solutions is to selectively sorb the isotope, as TcO_4, using a strong-base organic ion-exchanger (WHC 1995a).

Comment Number 0042.01

EPA

Comment The EIS addresses the treatment, storage, and disposal of Hanford Tank Waste to meet the requirements of the Hanford Federal Facility Agreement and Consent Order and the Resource Conservation and Recovery Act as amended by the Hazardous and Solid Waste Amendments of 1984. As a signatory to the Agreement and Consent Order, EPA has endorsed the approach identified in the Draft EIS as the preferred alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0005.07.

Comment Number 0043.02

Hanford Communities

Comment In its selection of an alternative for the cleanup of tank wastes, we believe that the Department of Energy must comply with State and Federal laws and must also comply with its commitments under the Tri-Party Agreement. We believe that the Department should proceed with an ex situ process of extensive waste retrieval with phased implementation. This process appears to have the strongest backing of people in this area and provides the best long-term environmental solution.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology intend to comply with all Federal, State, and local regulations and ordinances applicable to tank waste remediation. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0076.01

Blazek, Mary Lou

Comment I had passed out a comment, or a formal comment that I would like to have read into the record. I won't do that now, it would be lengthy. I just like want to say on the record that Governor Kitzhaber and the Oregon Department of Energy strongly support the proposed alternative in this Environmental Impact Statement. The retrieval for all the tank waste that are technically possible, up to 99 percent we think is critical that occur. The need for this undertaking is compelling in our minds. The potential impact to the Columbia River cannot be impacted in this way.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology remain committed to protecting the Columbia River and the analysis of potential impacts of TWRS alternatives includes impacts to the River as presented in Volume One, Section 5.2 and Volume Four, Appendix F. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of

alternatives.

Comment Number 0076.02

Blazek, Mary Lou

Comment The other alternatives under consideration leave most, or all of the waste in the tanks, with the exception of the in situ vitrification, which is an immature and unproven technology. Other alternatives do little to remove the hazards posed by the waste. The major criteria that must be applied to any decision is the protection of public health and safety and the environment. This criteria eliminates all of the alternatives, which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, although it's an immature and unproven technology. Because the in situ vitrification technology is uncertain, we oppose all of the alternatives, which leaves the waste in Hanford tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and 0005.18, which discusses tank waste residuals.

Comment Number 0077.03

ODOE

Comment Sacrificing Hanford in this way does not adequately reduce the harm and risks to the environment or to future generations. For these alternatives, the risk analyses in the EIS show massive plumes of radioactive material slowly moving across the Hanford site and into the Columbia River for hundreds to thousands of years.

Cost should not be the sole or even predominant criteria used to select among the alternatives. The first criteria that must be applied is protection of public health and safety and the environment. This criteria eliminates all of the alternatives which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, although it is an immature and unproven technology for tank waste. Because in situ vitrification technology is uncertain, the potential for failure is unacceptably high. We strongly oppose all of the alternatives which leave the waste in Hanford's tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Removing, treating, and disposing of the tank waste would be the first step in providing protection to the vadose zone, groundwater, and the Columbia River. Please refer to the response to Comment numbers 0076.02, 0040.01 and 0005.18 for more information. The response to Comment number 0009.16 contains a discussion of the analysis of cost alternatives.

Specific Preference for Vitrification

Comment Number 0047.01

Ahouse, Loretta

Comment The wastes that are in the tank farms at Hanford must be dealt with at all costs. My preference is to see that all of the tank waste be removed and vitrified, regardless of whether or not the vitrified logs are ever moved to Yucca Mountain, Nevada.

It is an undisputed fact that the tanks at Hanford have leaked, although there appears to be a question of how far and how fast. Despite this, we do know that the tanks leak and may pose a potential danger to the groundwater under the Hanford site, and ultimately the Columbia River. For this reason, all of the waste that is technically feasible to remove, must be removed and immobilized in a safe manner. This should not be an issue of costs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. As more information becomes available from the ongoing vadose zone and groundwater monitoring and characterization program, DOE will be able to address issues related to tank farm closure. The EIS has been modified to include information on vadose zone contamination in Volume One, Sections 4.2 and 5.13 and in Volume Five, Appendix K. Vadose zone contamination is also discussed in the response to Comment number 0012.15.

Comment Number 0047.02

Ahouse, Loretta

Comment I do not agree with any plans which would leave a portion of the waste behind in the underground tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

The preferred alternative assumes 99 percent retrieval of the tank waste. In a separate NEPA review, DOE intends to consider alternatives to tank farm closure. The EIS analysis addresses a range of alternatives that includes leaving all or a portion of HLW onsite, as well as alternatives that retrieve from the tanks as much waste as practicable (assumed to be 99 percent). Decisions associated with the

extent of retrieval will be supported by the TWRS EIS; however, the decisions on closure are not within the scope of the TWRS EIS. Please refer to the response to Comment numbers 0005.18 (assumption used in analysis of alternatives), 0072.08 (a discussion of closure), and 0072.05 (NEPA requirements for analysis of alternatives).

Comment Number 0079.02

Knight, Page

Comment One of the proposal alternatives is to take wastes from only from the double-shell tanks which are not yet leaking, vitrify them, and fill the single-shell tanks with sand and in effect walk away. This would possibly push the liquid waste deeper into the ground, hastening the contamination flow to the groundwater, and thus to the Columbia River. Presently, at the T tank farm, plutonium has become bound up in chemicals of the tank waste, and is moving rapidly toward groundwater. This is an inkling of what is to come in the next 100 years if the waste is left in the tanks. This is thus, an unacceptable alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The TWRS EIS addresses the management, retrieval, treatment, and disposal of the tank waste and does not address closure of tank farm residuals, equipment, or soil contamination. For the purposes of this EIS, closure as a landfill was assumed, but this closure assumption contained in the EIS will not be used to identify a closure alternative in the TWRS ROD. Closure will be addressed in future NEPA documents. Please refer to response to Comment number 0072.05 for additional closure information.

DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River. The EIS analyzes the impacts to groundwater associated with each of the alternatives in Volume One, Section 5.2 and Appendix F. The Final EIS has been modified to include a discussion of emerging data on vadose zone contamination beneath the tank farms. This discussion is provided in Volume Five, Appendix K. Please refer to the response to Comment number 0076.02.

L.3.4.1.2 General Preferences

Miscellaneous Preferences Related to Remediation

Comment Number 0009.03

Broderick, John J.

Comment Over the past decade, Hanford has demonstrated that it can not complete a project that takes a long time to construct. Grout, the new tank farm and HWVP come to mind in this regard, but there are many others. The many canceled projects have spent hundreds of millions of dollars with nothing to show for the effort. Each time there seems to be a good reason to cancel - but the percentage of canceled projects is very high. For this reason, the remediation of the tank waste must be done in facilities that can be constructed in a short period of time.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Volume One, Section 3.4 and Volume Two, Appendix B contain the implementation and completion schedule for each alternative. The Preferred Alternative identified in the EIS is consistent with the proposed remedy contained in the Tri-Party Agreement and the remediation schedule milestones in the Tri-Party Agreement. In addition, the existing schedule has been accelerated by approximately two years as a result of concurrent TWRS activities. Please refer to the response to Comment numbers 0009.10 and 0009.18 for a discussion of issues related to implementation of the preferred alternative, including projected construction completion dates. Please also refer to the response to Comment numbers 0055.06 and 0009.16 for a discussion of issues related to the consideration of cost in the alternatives analysis and the applicability of the HWVP to the preferred alternative.

Comment Number 0009.04

Broderick, John J.

Comment The National debt is increasing every year. There are strong pressures to reduce the deficit, and the debt itself. We have already seen the DOE budget drop substantially; and there are pressures to cut it even more. For this reason, the remediation of the tank waste must be done at the lowest possible price.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. DOE and Ecology believe that there is a potential to reduce the cost for tank waste remediation by allowing the market place to establish, through the competitive bidding process, the cost for waste treatment. Please refer to the response to Comment number 0036.15 for more information. The environmental impact of all factors analyzed during the evaluation of each alternative included in the EIS is presented in Volume One, Table 5.14.1.

Comment Number 0014.03

Bullington, Darryl C.

Comment Further proposals of hazardous chemical processes based upon unproven technology using insupportable assumptions such as a ninety-nine percent retrievability of sludge to generate so much high-level waste that it can not be safely contained in existing repositories continues to erode any credibility that may yet exist between the DOE and the public. Such reports not only wasted resources, they assure continued inaction and indecision.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. For each of the alternatives, technical uncertainties were addressed in Volume One, Section 3.4 and Volume Two, Appendix B. For the Final EIS, Volume Five, Appendix K was added to the EIS to consolidate discussion of uncertainties associated with the analysis of environmental and human health impacts. The EIS also analyzes alternatives involving retrieval of less than 99 percent of the tank waste. These alternatives include the in situ alternatives which would involve minimal waste retrieval and the ex situ/in situ combination alternatives which would involve partial waste retrieval. For more information regarding the 99 percent retrieval assumption, please refer to the response to Comment numbers 0005.18 and 0089.07. Please also refer to response to Comment numbers 0069.04 and 0037.03 for issues related to regulatory compliance requirements associated with disposal of tank waste and geologic repository availability.

Comment Number 0021.01

Shilling, Fred E.

Comment Our concerns regarding the storage of nuclear wastes at Hanford: some of the stuff is leaking and it was not supposed to; some of it presents the threat of explosion, and it was not supposed to; some sort of omnibus cleanup was supposed to be under way by now but it is not; all the while the costs keep escalating while axe grinders argue for use of the plutonium for fuel for their profit and our disposal problem. And there is still no safe disposal.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The TWRS EIS was initiated because DOE needs to manage and dispose of tank waste to "reduce existing and future risk to the public, Site workers, and the environment" (Draft TWRS EIS, Section 2.0). The EIS addresses the DOE proposed action to manage and dispose of tank waste, as well as a range of reasonable alternatives. The use of plutonium for fuel is beyond the scope of this EIS. For each alternative, the EIS analyzes potential impacts to the human and natural environment including potential impacts from future releases to groundwater in Volume One, Section 5.2, releases to the air in Section 5.3, impacts to ecological and biological resources in Section 5.4, impacts to human health in Section 5.11, and impacts from explosions and other accidents in Section 5.12. Each of the alternatives, except No Action and Long-Term Management identify how tank waste would be disposed of. For HLW retrieval from the tanks, disposal would be offsite in the proposed geologic repository. For discussion of waste disposal under each alternative see Volume One, Section 3.4, and Appendix B.

Comment Number 0026.01

Blazek, Mary Lou

Comment I see three long-term strategic hazards that must be considered:

1. prevention of dispersal into the environment
2. prevention of direct human exposure (i.e., Site workers, etc.)
3. prevention of misappropriation by terrorist/criminal groups.

These concerns are not limited to high-grade plutonium.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment number 0021.01 for a discussion of EIS analysis regarding disposal of water into the environment. Prevention of direct human exposure is addressed for each alternative in Volume One, Section 3.4, and Appendix B. All alternatives would provide for appropriate security to minimize the risk of misappropriation.

Comment Number 0026.02

Blazek, Mary Lou

Comment I believe there are reasons to select a variety of processes in management. Some elements will be best served by vitrification, and others by simple long-term storage. I see no reason why at least a portion of the waste should not be stored at ground level, where it can be adequately monitored for leakage or casket deterioration and repackaged as indicated.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The bounding approach to the evaluation of reasonable alternatives provides the option for the decision makers to select a variety of processes in the ROD. The EIS range of alternatives included retrieval from zero to 99 percent of the waste, as well as a discussion of those technologies currently available for retrieval, separations, and immobilization. In addition, the EIS addresses four alternatives (i.e., ISV, In Situ Fill and Cap, and Ex Situ/In Situ Combinations 1 and 2) that include storage and/or disposal of all or part of the waste near surface onsite.

Risks to human health associated with transportation of HLW to the proposed geologic repository were analyzed and compared for each alternative in the accident scenarios discussed in Volume One, Section 5.12, and Volume Four, Appendix E. This analysis in conjunction with the analysis of risks associated with onsite disposal versus offsite disposal of HLW, supports the comparison of alternatives. Long-term risk to human health and the environment specific to onsite and offsite storage and risks in general were discussed in Volume One, Section 5.11 and Volume Three, Appendix D. All ex situ alternatives, except for the Ex Situ No Separations alternative, specify that the LAW be stored onsite in a near surface vault and that the remaining HLW be stored onsite pending disposal at the proposed geologic repository. The Ex Situ No Separations alternative would result in offsite disposal of the tank waste. Please refer to the response to Comment numbers 0026.01 and 0072.05.

Comment Number 0026.03

Blazek, Mary Lou

Comment In general I do not favor transfer to other sites. I believe the actual transfer would often times be hazardous, I see no advantage to deep burial over surface interment, and it is generally viewed as a means of "getting it out of my backyard" with all the political overtones and delays involved.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0026.01 for discussion of the analysis of impacts in the EIS, and 0026.02 for a discussion of a comparison of alternatives relative to onsite verses offsite disposal.

Comment Number 0026.04

Blazek, Mary Lou

Comment I see a need for use of a variety of separation/purification techniques, a variety of storage techniques, and a sense of urgency to start the process. We have spent far too long on looking for a single perfect solution and site. Technology will change over the next 50-100 years, and we can neither wait for that to happen nor insist on locking ourselves into a single process.

Response Please refer to the response to Comment numbers 0026.01, and 0026.02 for a discussion of the range options available for the decision makers based on the EIS analysis and the response to Comment number 0072.05 for discussion of NEPA requirements for analysis of a range of alternatives. The response to Comment number 0076.03 addresses modification to technologies over time, and the response to Comment number 0009.01 discusses technology optimization and the urgency associated with tank waste remediation.

Comment Number 0032.02

Heacock, Harold

Comment The continued management and minimum waste retrieval alternatives are not acceptable solutions to a major environmental problem since they do not include the retrieval of waste from the single-shell tanks.

We believe that any tank waste remediation program must include removal and processing the waste to an acceptable solid in order to eliminate the environmental threats resulting from any retention of the waste in tanks of questionable integrity and lifetime.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

The EIS analysis presents data to support a comparison of the potential environmental impacts form retention of waste in the tanks (No Action and Long-Term Management alternatives) verses various waste management and disposal strategies represented by the other alternatives analyzed in the EIS. Please refer to the response to Comment numbers 0026.01 and 0026.02 for more information.

Comment Number 0034.02

Belsey, Richard

Comment So there are real compelling reasons to do the one thing that will most increase the safety and health issues for workers, people, and the environment. And that is this material needs to be stabilized so it does not and cannot move.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to response to Comment numbers 0026.01, 0026.02, and 0072.05 for a discussion of the range of alternatives addressed in the EIS, including alternatives involving immobilization of all or portions of the waste.

Comment Number 0034.03

Belsey, Richard

Comment Waste management side there are compelling reasons too. Interestingly they are dollars. The cost of sitting or baby-sitting these tanks is the most frustrating thing that I can think of.

It costs -- has costs anywhere from 200 to 300 million dollars a year. Finally, the people in the Tank Waste Remediation System are beginning to bring this mortgage down by a variety of techniques, but it is still the largest single overhead -- and I put it in as overhead because it does not produce any cleanup.

It does not produce any movement. Those resources are needed to do actual cleanup work. And the meter is running. As we sit here, the meter runs every single day.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Reduction in mortgage costs associated with continued management of tank waste was accounted for in the cost estimates for each alternative analyzed in the EIS. The No Action alternative cost estimate represents the 100-year mortgage for tank waste management. Please refer to the response to Comment number 0009.16, which discusses the methods by which cost was incorporated into the alternative analyses.

Comment Number 0034.04

Belsey, Richard

Comment And these were because people knew or had learned about the problems in the tanks, and they wanted to do something about it. This was an intense five or six-month period. And the Tank Waste Task Force came out and said we have to change what we were doing. We need to put both the high-low-level activity fractions into glass, different kinds of glass.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The approach to tank waste identified in the Comment is represented in the EIS in the various ex situ alternatives presented in Volume One, Section 3.4. The ex situ alternatives provide for varying Volumes of low-activity verses HLW to be vitrified based on the level of separations (i.e., from separations to extensive separations).

Comment Number 0034.06

Belsey, Richard

Comment And I say all of this because -- as background to the fact that the committee and the board now has supported the alternative path as the one that is most likely to meet the needs of the Tri-Party Agreement, not the milestones.

The milestones are just indicators of how you are working on health and safety issues, moving toward the ultimate first step, the biggest step, which is taking it from being in a soluble form which can migrate into the ground, into the groundwater, into the Columbia River, and stabilizing that so it will keep in place for thousands of years.

Response DOE and Ecology acknowledge the concern expressed in the comment. DOE and Ecology are fully committed to the intent, as well as the milestone requirements in the 1994 Tri-Party Agreement and amendments to the Tri-Party Agreement.

Comment Number 0074.01

Sims, Lynn

Comment I think one of the issues here is that this project that we're talking about is probably the largest civil works project, the most expensive, and the most dangerous project ever attempted by mankind in history. And we're all very concerned about it and want to do the best we can to make it work. And that's, everybody is emotionally involved with this, and there might not be any good solutions, except to try to keep it out of the water, out of the Columbia River.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and the response to Comment number 0026.02 for a discussion of impacts analyzed in the EIS, including impacts to groundwater and the Columbia River.

Preferences Related to Tank Waste Removal

Comment Number 0012.02

ODOE

Comment Oregonians oppose all tank waste options which leave significant amounts of waste in Hanford tanks. The cumulative impacts from all of the past activities at Hanford on public health and safety, the environment and the Columbia River make it inappropriate to consider leaving any of the tank wastes in place. The Northwest has shouldered more than a fair share of the cold war burden and its legacy. Hanford's cleanup mission must proceed.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Cumulative impacts from the TWRS alternatives and other proposed or reasonably foreseeable related actions are presented in Volume One, Section 5.13.

Comment Number 0012.04

ODOE

Comment The other alternatives under consideration leave most or all of the wastes in the tanks. With the exception of in situ vitrification, which is an undeveloped and unproven technology, other alternatives do little to remove the hazards posed by the wastes. To reduce the risks to people, these alternatives would require permanent closure of Hanford lands to other uses. Sacrificing Hanford in this way does not adequately reduce the harm and risks to the environment or to future generations. For these alternatives, the risk analyses in the EIS show massive plumes of radioactive material slowly moving across the Hanford site and into the Columbia River for hundreds to thousands of years.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Technical uncertainty of undeveloped or unproven technology, and the long-term risk associated with the various alternatives were factors analyzed by DOE and Ecology for each alternative. This information is presented in Volume One, Section 5.4. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. As stated in Volume One, Section 3.3, decision on closure of the tank farms will be made in the future. Additional analysis will be performed at that time concerning any additional measures that need to be taken to protect the groundwater and its future potential users. The TWRS EIS addresses the management, retrieval, treatment, storage, and disposal of the tank waste and does not address final remediation of the tank farm residuals, equipment, or soil contamination. For more information on closure, please refer to the response to Comment number 0072.08.

Comment Number 0012.05

ODOE

Comment Cost should not be the sole or even predominant criteria used to select among the alternatives. The first criteria that must be applied is protection of public health and safety and the environment. This criteria eliminates all of the alternatives which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, but because in situ vitrification technology is uncertain, the potential for failure is unacceptably high. We strongly oppose all of the alternatives which leave the waste in Hanford's tanks.

Also, the cost analyses do not include the lost value of the lands or the costs from harm to future generations or the environment. Ultimately, the costs of these alternatives would prove to be much greater than removing and cleaning up the wastes, as called for by the preferred alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume One, Section 5.12 contains discussions of accident risk for each alternative. The EIS discusses long-term loss of land use and immediate and potential future risks to human health impacts. Neither is analyzed in terms of cost because a dollar value to human life and the land cannot be assumed.

Cost and risk to human health and the environment were several factors analyzed by DOE and Ecology for each alternative. Assessing the economic impact due to lost land value or harm to future generations other than health impacts or the environment were beyond the scope of this EIS and were not considered. Each impact was analyzed using a consistent methodology. The results were objectively presented in the EIS for the public and the decision makers. DOE and Ecology are committed to the Tri-Party Agreement requirement that no residual volume greater than 1 percent remain in the given tank, unless this requirement is not technically achievable.

Comment Number 0037.01

Eldredge, Maureen

Comment The risks in this EIS show clearly that the only responsible option is retrieving all the waste. This needs to start happening now.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0021.01.

Comment Number 0073.01

Yazzolino, Brad

Comment I simply wanted to put this in perspective, in the sense that I'm in the art world. The art world is basically lasts for thousands of years in the same sense that the radioactivity does. And I've been immersed in the geology of the Hanford area for the last year or so, and some other aspects about the river. And basically you need to remove the radioactive material from its proximity to the river because in fact that river valley has been there for about 21 million years. And it's going to persist in that area, and it's going to eventually wash your radioactivity to the sea, and spread it all over the river valley if you leave it there. It needs to be removed.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The long-term impacts associated with tank waste alternatives, including impacts for alternatives that would leave all or part of the waste in place in the tanks and others that would retrieve the greatest extent of waste practicable, were among the factors analyzed in the EIS. This analysis included human health and groundwater impacts that were calculated to 10,000 years in the future, as well as impacts associated with climate changes that potentially would result in the situation described in the comment. The response to Comment numbers 0012.01 and 0012.15 discusses the impact of past tank leaks and current efforts to determine the extent to which these leaks have impacted the area beneath the tanks.

Comment Number 0090.04

Postcard

Comment Please listen to us say no:

to leaving High-Level Nuclear Waste in our ground.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0026.02 for a discussion of the extent to which each of the alternatives would result in onsite disposal of HLW.

Comment Number 0091.02

Dyson, Jessica

Comment It is time to stop being in denial and start making public safety your utmost concern. In doing so, you must follow the Tri-Party Agreement and vitrify all the waste in the tank and it is not acceptable to leave any waste in the tank because that could pose a danger to the public in the future.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The DOE and Ecology preferred alternative, Phased Implementation, would comply with the requirement of the Tri-Party Agreement. As indicated in Volume One, Section 2.0, the underlying need for action is to "reduce existing and potential future risk to the public, Site workers, and the environment." DOE also must take action to "ensure compliance with Federal and Washington State laws regulating the management and disposal" of the tank waste and the cesium and strontium capsules. These underlying needs for the proposed action are also the basis for the continued management of the tank waste by the TWRS program, as described in Volume One, Section 3.2. Please refer to the response to Comment number 0026.02 for a discussion of the extent to which each alternative would retrieve waste from the tanks.

Preferences Related to Privatization

Comment Number 0014.04

Bullington, Darryl C.

Comment If Congress is really serious about containing existing hazardous wastes along with adequate monitoring and emergency planning it should set aside funds in separate easily identified accounts which are not subject to whatever political whim that comes along to be used exclusively to:

1. Identify the size of all waste streams from all anticipated future sources and then establish a final repository sufficiently large to accommodate the demand for storage as required.
2. Monitor the integrity of all existing tanks and establish plans and funds to reduce the danger of further leakage including emergency plans should further leakage occur.
3. Reduce the options for safely confining stored wastes to several that can be achieved in the time frame established using existing technology and involving a minimum of time consuming and costly research and development. Chosen methods should have a high probability of accomplishing all milestones with the least risk to the public and the workers involved. Funds should also be set aside for insurance purposes should accidents occur. Safety of the public and the environment should take precedence over providing jobs or solving other social needs. These few alternatives, assuming that all the 50,000 curies of plutonium can be excluded from the biosphere, should then be contrasted with the do-nothing alternative. The report should show the costs and consequences of each alternative including a discussion of accidents that may occur along the entire pathway until confinement.

Response The purpose of this EIS is to present and analyze the range of reasonable alternatives that are available to remediate the tank waste at Hanford. Please refer to the response to Comment number 0072.05. DOE Richland Operations Office prepares a budget each year, which includes requests for funds used for cleanup; however, only Congress has the authority to appropriate funds. Congressional funding issues were not included in the scope of this EIS.

There are several ongoing activities involved with collecting and analyzing data on tank contents. Tank inventory data are presented in Volume Two, Appendix A (Tables A.2.1.1, A.2.1.2, and A.2.1.3), and waste projections for future tank waste additions are shown in Table A.2.4.1. Please refer to the response to Comment numbers 0012.14 and 0072.07 for a discussion of the tank waste inventory and characterization methods planned or currently under way.

Establishing a final repository is not included in the scope of this EIS; however, for the purposes of analyzing the alternatives presented in this EIS, a potential geologic repository candidate site at Yucca Mountain, Nevada was assumed to be the final disposal site. A discussion of the requirement for HLW disposal in a geologic repository is provided in Volume One, Section 6.2.

The TWRS program also includes monitoring the integrity of tanks and characterizing the vadose zone around the tank farms to detect leaks. DOE also conducts numerous activities to provide continued safe storage of the tank waste, and emergency plans have been developed and are in place. Descriptions of ongoing programs and tank safety issues are presented in Volume One, Section 3.2 and Volume Two, Appendix B, respectively. All monitoring and safety programs (Section 3.4) would continue through remediation. DOE is required to mitigate all accidents involving releases to the environment and Volume One, Section 5.20 identifies potential mitigation measures that could be implemented to alleviate the environmental impacts of the alternatives.

A range of reasonable alternatives was analyzed for the TWRS EIS, including the No Action alternative and alternatives involving extensive retrieval. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The purpose of the EIS is to present the results of impact analyses in the most objective manner possible. These results will also be used by the decision makers to select an alternative and prepare the ROD. Volume One, Section 3.7 and Volume Two, Appendix B contain summary discussions of the alternatives comparisons. The Summary, Section S.7 contains an alternatives comparison, based on impact type and Volume One, Section 5.14 summarizes the environmental impacts of each alternative.

Comment Number 0017.01

Fisk, Charles P.

Comment Given Westinghouse's, Battelle's, etc. dismal performances, I certainly would not recommend privatization! Government created the mess and government should accept cost of remediation, not some for-profit corporation.

Response DOE and Ecology acknowledge the recommendation expressed in the comment. Although the contracting strategy known as privatization is not addressed in the EIS, the discussion of the Phased Implementation alternative does address the technical strategy of an incremental approach to tank waste remediation. Please refer to Volume One, Sections 3.3 and 3.4 of the EIS for more information on alternatives implementation and the Phased Implementation alternative.

Comment Number 0017.02

Fisk, Charles P.

Comment The "preferred alternative" is full of holes, as HEAL has persuasively analyzed far better than I can.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and the response to Comment number 0009.19 for reasons Phased Implementation is the identified preferred alternative.

Comment Number 0017.03

Fisk, Charles P.

Comment The entire amount of waste needs to be vitrified, not just 25 percent of it, regardless of the cost. If, as Republicans propose, we could afford a continuation of "Star Wars", we can be assuredly cancel that wasteful idea and put the money into a completed and thorough clean up of the mess.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Cost was one factor analyzed by DOE and Ecology for each of the alternatives. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. For a discussion of the extent to which each alternative would result in waste retrieval and/or treatment please refer to the response to Comment number 0026.02. DOE and Ecology note that the preferred alternative would result in remediation of all waste practicably or no less than 99 percent.

Comment Number 0017.04

Fisk, Charles P.

Comment We have the technology for vitrification; now get with it and DO IT! The Columbia River deserves maximum protection as soon as possible.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology are committed to protecting the Columbia River. The response to Comment number 0012.01 addresses groundwater contamination and vadose zone characterization and monitoring. Please also refer to the response to Comment number 0072.05 for discussion of the approach to analyzing alternatives and technologies in the EIS.

Comment Number 0060.01

Davenport, Leslie C.

Comment I support the preferred Phased Implementation alternative, but with some changes; primarily that only one separations/LAW/HLW processing facility be built by a private contractor during Phase 1. The primary reason for this choice is that it can meet the Tri-Party Agreement and yet result in the minimization of overall costs and ultimately facilities needing decontamination and disposal. Whether additional separations should remove technetium, cesium, strontium, and TRU elements should be left to engineering judgement, dependent primarily on meeting required LAW product specifications for disposal onsite in near-surface retrievable disposal vaults. The other primary consideration would be to ensure that interim and final disposition methods for TRU elements always are critically safe.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. DOE and Ecology remain committed to compliance with the Tri-Party Agreement under which the general requirements for the preferred alternative were renegotiated in 1994. Specific separations technologies will be evaluated during the detailed design phase that will follow the final remedy selection and the ROD. Separation technologies, along with removal and immobilization technologies, will be tested during the demonstration phase (Phase 1).

Comment Number 0078.07

ODOE

Comment USDOE must move forward with cleanup as quickly as possible. USDOE must commit to remove all the waste from the tanks and convert it to a durable and stable waste form. The privatization alternative is the only alternative of the four acceptable alternatives that can be done soon. All of the others will involve extensive delays.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05, 0076.03, and 0009.19.

Miscellaneous Preferences Related to the Alternatives

Comment Number 0032.03

Heacock, Harold

Comment We also do not believe the technical feasibility of several of the in situ treatment processes has been demonstrated adequately to seriously consider them as viable alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. ISV is a relatively new process that has not been tried at this scale previously, but was considered a potentially viable alternative. Implementability issues for each of the alternatives are discussed in Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to response to Comment numbers 0072.10 and 0072.80 for information on NEPA requirement to consider reasonable alternatives in the EIS.

Comment Number 0035.02

Martin, Todd

Comment It continues to debate issues that have long been laid to rest, such as what is the waste form that we will use at Hanford. The preferred alternative does not mandate the glasses used. It does not mandate vitrification. It should. We have made that decision. Let's go forward.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Vitrification and glass-types were analyzed for the HLW disposal; however, DOE and Ecology have identified the treatment process for the LAW as immobilization rather than vitrification for the Phased Implementation alternative. As identified in Volume One, Section 3.4 and Volume Two, Section B.3 of the EIS, LAW would be processed using a technology that would meet LAW specifications. These specifications would be performance based, using vitrification as a benchmark, and would have specific requirements for size, chemical composition limits, isotopic content, and physical parameters. Even though the Tri-Party Agreement suggests that certain decisions have been made, NEPA requires an objective analysis of all reasonable alternatives. Please refer to the response to Comment numbers 0060.02, 0005.07, and 0034.05.

This approach to LAW treatment is consistent with the Tank Waste Task Force (HWTF 1993) recommendation to use the most practicable, timely, available technology, while leaving room for future innovation. All HLW removed from the tanks and that remains after separations will be vitrified under the preferred alternative. Please refer to the response to Comment number 0009.19 for a discussion of the reasons Phased Implementation is identified as the preferred alternative.

Comment Number 0036.09

HEAL

Comment HEAL supports the preferred alternative's pretreatment process.

The TWRS Task Force values on pretreatment are explicit and strongly held. According to the TWRS Task Force Final Report:

The high cost and uncertainty of high-tech pretreatment and R&D threatens funding for higher performance low-level waste forms, vitrification, and cleanup. Use the most practicable, timely, available technology, while leaving room for future innovation. Keep a folio of technological options and make strategic investments over time to support a limited number of promising options. Give up further research on unlikely options (TWTF p. 11)

The intermediate separations case is response to this value (although the difficult challenge of technetium removal in the Phased Implementation alternative is a concern). HEAL strongly opposes any movement toward an extensive separations pretreatment technology.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0098.02.

Comment Number 0046.04

DiGirolamo, Linda Raye

Comment Yes, encase in glass and bury this "CRUD" and more importantly... Stop all future plutonium fuel rod production at once. New Age Energy must be embarked upon at once to save man and the earth.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0059.01

James Jordan Associates

Comment JJA recommends that the Environmental Impact Statement include in its analysis an alternative concept invented by Drs. Morris Reich, James Powell, and Robert Barletta of Brookhaven National Laboratory for the safe immobilization and isolation from-the-environment radioactive waste. This novel concept has the potential of being the safest, least costly, and most expeditious method for the disposal of the various radioactive wastes currently stored in the underground storage tanks at Hanford, including, if desired, the vitrification of the cesium and strontium capsules located at the Hanford Site.

This system which uses modular canisters with integral vitrification capability does not require an upgrade to the tank farm waste transfer system. This system will not require the construction of extensive buried transfer lines that is included in all of the alternatives except the No Action alternative. Indeed, the elimination of the complex tank farm waste transfer system significantly reduces the potential for short-term impacts of human health and the environment. Using modular canisters with integral vitrification provides for a dramatic reduction in the risk of long-term impacts on the public health and the environment in that the system does not have a large central vitrification facility to deactivate and dispose of at the end of the vitrification campaign. Compared to a conventional vitrifier, the in-can vitrifier does not require the pouring of molten radioactive glass.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Draft EIS addressed the full range of reasonable alternatives. The alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS. DOE and Ecology therefore believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment numbers 0072.05, 0072.79, and 0097.01.

Comment Number 0060.02

Davenport, Leslie C.

Comment Both continued management alternatives are unacceptable for the long term.

The Minimal Waste Retrieval (In Situ) alternatives do not meet waste disposal laws, regulations, and policies and I feel are unacceptable in the long term. The In Situ Fill and Cap would not immobilize the wastes, only fill the tanks with gravel (creating more contaminated waste) and keep it all onsite in a form that would eventually leach to the groundwater. The In Situ Vitrification alternative is interesting and perhaps could be used on some of the small Multiple Underground Storage Tanks (MUSTs) that contain lower amounts of radioactivity, but the degree of technical uncertainty is too high to consider application to an entire tank farm of up to 20 tanks at once. Verifying that all tanks are completely vitrified down to 60 ft below the ground surface is nearly impossible, and there is no way to immobilize radionuclide plumes below the leaking SSTs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not comply with laws and regulations. The TWRS EIS addresses 10 alternatives for tank waste, ranging from No Action to extensive retrieval, and four alternatives for the cesium and strontium capsules. Please refer to the response to Comment numbers 0072.80 and 0072.10 for a discussion of the NEPA requirement to include a No Action alternative in the EIS analyses.

Comment Number 0060.03

Davenport, Leslie C.

Comment The partial waste retrieval alternatives do not meet waste disposal laws, regulations, and policies because they would retrieve only 90 percent or less of the radionuclides. I feel they will be deemed unacceptable in the future, thereby necessitating additional future operations to finish the job.

Response DOE and Ecology acknowledge the concerns presented in the comment. DOE and Ecology remain committed to compliance with the Tri-Party Agreement, which requires removal of all technically achievable waste or no less than 99 percent of the waste from each tank. Please refer to the response to Comment number 0060.02 and for discussions of the NEPA requirement to address a range of alternatives including alternatives that do not comply with regulations. Refer to the response to Comment numbers 0072.80 and 0072.10.

Comment Number 0060.04

Davenport, Leslie C.

Comment The extensive waste retrieval (ex situ) alternatives appear to be the only acceptable methods to deal with the approximately 200 MCi of radionuclides. However, the Ex Situ No Separations alternative appears to be too expensive because all tank wastes would be vitrified and/or calcined, resulting in too many high-level waste packages to ship to and store in a waste repository. The Ex Situ Intermediate and Extensive Separations alternatives are difficult to choose between, because the efficiency of the sludge washing, ion exchange, and multiple complex chemical separations processes are not fully known for the various types of tank wastes. Hence, those two alternatives should be compared in a pilot plant using a Phased Implementation (possibly along with the In Situ Vitrification alternative applied selectively, particularly for MUSTs, and SSTs that have not leaked).

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Technical evaluation, categorization of tank waste, and application of appropriate technology would be conducted during Phase 1 (demonstration phase) of Phased Implementation and during the detailed design phase of any alternative analyzed in the EIS. Volume One, Section 3.4 includes descriptions of the processes, cost, and Implementability for each tank waste alternative. Volume One, Section 5.14 provides a summary of the environmental impacts for each tank waste alternative. The EIS provides

the basis for comparison among the alternatives identified. DOE and Ecology believe sufficient differentiation exists between the alternatives to support a decision on the alternative to be implemented; therefore, a demonstration phase comparison of the two alternatives would postpone remediation.

Comment Number 0072.10

CTUIR

Comment The Tri-Party Agreement mandates full retrieval as the goal; only if this is not practicable on a tank-by-tank basis can lower retrieval goals be negotiated. Therefore, the in situ alternatives are not allowed and did not have to be evaluated.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

As required by the CEQ, the TWRS Draft EIS identifies and analyzes a range of reasonable alternatives for the proposed action, including those that are "not within the jurisdiction" of the agency (40 CFR 1502.14). DOE guidance on NEPA requires that EIS alternatives be addressed even if there is "conflict with lawfully established requirements" (DOE 1993d). However, the Agency is required to identify the laws and regulations that apply to each alternative and indicate if the alternative, if selected for implementation, would comply with applicable laws and regulations. This information must be provided to the public and the decision makers. Therefore, the failure to comply with the Tri-Party Agreement is not sufficient basis for excluding an alternative from detailed analysis in the EIS (40 CFR 1502.2d). A discussion of the methods used to develop the alternatives in compliance with NEPA requirements is presented in the response to Comment number 0072.05. Please refer to the response to Comment numbers 0072.80 and 0072.52.

Comment Number 0072.16

CTUIR

Comment In situ alternatives were not necessary since they are not allowed under the Tri-Party Agreement.

Response Please refer to the response to Comment numbers 0072.10 , 0072.52, and 0072.80.

Comment Number 0076.03

Blazek, Mary Lou

Comment The preferred alternative relies on using proven technology, and using a phased approach. We think a learn as you go approach makes sense, given the history of Hanford. And that should identify problems earlier, and at smaller economic and environmental cost.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Preferred Alternative would allow DOE to proceed with tank waste remediation. System modifications would be evaluated as waste inventory, removal method, separations, and disposal data are collected and analyzed during the Phase 1 demonstration. This continuous improvement is the cornerstone of the "learn and improve while doing" approach cited in the comment. Please refer to the response to Comment numbers 0060.04, 0060.02, and 0009.19 for more information on the preferred alternative.

Comment Number 0077.02

ODOE

Comment Leaving wastes in the tanks poses huge risks. The tanks are corroding and failing. As they fail, the radioactive waste is released to the soil and ultimately to the groundwater and to the Columbia River. Vitrifying the tank waste makes it far more stable and greatly reduces the threat to the public and the environment. While the cost of the preferred alternative is substantial, it is the only alternative which satisfactorily deals with the dangers presented by these wastes as quickly as practical. The phased approach allows USDOE to get on with cleanup while allowing for possible development of better approaches which remove all tank wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0076.03 and 0060.04. The response to Comment number 0091.01 addresses protection of the Columbia River in relation to the preferred alternative.

Comment Number 0078.02

ODOE

Comment Unacceptable Alternatives

The EIS evaluates the alternatives USDOE believes are available for the tank waste. Four alternatives are unacceptable because they could allow exposures to the environment and the public at levels higher than allowed. These include:

1. Two alternatives manage the waste as is; in failing tanks,
2. Two alternatives leave all or most of the tank waste in the tanks covered with sand and a complex barrier to keep rain water out,
3. One alternative proposed vitrifying all of the waste in the tanks in place.

A sixth alternative was added as the EIS went to print. This alternative is included in the cover letter for the EIS and is not analyzed in depth in the EIS. It would leave most of the waste in the SSTs, fill the tanks with sand and cover them with a barrier.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. NEPA requires an EIS address a comprehensive range of reasonable alternatives. The TWRS EIS fully addresses 10 alternatives for tank waste, which includes no action, long-term management, in situ, ex situ, and combination alternatives. NEPA also requires that these alternatives be analyzed regardless of regulatory compliance to allow an even-handed analysis of all factors, as discussed in the response to Comment number 0072.80. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0078.03

ODOE

Comment

Unacceptable Alternatives

The EIS includes four alternatives which meet legal requirements. These are:

1. Retrieve all of the waste, glassify it and sent it to a national high-level nuclear waste repository,
2. Retrieve all of the waste, use extensive chemical processes to separate the nonradioactive portions from the radioactive portions, glassify them and send the glass to a national high-level nuclear waste repository,
3. Retrieve all of the waste, use less extensive separations of the waste into high-activity and low-activity fractions, glassify, both, bury the low-activity fraction at Hanford and send the high-activity fraction to a national high-level waste repository (Government owned and contractor operated),
4. Do the same as three, but do it in phases using private companies to build and operate the plants. (This is the preferred alternatives in the EIS).

If privatization fails, the Tri-Party Agreement requires USDOE to revert to government owned and operated vitrification plants.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment number 0072.80 for a discussion of the NEPA requirements to analyze a full range of alternatives in an EIS regardless of regulatory compliance.

Comment Number 0079.01

Knight, Paige

Comment Hanford Watch supports the phased implementation plan, not because it's so great, but because it gets the waste out of the tanks. It is our conviction that waste must be removed from the tanks and put in a stable form. If this new preferred alternative reaches a point of failure, you must be prepared to turn back immediately to the path outlined in the Tri-Party Agreement, and follow the advice given by the Tank Waste Task Force, in the summer and fall of

1993. That advice can be summed up in the words get on with cleanup. The public has stated time and time again that the DOE must get on with it. Hear us. Do not change paths again.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0076.03. Please also refer to the response to Comment numbers 0009.19 and 0060.02 for more information on the reasons Phased Implementation was identified as the preferred alternative.

Comment Number 0079.03

Knight, Paige

Comment The alternative of long-term management also is unacceptable because according to the TWRS EIS that document will end in, that management will end in 100 years. This possibility the amount of time previous to the waste plumes becoming a severe health risk to the public and the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment number 0040.02 and 0101.01 for a discussion of the 100-year administrative control period.

Comment Number 0079.04

Knight, Paige

Comment The in situ alternative is also unreasonable, because again no protection of the groundwater is offered, and security and external control will end in 100 years. And that's when the contamination, theoretically, is going to become a real problem for the health and environment, health of people and environment. Further, the use of riprap basalt is suggested. And we fear that this material will be taken from sites at Hanford, that are sacred to the Indian tribes.

In short, any plan to leave this deadly brew of wastes in the tanks is totally unacceptable, and will meet with the resounding opposition from the citizens of the region. Water is sacred, and must be protected at all costs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment numbers 0091.01 and 0012.01 for discussions of groundwater issues related to current and planned monitoring programs and protection of the Columbia River.

Volume One, Section 5.7 describes the land-use impacts of the various alternatives, including impacts to potential borrow sites. Volume One, Section 5.5 describes the cultural resources impacts, including prehistoric and historic sites, and issues of potential concern to Native Americans. DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River and impacts to groundwater and the Columbia River are addressed in Volume One, Section 5.2 and Volume Four, Appendix F. Please see the response to Comment number 0019.03 for a discussion of borrow site issues. Please refer to the response to Comment number 0040.02 and 0101.01 for a discussion of the 100-year administrative control period. Response to Comment numbers 0091.01 and 0012.01 discuss groundwater issues related to current and planned monitoring programs and protection of the Columbia River.

Comment Number 0085.01

Klein, Robin

Comment Except to say that the no action alternatives, including long-term management are unacceptable options. They are not within the range of reasonable alternatives as the Draft EIS states. But are imprudent, hazardous, and in violation of the Tri-Party Agreement.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0072.52, 0072.05, 0078.02 and 0072.80.

Comment Number 0087.04

Tewksbury, Ross

Comment And I think that they should do the extensive waste retrieval and vitrify all, or nearly all of it, and whether it's stored on the site, or off the site is not really the major thing. The major thing is to get it in a form where it's not able to leak out into the groundwater and soil and the river, and everything else, and to do that as fast and as safely as possible. And I think that you should not really be concentrating on this waste separation idea that you were going over tonight, except what's absolutely necessary for the technical, chemical, and safety purposes. Because all of it has to be taken care of for hundreds, if not thousands of years. Thank you.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0078.02. The phased approach to the alternative implementation is discussed in the response to Comment numbers 0060.04 and 0076.03. Groundwater protection issues are discussed in the response to Comment numbers 0091.01 and 0012.01.

Comment Number 0088.01

Porter, Lynn

Comment I guess I support the preferred alternative because it sounds better than the others.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0014.04, 0072.05, 0078.02, 0009.19, and 0060.02 for a discussion of the reasons Phase Implementation has been identified as the preferred alternative.

Comment Number 0089.01

Nez Perce Tribe ERWM

Comment The Nez Perce Tribe ERWM favors protection of the Columbia River and its ecosystem through removal and disposal of tank wastes from 200 Area tanks as supported by the EIS. ERWM believes groundwater and the Columbia River are at risk from potential radionuclide or toxic chemical releases from the tanks. We endorse the alternative calling for removal of tanks wastes through one of the Ex Situ Separations alternatives or Phased Implementation.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0014.04, 0072.05, and 0078.02.

DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River and its ecosystem. An analysis of impacts to groundwater and the Columbia River are provided in Volume One, Section 5.2 and Volume Four, Appendix F. Discussions related to groundwater and protection of the Columbia River are contained in the response to Comment numbers 0091.01 and 0012.01.

Comment Number 0093.02

Devoy, Tiffany

Comment I also would like to say that I do think the Tri-Party Agreement should be followed in this case and actually in most cases and it seems odd that there is always someone trying to get out of it. It was signed and I think it should be followed. I think that they need to vitrify as much waste as possible and to leave as little waste behind as possible and I do not think that is an unrealistic expectation. There are 177 tanks and I do not even remember what was quoted to me as to how many gallons each those tanks were but it is pretty amazing and to think of all that waste concentrated and to just leave it there, I know that is not your preferred alternative, but I think some of your alternatives are not that much better. So vitrify it as much as possible, leave as little behind as possible, and follow the Tri-Party Agreement. That is about it.

Response DOE and Ecology acknowledge the preference for extensive waste retrieval, treatment, and disposal within the context of the Tri-Party Agreement expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating TWRS waste. The inclusion of alternatives in the EIS that do not comply with the Tri-Party Agreement complies with the NEPA, which is the Federal law requiring the preparation of this EIS. Please refer to the response to Comment numbers 0072.10 and 0072.80 for a discussion on requirements for inclusion of alternatives in an EIS analysis.

L.3.4.2 Elements Common to Tank Waste Alternatives

Comment Number 0098.03

Pollet, Gerald

Comment The public deserves to know how much money is going to be taken out of the authorization for Hanford clean up for the so-called privatization reserve. This process is a sham so long as an undisclosed amount of your Hanford clean up dollars are being removed in the future. Let us face it, basically the President and Congress have said you are going to have less money for Hanford clean up, we know what the President's projection is, it is seriously less than it used to be, and out of that a future chunk is going to privatization in a liability reserve but you and I can not see what it is. At the same time, the Department of Energy has target budgets now through the year 1998 which fail to fully fund essential safety and Tri-Party Agreement activities such as characterizing the wastes in these tanks. As the General Accounting Office has said, If you fail to properly characterize, you can not expect the contractors to be able to vitrify and, in fact, anyone can see down the road that the contractors are liable to say, You did not characterize properly, therefore, you owe us the full cost we put out for building the plant and our anticipated profit, we will take that 1.4 whatever billion dollar reserve it is, put it in our corporate pockets, the government will be out that money, you will have a plant that will not work because wastes were not characterized. Currently, the Department of Energy is planning in its budgets to be at least 3 years behind the Tri-Party Agreement requirement for characterizing the wastes. This can not be allowed to go forward.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The privatization contracting strategy and the budgetary process for funding the alternative selected are outside the scope of this EIS. DOE Richland Operations office prepares a budget each year, which includes funds required for cleanup; however, only Congress has the authority to appropriate funds. Please refer to the response to Comment numbers 0012.14 and 0072.14 for discussions of issues related to the tank waste inventory and ongoing efforts to characterize the tank waste.

Comment Number 0101.01

Yakama Indian Nation

Comment Unrealistic Assumptions Regarding Institutional Controls Restricting Future Human Actions --Design basis assumptions associated with the disposal of waste at Hanford optimistically assume protective conditions will exist in the future in connection with the estimation of impacts to the public

health and safety and the environment. Specifically, we consider the assumption of institutional controls restricting intruder actions or inadvertent intruder actions beyond about 130 years hence is invalid.

Response DOE and Ecology concur that intruder or trespasser activities could not be monitored or restricted beyond 100 years. The 100-year administrative control period is a bounding assumption used during the analysis of the alternatives. For all alternatives analyzed in the EIS, post-remediation risks assume that institutional controls would not exist beyond 100 years. Please refer to the response to Comment numbers 0040.02 and 0040.03 for more information regarding administrative controls. Because the information contained in the text was correct, no change was made to the document.

Comment Number 0101.04

Yakama Indian Nation

Comment Consideration of Low-Impact Waste Management Alternatives--Alternatives which evaluate impacts associated with the minimization of the volume of waste retaining a long-lived hazard (hazardous for 130 years or more) and large cask storage of stabilized wastes was not accomplished. We believe such options which were addressed in preliminary impact analyses, should be presented in the impact statement to allow full assessment of options. We consider that DOE (OCRWM) actions in preparation of the EIS to require consideration of small casks with no apparent technical or economic basis is unwarranted and capricious.

For example, the use of 10 cubic meter capacity (m^3) (360-cubic foot [ft^3] casks for storage and/or disposal of stabilized high-level radioactive wastes should be evaluated. Furthermore, consistent with evaluating alternatives which minimize the volume of waste for disposal, the option of using waste processes that would purify sodium salts (making up about 85% of the solids in the tanks) to a specific activity and hazard equivalent to Class A low-level radioactive waste with the calcination of the remaining high-level radioactive waste stream should also be specifically compared with processing options that produce larger volumes of long-lived hazardous wastes.

We note that the an additional benefit of removing sodium is the added stability of potential high-level radioactive waste forms without significant sodium, making this processing option desirable for disposal performance assessments.

Response The Ex Situ No Separations Vitrification and Ex Situ No Separations Calcination alternatives have been revised for the Final EIS to use a 10-m^3 (360-ft^3) canister for HLW storage and disposal. The size assumptions are presented in Volume One, Section 3.4 and Volume Two, Appendix B. These canister sizes have been used for impact analysis presented in Volume One, Section 5.0, Volume Three, Appendix D, Volume Four, Appendices E and F, and Volume Five, Appendices G and H. Please refer to the response to Comment number 0081.02 for related information.

The use of crystallization to remove sodium salts from the waste stream is included in the Ex Situ Extensive Separations alternative as a technology that could potentially reduce the LAW volume. This technology was not included as a primary treatment technology because it was not sufficiently mature to allow detailed evaluation. The focus of the EIS was to evaluate alternatives, rather than specific technologies, to allow sufficient flexibility to evaluate and implement emerging technologies in the future. Please refer to the response to Comment number 0072.05 for information on NEPA alternatives analysis requirements.

DOE and Ecology agree that removal of the sodium from the waste stream prior to immobilization potentially would reduce the volume of HLW for the Ex Situ No Separations Vitrification alternative and LAW for the ex situ alternatives that include separating the HLW and LAW for treatment. It would be expected that removal of the sodium would result in increasing the waste loading such that either waste form would meet waste form performance criteria. Please refer to the response to Comment numbers 0027.11 and 0008.01 for more information related to waste loading and the response to Comment numbers 0008.01 and 0009.08 for more information regarding consideration of canister (cask) size in the Draft and Final EIS.

Comment Number 0101.07

Yakama Indian Nation

Comment On another scale the impacts associated with the disposal of waste streams generated by the actions being considered must also be considered in a integrated manner. The issue associated with waste minimization and waste package sizing greatly affects disposal costs and other impacts, particularly those associated with the high-level radioactive waste deep repository at Yucca Mountain. Integration of the disposal facilities under the office of Civilian Waste Management (OCRWM) and the TWRS in DOE's overall environmental management actions should be evaluated and assessed from a systems engineering approach to resolve this issue.

We consider large savings (several billion dollars) are possible if valid systems integrations are accomplished compared to the base-line alternatives currently being pursued by DOE. These estimates stem from cost evaluations accomplished by the authors of the subject EIS.

Response Large canisters have been addressed in the Final EIS.

Please refer to the response to the following comments for more information:

- Comment numbers 0004.01 and 0081.02 - coordination with Office of Civilian Radioactive Waste Management (OCRWM) and revisions to repository cost calculations
- Comment number 0008.01 - canister size re-evaluation decision
- Comment number 0027.02 - systems engineering approach to the alternatives evaluation
- Comment number 0037.04 - relationship of the TWRS EIS to other Sitewide NEPA and programmatic documents.

The cost estimates in the EIS include contingency and a range of uncertainty based on the conceptual nature of the alternatives and standard industry practice for large capital projects. DOE expects that as detail design progresses, progress in technology optimization will result in cost savings. Please refer to response to Comment numbers 0052.04 and 0081.03.

<u>L.3.4.2.1 Issues Related to Disposal Costs Calculations and Repository</u>

Comment Number 0004.01

Boldt, A.L.

Comment References:

1. DOE, 1996, *Draft Environmental Impact Statement for the Tank Waste Remediation System*, DOE/EIS-0189D, U.S. Department of Energy, Richland, Washington and Washington State Department of Ecology, Olympia, Washington, April, 1996.
2. DOE, 1995, *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program*, DOE/RW-0479, U.S. Department of Energy, Washington D.C., September, 1995.
3. *Nuclear Waste Policy Amendments Act of 1987*, Public Law 100-203, December 22, 1987, 42 USC 10101 et seq.
4. Federal Register Notice, *Civilian Radioactive Waste Management; Calculating Nuclear Waste Disposal Fees for Department of Energy Defense Program Waste*, pp. 31508-31524, Vol. 52, No 161, August 20, 1987.
5. TRW, 1995, *Assessment of Pre-Closure System Cost and Health and Safety Impacts of Hanford HLW Vitrification Options on the Civilian Radioactive Waste Management System*, A00000000-01717-5705-00003, Rev. 0, TRW Environmental Safety Systems, Inc., Vienna, Virginia, April 27, 1995.

The geologic disposal costs presented in section B.3.0.8 of the draft TWRS EIS (ref 1) are based on a linear extrapolation of the unit container disposal costs provided by reference 2 for a specific scenario. The linear extrapolation of the unit container disposal cost from reference 2 to all the TWRS alternatives does not meet the requirements of the Nuclear Waste Policy Amendments Act (ref 3) and Federal Register Notice 52-161 (ref 4).

Federal Register Notice 52-161 identifies, in detail, the method to be used in estimating the disposal fees for the Department of Energy defense program HLW (HLW) share of total Civilian Radioactive Waste Management System (CRWMS) costs. Federal Register Notice 52-161 cost allocation is based on the concept of full cost recovery with sharing formulas applied to all fixed and variable system cost components.

The assumption of linear extrapolation of unit container disposal costs in the draft TWRS EIS greatly underestimates the disposal costs of the extensive separations alternative and greatly overestimates the disposal costs of the no separations alternative. Example disposal cost variability for alternate HLW container sizes and HLW volumes resulting from no separations, intermediate separations, and extensive separations using the methodology specified in Federal Register Notice 52-161 are provided in reference 5.

I am requesting that the draft TWRS EIS be revised to incorporate HLW disposal costs calculated with the methodology specified by Federal Register Notice 52-161.

Response As stated in Volume One, Section 3.4, the repository fees are based on the 1995 Analysis of the Total System Life Cycle Cost (1995 TSLCC) of the Civilian Radioactive Waste Management Program. The Draft EIS also acknowledges that the 1995 TSLCC was based on a single scenario and one repository. It is acknowledged that there is uncertainty in identifying a disposal fee prior to the final licensing of a national repository. Additional uncertainty results from analyzing various options considered in the EIS as the number of canisters varies from the baseline. However, DOE will comply with the provisions of the Nuclear Waste Policy Act requiring full cost recovery. The purpose of the cost analysis is to provide a basis for comparison among the alternatives (TWRS Draft EIS, Volume Two, Appendix B, page B-40).

In response to public comment, for the Final EIS, DOE and Ecology have reevaluated the estimate of disposal costs presented in the Draft EIS, using the 1987 methodology to more accurately reflect possible costs associated with disposal for the various canister options presented. This effort was coordinated through the OCRWM. Please refer to the response to Comment numbers 0081.02 and 0008.01 for additional information.

Comment Number 0005.44

Swanson, John L.

Comment I do not get the point of the sentence on page 3-37 "The use of a standard-sized canister does not consider waste loading, which ranges from 113,000 curies per canister to about 300-."

Response The use of the term "waste loading" here certainly could be confusing as it also refers to the waste loading of the glass with respect to percent sodium or waste oxides. Individual chemical entities such as sodium were considered in the "waste loading" of the glass. The quantity of radioisotopes and curie content was not limited in the glass formulations because the maximum heat load per canister was below the limit of 1,500 watts set for the repository.

The Final EIS was revised to include larger HLW canisters, which eliminates the need for the subject discussion in Volume One, Section 3.4. Please refer to the response to Comment numbers 0008.01 and 0081.02 for more information.

Comment Number 0008.01

Evett, Donald E.

Comment First, Current planning also assumes that this waste could be contained in approximately 18,000 standard-sized canisters. Also, there is insufficient capacity in the first repository to accept all Hanford Site -high-level waste under almost every alternative. Your study states that an estimated $360,000 cost per canister disposed of at the repository. The report alludes to the feasibility of using much larger canisters whereby the repository fees could be substantially reduced. In my opinion, I would think that the Department of Energy would vigorously pursue the much larger canisters.

Response Larger HLW canisters result in fewer waste packages for disposal at the geologic repository and offer substantial cost savings over the use of standard-sized HLW canisters. DOE is pursuing the use of HLW canisters that are larger than the standard-sized canister currently defined in the repository Waste Acceptance Systems Requirements Document (DOE 1994g). Since the Draft EIS was published, DOE-RW has acknowledged the technical feasibility of a larger canister for HLW and an independent technical review team convened to review the waste loading and blending assumptions used in the Draft EIS. The recommendations of the independent technical review team, along with the larger HLW canister specifications, have been incorporated into the ex situ alternatives for the Final EIS. The use of larger canisters and revised estimates for HLW volumes have been incorporated into the repository fee estimates shown in the Summary, Volume One, Section 3.0, and Volume Two, Appendix B. Section 3.4 describes the common assumptions for canister size and waste loading and additional detail is provided in Appendix B. Please refer to the response to Comment number 0081.02.

Comment Number 0008.02

Evett, Donald E.

Comment What happens if the Yucca Mountain project is defeated? What happens next and where will the canisters be disposed? If the year 2015 is the earliest date for acceptance of the high-level waste in canisters, where will the canisters be stored until this time? It is assumed that the use of canisters can commence much earlier than the year 2015.

Response DOE fully intends to comply with the Nuclear Waste Policy Act of 1982 as amended, which requires development of sites suitable for long-term disposal of spent nuclear fuel and HLW, and with DOE Order 5820.2A, which requires that HLW be processed and disposed of in a geologic repository. Therefore, disposal of HLW in a geologic repository was assumed and used as the basis for all alternatives involving HLW retrieval. The in situ and combination alternatives would result in onsite HLW disposal and the EIS analyzes the impacts associated with those actions. See Volume One, Section 6.0 for a discussion of the regulatory requirements and Volume One, Section 3.4 for assumptions associated with the geologic repository included in the EIS. Onsite storage at the Hanford Site for the HLW under the ex situ alternatives for up to 50 years is analyzed in the EIS. If longer-term storage is required due to delays in opening the geologic repository for disposal, appropriate NEPA analyses will be conducted.

Comment Number 0012.06

ODOE

Comment A large part of the cost shown for the vitrification alternatives included charges to dispose of the waste to the national high-level waste repository. These charges should not be used to decide whether to put the waste in a stable and durable form.

Several alternatives call for removal of all wastes from the tanks and vitrification. They differ in the methods used, complexity, speed and cost. The repository charges should be used as one criteria in deciding among these alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The cost estimates developed for each ex situ alternative presented in Volume One, Section 3.4 list the treatment cost, the estimated repository fee, and a total alternative cost range that combines treatment cost and estimated repository fee. The estimated repository fees, as acknowledged in the Draft EIS, have a high degree of uncertainty. Please refer to the response to Comment numbers 0004.01, 0008.02, and 0081.02 for more information concerning repository costs, canister size, and related uncertainties.

Comment Number 0027.02

Roecker, John H.

Comment Technical Data Manipulation

In Chapter 3 (page 3-33) DOE discusses the wide range of HLW canisters that could be produced and it makes reference to a WHC document for the low end of the range and a DOE document for the high end. The WHC document is an engineering document containing factual technical data and the DOE document is a set of comments on the TWRS System Requirement Document, which are not supported by technical data. This is another example of DOE Headquarters continuing to manipulate the technical data to support and satisfy their agenda rather than letting facts tell the story openly and honestly. Incidentally, the TWRS System Requirements Document has not yet been approved, to my knowledge, but yet here we are reviewing EIS alternatives which are supposed to be based on systems engineering. More on that later. I would request that in the Final EIS such manipulations of the technical data be eliminated and that all data be presented in accordance with standard systems engineering techniques and principles.

Response Because the alternatives evaluated in the EIS are conceptual at this time, engineering feasibility is limited to an Implementability review for each alternative. This is consistent with CEQ guidance that NEPA analysis occur as early in the decision making process as possible and always before irreversible and irretrievable commitments of resources have been made (40 CFR 1500). Following the publication of the Final EIS and approval of the TWRS ROD, a systems engineering and safety analysis of the preferred alternative will continue during the detailed design phase of the demonstration facilities. DOE intends to continue using systems engineering as a method for evaluation and implementation of the TWRS mission. It is anticipated that the detailed design of the waste retrieval, transfer, treatment, and storage demonstration facilities will be conducted using the system engineering and safety requirements currently being developed for TWRS (and concurrently with the TWRS Draft EIS).

The EIS presents an unbiased evaluation of each of the alternatives using the best available information. More information on canister assumptions and revisions to the EIS in response to revised information on canister size can be found in the response to Comment number 0008.01

Comment Number 0027.05

Roecker, John H.

Comment Repository Cost

I am not a lawyer, but in my reading of the Nuclear Waste Policy Act (NWPA) of 1982 as amended in 1987 and the Federal Register Notice 52-161 I believe it is quite clear on how the repository fee for disposal of HLW should be calculated. The use of linear extrapolation of a unit container cost for a specific disposal scenario to calculate the repository fee for all alternatives is completely wrong, misleading and totally obscures the real cost of each alternative. The use of a linear extrapolation of unit container cost greatly understates the cost of disposal for the extensive separations alternative and greatly overstates the cost for the No Separations alternative. This is a blatant example of data manipulation to make a particular alternative look attractive and misleads both the public and decision makers.

Response Please refer to the response to Comment numbers 0004.01, 0008.01, and 0081.02.

Comment Number 0027.07

Roecker, John H.

Comment Use of 0.62 m^3 HLW Canister

Requiring Hanford to use the 0.62 m^3 canister is overly restrictive and ridiculous particularly in light of the fact that a larger canister will be required for spent nuclear fuel. A larger HLW canister is a significant advantage for Hanford waste disposal and should be utilized.

Response DOE and Ecology recognize the potential benefits of using a larger canister for HLW. The use of larger HLW canisters has been included in the Final EIS. The size assumptions are presented in Volume One, Section 3.4 and Volume Two, Appendix B. These canister sizes have been used for impact analysis presented in Volume One, Section

5.0 and Appendices D, E, F, G, and H. Please also refer to the response to Comment number 0008.01 for more information on canister size and related impact on repository costs.

Comment Number 0035.04

Martin, Todd

Comment A clear stakeholder value has been that Yucca Mountain should not drive decision. We have said that the best waste form should determine which waste form is used, not the site, nor size, nor cost of a speculated national repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Repository considerations associated with the size, location, and cost of the potential repository did not drive the EIS analysis of waste form. The waste forms analyzed in the EIS are discussed relative to their ability to comply with existing waste acceptance criteria at the proposed repository; however, the analysis shows that the only waste form acceptable at the proposed repository is the one presently identified in the Tri-Party Agreement. This waste form is a borosilicate glass. Further, the information regarding timing is presented to provide a base case plan for analysis of impacts as required under NEPA. Information regarding the size of the repository is presented to inform decision makers and the public of the potential impact of TWRS waste on planning for the repository and the potential need for a second repository. In all cases, the EIS assumes, for purposes of impact analysis, that the waste would be stored on an interim basis at the Hanford Site and ultimately shipped for disposal at a geologic repository. The Final EIS has been revised to provide for up to 50 years of interim storage onsite. Each ex situ alternative includes interim onsite storage large enough to hold all HLW produced. This allows the waste treatment program to move forward with out relying on the geologic repository. The interim storage method provides for shielded storage of the immobilized HLW, protective of human health and the environment.

This is consistent with the Tank Waste Task Force value that DOE "accept the fact that interim storage, at least, of the waste in an environmentally safe form will occur for some time at Hanford" (HWTF 1993). Later in the Tank Waste Task Force report when addressing waste storage, a discussion is included that advises DOE to "assume temporary storage will occur at Hanford but don't assume that all radionuclides should be here forever." Please refer to the response to Comment numbers 0008.02, 0004.01, 0038.10, 0052.01, 0035.04, 0012.11, and 0055.03 for all issues related to tank waste disposal and the TWTF.

Comment Number 0035.05

Martin, Todd

Comment I would like to address the cost estimates and how they effect the TWRS EIS, particularly in regards to Yucca Mountain.

If you look at some of the simple technical assumptions that are made in the EIS, such as waste loading, the amount of waste that gets into the glass, it dramatically affects cost.

The waste loading has been altered by a mere factor of a little bit more than 10 percent over the last couple of months. Some of the blending assumptions have been changed.

What does that do to cost? If you look at the preferred alternative, it changes the repository cost from four billion dollars all the way up to 12 billion dollars. That is a big impact for such a small change.

The no separations options, change the canister size. What does that do to the cost? It changes the repository cost from about 13 billion all the way up to over 250 billion dollars.

These overly conservative assumptions and the uncertainty with the repository are driving the costs that we see in this EIS. That is inappropriate, and the stakeholders have made that clear in the past.

Response The repository fees presented in the Draft EIS for the ex situ alternatives were overly conservative, but consistent with the published information DOE had at the time the Draft EIS was published. The Final EIS has been modified based on new guidance from the repository and an independent technical review of the Draft EIS. Please refer to the response to Comment numbers 0004.01 (repository fees and associated uncertainty), 0008.01 (canister size assumptions and associated changes in repository costs), 0027.11 (HLW waste loading), 0035.04 (comprehensive repository issues), and 0081.02 (separation of respository costs from alternative costs).

Comment Number 0036.01

HEAL

Comment Unfortunately, the repository plays an important role in the cost analysis of EIS alternatives. The EIS does include the speculated repository cost as a separate cost item, allowing the careful reader to see the role the repository plays in cost. This is an improvement. But many will not read beyond the Summary -- where the total cost is the only number available. The EIS itself makes a very good case for removing the repository cost numbers:

(The estimate of repository disposal costs)"... is an estimate based on numerous assumptions. Nor should the assumptions used in the analysis be interpreted as final DOE policy. The program is in the early stages of development and design concepts for items such as the repository surface facility, underground layouts, and waste packages are very preliminary. The techniques used to estimate the total system cost were appropriate to the limited level of design development and entail a corresponding level of uncertainty ... There is a high degree of uncertainty in using a fixed cost per canister for geologic disposal over the wide range in the number of canisters that would be produced for the TWRS alternatives." (p. 3-37)

In other words, there is almost no basis for the repository disposal costs and they should not be trusted.

The continued high-profile role of the speculated repository is unacceptable. It goes against past stakeholder values and common sense. Further, the EIS itself says that DOE will bring the program to a safely stored state at Hanford, regardless of the repository's existence. Each of the ex situ alternatives will include onsite storage sufficient for ALL the waste. According to the EIS, "This would allow each of the alternatives to operate independent of the acceptance schedule for the potential geologic repository" (p. 3-38). The Final EIS must be rewritten in such a way as to clearly put the repository in perspective and dramatically reduce the role the repository plays in the document.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Final EIS has been revised to discuss HLW disposal at the geologic repository

and the associated cost separately. See Volume One, Section 3.7 and Volume Two, Section B.9 for the revised discussion of HLW disposal at the geologic repository. Please refer to the response to Comment numbers 0004.01, 0008.02, 0035.04, and 0081.02.

Comment Number 0036.02

HEAL

Comment The EIS is biased to maximize the cost impact of the national repository.

Over the last few months, changes in waste loading, blending, and canister assumptions have maximized repository costs. The assumption changes are a radical departure from past TWRS assumptions and are not based on any evident engineering data.

Assuming waste loadings similar to those in Tri-Party Agreement studies results in the following repository fees:

- about $4 billion dollars for the "Phased Implementation" alternative.
- about $13 billion for the "no separations" alternative.

After the assumptions were changed, the "Phased Implementation" repository fee rose to about $12 billion and the "no separations" skyrocketed to over $250 billion. Meanwhile, the repository fee for extensive separations stayed relatively constant.

These assumptions may seem minor, but obviously have a large -- and inappropriate -- impact.

Response DOE and Ecology acknowledge that the repository fees presented in the Draft EIS for the ex situ alternatives were overly conservative. The data to support the TWRS EIS assumptions, analysis, and calculations were cited in the Draft EIS and engineering data packages, and calculations were provided for public review in DOE Reading Rooms and Information Repositories. The Final EIS has been modified based on new guidance from the repository and an independent review of the Draft EIS. Please refer to the response to Comment numbers 0004.01, 0008.02, 0035.04, and 0081.02.

Comment Number 0037.03

Eldredge, Maureen

Comment I am concerned about the cost estimates in the program, particularly including repository costs. It does not make any sense. It is ludicrous. We do not have a repository. DOE needs to wake up to that fact.

We are not going to get a repository any time soon, not by 2015. It is just not going to happen. We do not know what the repository, if we ever get one, will look like. We do not know what its loading requirements will be. We do not know what its technical capabilities will be. We do not know what its size will be.

Any predictions of cost for a repository are highly speculative. Even if Yucca Mountain by some chance happened to open in any kind of reasonable time frame, the first people in line are the commercial nuclear utilities.

And believe me, they are going to make sure they keep their place first in line. And they are going to make sure all of their waste gets into the facility before any defense waste gets a chance.

Even if defense waste gets in the door, only 10 percent of the repository is slated to be for defense high-level waste. And I am afraid that we are going to run out of space at Yucca Mountain at least very soon, if it opens at all.

Then we are looking at a really fun option of going for a second repository. It is just not going to happen. And it is time to start making plans and start looking at the future with more reasonable expectations.

Response The siting, design, and licensing of a geologic repository to isolate spent nuclear fuel and HLW for long-term protection of public health and safety of the environment is a highly technical and complex process. As stated in Volume One, Section 6.2, the current program planning assumption is that any DOE material qualified and selected for emplacement in the first repository would be disposed of beginning in the year 2015.

As stated in the EIS, current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository. The ex situ alternatives presented in the TWRS EIS were developed to be consistent with this policy. Current projections for commercial spent nuclear fuel and defense HLW exceed the statutory limit of 70,000 equivalent metric ton heavy metal (MTHM) in the first repository. The need for a second repository will not be addressed until between January 1, 2007 and January 1, 2010 when the Secretary of Energy is required to report to the President and Congress under the Nuclear Waste Policy Act. Please refer to the response to Comment numbers 0004.01, 0008.02, 0012.20, 0035.04, and 0069.04 for additional information.

Comment Number 0038.10

Reeves, Merilyn

Comment The cost of the national repository, which you have heard about tonight, it should be removed from the EIS. The hypothetical, national repository has been a driver for the tank waste treatment and disposal decisions. And this is not in the best interest of cleanup at Hanford.

The Tank Waste Task Force of 1993 was very clear, quote, let the ultimate best form for the waste drive decisions, not the size, nor the timing of the national repository.

The repository costs are not broken out in the summary, misleading the reader by not communicating the importance of repository costs for each option. And the speculated cost of repository should be removed from the EIS.

Response The presentation of the cost estimates has been revised for the Final EIS by separating the cost and discussion regarding HLW disposal. See Volume One, Section 3.7 and Volume Two, Section B.9 for HLW disposal costs. There are real costs associated with disposal of HLW at the geologic repository, and removal of these cost estimates from the EIS would not allow for an equitable comparison among the alternatives as required under the NEPA process. It is necessary to show these costs in the EIS to fully inform the public and the decision makers of the total cost of the alternatives. Please refer to the response to Comment numbers 0004.01, 0008.01, 0035.04, 0052.01, 0069.04 and 0081.02 for additional information on issues related to cost estimates, the geologic repository, waste loading and waste forms, and interim onsite storage.

Comment Number 0050.01

Boldt, A.L.

Comment I have a comment on the Draft EIS disposal cost. The geologic disposal cost presented in the Draft EIS are based on the linear extrapolation of the average container disposal cost provided by the document from DORW0479 referenced in the EIS, Analysis of Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program. This analysis cost in this document was for a specific scenario of waste in a number of canisters. The linear extrapolation of this average container cost - disposal cost from this previous reference to all the TWRS alternatives does not meet the requirements of the Nuclear Waste Policy Amendments Act of 1987 and the Federal Register Notice 52161, the Civilian Radioactive Waste Management Calculating Nuclear Waste Disposal Fees for the Department of Energy Defense Program Waste.

Federal Register Notice 52161 identifies, in detail, the method to be used in estimating the disposal fees for the Department of Energy Defense Program HLW share of the Civilian Radioactive Waste Management System costs. The Federal Register Notice 52161 cost allocation is based on the concept of full cost recovery with sharing formula supplied to all fixed and variable cost system or system cost components. The assumption of the linear extrapolation of average container disposal cost in the Draft EIS, greatly under estimates the disposal cost for the Extensive Separations alternative and greatly over estimates the disposal cost of the No Separations alternative. Example, disposal cost variability for alternate HLW container sizes and high-level waste volumes resulting from No Separations, intermediate separations, and extensive separations using the methodology of the Federal Register Notice 52161 are provided in a document by TRW for Environmental Safety Systems and it has long numbers on the copy I will give you but it is assessed on the pre-closure system cost health and safety in facts of Hanford high-level vitrification options on the civilian radioactive waste management system. This document is dated April 27, 1995.

I am requesting with the Draft TWRS EIS be revised to incorporate high-level waste disposal costs calculated with methodology specified in Federal Register Notice 52161.

Response Please refer to the response to Comment numbers 0004.01 (repository costs related to canisters) and 0081.02 (separation of repository, retrieval, and treatment costs).

Comment Number 0052.02

Pollet, Gerald

Comment What we need to remove from your total cost estimates is the entire set of repository fees. It is not sufficient to say that we broke out the repository fee in the details because you are still presenting a total range of cost estimates that the public and media and the decision makers are actually going to look at and they're going to say by gosh, that

No Separations alternative costs a quarter trillion dollars. What kind of lunatic wanted No Separations? And what the decision makers, public, and media will not know is that, in fact, No Separation alternative actually has a rather reasonable price tag of below 30 billion dollars and that 211 billion dollars is a hypothetical repository fee for a hypothetical repository. A fee charged by the department to itself for repository which it admits in the EIS will never have the capacity for this. So it is a hypothetical fee for a hypothetical repository that the one certainty is does not have the capacity for it ever opened. There is something wrong with that picture and presenting it to decision makers, the public, and the media, it is apparent to the casual observer that someone is trying to skew the results.

Response DOE and Ecology have revised the Final EIS in response to public comment and put the costs of the repository into a separate presentation. The estimated costs for disposal of the HLW at the potential geologic repository are included in the Final EIS because there would be real costs associated with packaging, transport, and placement of HLW in a geologic repository. Eliminating the repository fees from the cost estimates presented in the EIS would not provide all of the costs associated with the alternatives and would bias presentation of the alternatives. Please refer to the response to Comment numbers 0038.10 and 0081.02 for discussion of repository costs as these issues relate to the alternatives analysis and the response to Comment numbers 0037.03 and 0008.02 for a discussion of the proposed geologic repository availability and statutory capacity.

Comment Number 0052.05

Pollet, Gerald

Comment One last closing thought for our comments tonight which is if you have a hypothetical repository fee for the hypothetical space at a hypothetical repository and the hypothetical land, then for the very real cost to the three tribes to the future generations of this region why isn't there assigned a cost for the permanent use of land in the leave it in place alternatives that are clearly being shown a preference through out all the cost estimates in this EIS. You need to consider internalizing the externalities and I would say that is less hypothetical and I think that the public could provide you and the tribes some very real cost estimates for creating a sacrifice found under the leave it there scenarios.

Response The cost estimates for the in situ or ex situ alternatives do not include cost associated with permanent land commitment, or land use restrictions associated with groundwater contamination. The amount of land committed to waste management and disposal was estimated for each of the alternatives, as was the extent of a groundwater contamination and associated human health impacts. The costs associated with long-term loss of land use or groundwater use can be understood within the overall context of the relative difference among various alternatives land use and groundwater use restrictions. The more land or groundwater is restricted the higher the cost. So while absolute dollar estimates are not provided the EIS does provide an appropriate level of analysis to support the comparison of alternatives. Land use issues related to Tribal Nation concerns are described in Volume One, Sections 5.5 and 5.19. Please also refer to the response to Comment numbers 0072.26, 0072.22, and 0036.18.

Comment Number 0055.04

Martin, Todd

Comment A third point would be that the repository should not be driving decision making at Hanford.

Response DOE and Ecology acknowledge the concern expressed in the comment. NEPA requires that all reasonable alternatives be evaluated. Consideration of geologic repository availability was included in the evaluation of the ex situ treatment alternatives in the EIS to the extent that availability was assumed; a limit would be placed on the accepted volume, type, and final waste form of Hanford materials, and the interim storage facilities would include a 50-year design life to provide sufficient time for availability. Data that support the impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and the public during the comment period. Please refer to the response to Comment numbers 0008.02, 0035.04, 0037.03, 0038.10, and 0052.01.

Comment Number 0055.05

Martin, Todd

Comment I want to address cost estimates in Yucca Mountain. I think people have heard that several times but I want to address some of the specifics. In looking at the numbers, you change a few assumptions here and there and it is amazing what it does to those cost numbers. For example in Phased Implementation when we look at the repository cost. You shift the waste loading, the amount of waste that goes into the glass by a mere 10 percent into essentially a percentage that is much lower than I have ever seen in any documents. What does that do to the repository cost for that option. Moves from 4 billion dollars to 12 billions dollars. Just a little assumption like that. Let us look at the no separation option. You take a fairly large canister, your repository cost is about 13 billion dollars. Shrink that canister down a bit and it jumps to 252 billion dollars. These are the kind of assumptions that I think that Mr. Pollet pointed out appeared to have been skewed to maximum the impact of the Yucca Mountain on the EIS. And I would agree with that assertion.

Response The changes in repository cost were a result of changes to the waste loading, HLW canister size, and use of a blending factor to account for uncertainties in the ability of the retrieval operations to deliver a uniformly blended waste feed stream to the treatment facilities. The variation in estimated repository cost based on waste loading and canister size is included in the cost ranges presented in the EIS. Please refer to the response to Comment numbers 0035.04. 0038.10, and 0081.02.

Comment Number 0057.04

Garfield, John

Comment The logic of the repository cost for example in the intermediate separations adding up to $12 billion dollars does not make sense from even the simplest technical that any member of the public can understand. The Hanford contribution to the repository in total is about 1 percent of the total radionuclides if all the high-level wastes goes to the repository and about 1 percent of the heat. Whether or not content into the small number of canisters or leave it in a large number of canisters will not significantly drive the repository costs. That is a fairly straight forward and simple approach or way of thinking about that problem that everyone can understand. Attributing $12 billion dollars to that repository or $211 billion dollars for the No Separations case does not stand up to the simplest scrutiny.

Response The amount of HLW that ultimately could be accepted at a national repository is a function of available subsurface area and emplacement constraints among HLW and spent nuclear fuel (SNF) within this area. In addition, there is a statutory limit on emplacement of HLW and SNF in a first repository (70,000 MTHM) until a second repository is in operations. As a planning basis, the Department has allocated 10 percent of that statutory capacity of the first repository for defense SNF and HLW.

The physical amount of available subsurface area for HLW and SNF disposal, and the associated number of packages of HLW and SNF, would be defined through repository design and performance assessment activities, based on information collected during repository scientific investigations. Neither of these activities are completed. However, for planning purposes, the repository Advanced Conceptual Design assumes that 12,900 canisters of defense HLW, each containing 0.5 MTHM, can be accommodated within the statutory limit.

A number of factors are important in estimating disposal costs including number and size of canisters handled, number of waste packages, operation and capital costs, and number of shipments to a repository. In addition, there are common costs that must be allocated among waste generators, such as development and evaluation costs, to ensure full cost recovery. Using radionuclide inventory of Hanford HLW relative to other wastes would not provide an equitable basis for cost estimating. For more information on this issue, refer to the response to Comment number 0005.08.

A number of factors go into the repository cost estimate including heat load, canister size, waste package design, and number of waste packages. Looking at Hanford contribution of the repository cost solely from the standpoint of radionuclide contribution to the repository would not provide a straightforward and understandable basis for cost estimating. Please refer to the response to Comment numbers 0004.01, 0008.01, and 0081.02 for additional information on repository cost estimates.

Comment Number 0062.05

Longmeyer, Richard

Comment One of the things that would need to be re-looked at is if the Yucca Mountain facility is not going to become a reality, how would that affect the prioritization of these different plans. And my guess is that the Yucca Mountain facility, or any national repository for nuclear wastes, will never receive any nuclear wastes from across state lines in my lifetime, and probably not in the lifetime of my children. And so that means that we need to re-look at this, and prioritize them again. Doing so would probably leave us with three options. The in situ vitrification, the ex situ vitrification with onsite storage, and the Phased Implementation, which you have now with onsite storage. And so, those would be the three that I would recommend we look at more closely.

Response Current national policy calls for disposal of spent nuclear fuel and HLW in a geologic repository. DOE and Ecology developed the ex situ alternatives in accordance with this policy. In response to concerns regarding the timing and availability of the geologic repository to accept HLW from the Hanford Site, the Final EIS has been revised in Volume One, Section 3.4 and Volume Two, Appendix B to include the impacts associated with onsite interim storage of treated HLW for 50 years. The environmental impacts associated with the in situ alternatives identified in the comment are provided in the EIS in Volume One, Section 5.0 and associated appendices. Volume One, Section 5.12, and Volume Three, Appendix D contain discussions of the transportation risk associated with offsite disposal. Please refer to the response to Comment numbers 0008.02 (repository availability and related uncertainties) and 0037.03 (statutory limits), and 0052.01 (interim HLW onsite storage) for more information.

Comment Number 0072.84

CTUIR

Comment P3-28: PP 5: Does this mean you are only going to use one multi-purpose canister? Please explain in more detail in order for the readers to grasp how many and how much.

Response One type of multi-purpose canister was assumed as an overpack used for handling and interim onsite storage. This multi-purpose canister is referred to as a Hanford Multi-Purpose Canister (HMPC) throughout the document. The text has been revised in Volume One, Section 3.4 to discuss the relationship between the primary HLW canisters and the HMPC.

Comment Number 0077.05

ODOE

Comment A large part of the cost shown for the vitrification alternatives included charges to dispose of the waste to the national high-level waste repository. These charges should not be used to decide whether to put the waste in a stable and durable form.

Several alternatives call for removal of all wastes from the tanks and vitrification. They differ in the methods used, complexity, speed, and cost. The repository charges should be used as one criteria in deciding among these alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0004.01, 0035.04, 0052.01, and 0081.02 for more information regarding disposal costs, assumptions, and presentation in the Final EIS.

Comment Number 0079.05

Knight, Paige

Comment Repository costs must not be included in the total cost of any plan implemented. Cleanup dollars must go first towards stabilizing waste in a quality form that is not water soluble. Repository room must be considered. If Yucca Mountain is ever a viable option, it will only hold a small portion of Hanford waste. So the form of the waste must be not only stable, but retrievable. My reasoning there is that more than likely the waste in any kind of form is going to be sitting at Hanford for at least 40 years, and I would suspect much more than that.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0008.01, 0038.10, and 0081.02.

Comment Number 0081.05

Pollet, Gerald

Comment More importantly is the next bullet in our advice. Accept the fact that interim storage at least, at least, of the waste in an environmentally safe form will occur for some time at Hanford. Select a waste form that will ensure safe interim storage of this waste. The message was, Hanford is going to be the home for the high-level nuclear waste. Select the best form, and don't even put into the mix the theoretical cost of the repository, which the Department will charge itself, nor the theoretical capacity of it, because it doesn't have the capacity to handle it anyway, under any scenario here. We request that this advice be addressed, and placed in the front of this EIS. And it be addressed in the summary and throughout. We request that the repository costs be relegated to an appendix, and the total cost summaries be redone to show the total cost without the theoretical hypothetical self-dealing charge for replacing waste in the repository. When that is done, we should examine carefully the no separation versus the extensive separation scenarios. And we should see how much we pay for unproven technology under extensive separation, versus no separation and intermediate separation.

Response The storage of the HLW at the Hanford Site for 50 years has been included in the ex situ alternatives. Please refer to the response to Comment number 0089.18. Current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository and the ex situ alternatives were developed to be consistent with this policy. DOE and Ecology have revised the presentation of the cost estimates for HLW disposal for the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B. This will allow the reader to readily compare the estimated cost for waste treatment among the alternatives. There are real costs associated with packaging, transport, and placement of canistered HLW into a geologic repository, and failure of the EIS to present these costs would provide an incomplete picture for the decision makers and public. Please refer to the response to Comment numbers 0004.01, 0035.04, 0038.10, and 0069.04.

The EIS presents in Volume One, Section 3.4 and Volume Two, Appendix B, alternatives that are based on 99 percent retrieval with no separations (the Ex Situ No Separations alternative), intermediate separations (the Ex Situ Intermediate Separations alternative), and extensive separations (the Ex Situ Extensive Separations alternative). A summary comparison of these alternatives is provided in the Summary and a summary of the environmental impacts of each alternative is presented in Volume One, Section 5.14.

Comment Number 0089.18

Nez Perce Tribe ERWM

Comment Since the possibility exists that Yucca Mountain repository may not open, the design life of the onsite facility storing the vitrified high-level waste must be sufficient for the permitting and construction of an alternate high-level waste repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume One, Section 3.4, the Summary, and Volume Two, Appendix B.3 have been revised to include reference to the 50-year design life for the interim HLW storage facilities, which is based on a conservative estimate for approval and availability of the geologic repository. Please refer to the response to Comment numbers 0008.02, 0035.04, and 0052.11.

L.3.4.2.2 Alternatives Costs

Comment Number 0005.12

Swanson, John L.

Comment I applaud you for giving cost RANGES in comparing the different alternatives, but I am very surprised that you did not include the (large) uncertainties in HLW repository disposal costs in many of these ranges. In recent years, there have been reports of attainable cost savings through the use of higher waste loadings in HLW glass and the use of larger canisters; such savings could give estimated repository disposal costs only one-fourth as large as the values you give.

Response DOE and Ecology considered HLW disposal fees in the total cost range (treatment cost + repository fee) for the ex situ alternatives presented in the EIS. For example, when comparing the treatment cost range to the total cost range, the total cost range is not the sum of the treatment cost range and the repository fee. This methodology addressed only TWRS-specific parameters, mainly waste loading and canister size, in the cost uncertainty analysis. Uncertainties in the repository program are not within the scope of the EIS. However, 50 years of storage of the HLW is included in the ex situ alternatives to account for the uncertainty of when a repository may be available to accept waste for disposal. Please refer to the response to Comment numbers 0081.02, 0072.80, and 0008.01 for further discussions of repository and canister issues.

Comment Number 0005.13

Swanson, John L.

Comment Because of the large uncertainty in HLW repository disposal costs, I feel that it would be a more fair comparison of the costs of the alternatives in the Summary if you split out those estimates-something like "The cost of this alternative, exclusive of the HLW repository fee, is estimated to be in the range of ___ to ___. Based on the assumptions adopted for this EIS, the HLW repository fee for this alternative is estimated to be __; the use of other assumptions regarding higher waste loading in glass and the use of larger canisters could lower this estimated fee to ___."

Response DOE and Ecology recognize the concern regarding the cost uncertainty associated with the repository. The Final EIS has been revised to discuss HLW disposal at the geologic repository, the associated cost separately, and potential impacts (e.g., accidents during transportation). The Summary, Section S.8, Volume One, Sections 3.7 and 6.0, and Volume Two, Section B.9 contain a discussion of HLW disposal at the geologic repository. Please also refer to the response to Comment numbers 0081.02, 0008.01 and 0005.12 for further information regarding repository availability, cost estimate methodology, and assumptions.

Comment Number 0005.14

Swanson, John L.

Comment The more I look into your cost ranges, the more confused I become. For example; a) Footnote (3) to Table S.7.6 says that the relatively large ranges in costs for three of the alternatives is primarily a result of assumptions made for repository fee, but two of the three alternatives identified in this footnote do not fit this situation. b) Tables 3.4.13 and 3.4.14 contain footnotes indicating that the cost ranges are dependent on the canister size used, but the tables themselves give only individual values for the repository fees. Why aren't the repository fee ranges used given in the tables? Also, if the cost ranges resulting from canister size increase are given for this/these alternative(s), why aren't they given for the other alternatives as well? The way you have it is a mixture of "apples and oranges." c) Section B.8.3 ("Cost Uncertainty") does not do anything to help me, either-except to emphasize that "assumptions drive conclusions."

Response The footnote in question (footnote number 3 of Table S.7.6) is intended to provide the reader a summary-level explanation of why the cost ranges vary widely for the ex situ alternatives. The difference between the high and low cost range for the Ex Situ No Separations (Vitrification) alternative is $184 billion, the range for the Ex Situ No Separations (Calcination) alternative is $47 billion, and the range for Ex Situ Intermediate Separations and Phased Implementation alternatives is approximately $10 billion. The ranges estimated for these alternatives are greater than the other alternatives mainly because of repository fee assumptions. Technical assumptions regarding the HLW canister sizing have been revised for the Final EIS, which reduce the large cost ranges associated with the ex situ alternatives that produce large volumes of HLW. Additional detail on how the cost uncertainty and ranges were estimated is provided in Volume Two, Appendix B. Please refer to the responses to Comment numbers 0081.02 and 0005.03 for more information on uncertainty.

The Volume Two, Appendix B discussion on cost uncertainty is intended to provide an overview of the methodology and the analysis results. The detail input output data are included in the technical backup data that is publicly available as part of the TWRS EIS Administrative Record.

As noted in the response to Comment number 0005.12, the uncertainty in HLW disposal fees that would result from a variation in the number of HLW packages is included in the total cost range for each ex situ alternative. This allows for an equitable comparison among alternatives.

Comment Number 0052.03

Pollet, Gerald

Comment The costs have some other strange anomalies. For instance, some of the cost estimates for vitrification alternatives today are basable upon some market considerations in terms of what vendors are saying they believe they will be able to bid.

Response None of the cost estimates for the alternatives presented in the Draft EIS were based on privatization of the tank waste treatment. Privatization is an implementation strategy and as such was not addressed in the EIS. For a discussion of this, see Volume One, Section 3.3. All of the cost estimates were developed using the same methodology to provide an equitable comparison among the alternatives. Privatization issues are discussed in the response to Comment number 0060.01.

Comment Number 0052.04

Pollet, Gerald

Comment But what is kind of incredible in this EIS is continuing the historic practice at this site of having a capital contingency built into all the cost estimates of not just 30 percent here but 30 to 50 percent. It is really hard to talk about how the TWRS program is reaming in its costs when its capital cost estimates have a contingency added in of 30 to 50 percent. It is very disturbing and from point of view of how this is then presented to Congress, what we have is a set of alternatives that may emerge that are the ones that are necessary to meet the legal requirements of removal, retrieval, and treatment which are inflated because of their capital considerations by 50 percent and which are inflated by up to $211 billion dollars by a hypothetical repository fee and then we wonder why Congress may not want to fund vitrification.

Response The use of contingencies in cost estimates is standard practice throughout the public and private sector. This is especially true of conceptual estimates for any large construction projects. The use of a contingency in the capital cost estimates is a means to quantify the uncertainty inherent with conceptual designs. The use of contingencies is appropriate for all construction projects, especially projects involving the complexity of the TWRS program. Cost estimates associated with the repository are provided in response to Comment numbers 0004.01 and 0081.02. Capital construction costs are discussed in the response to Comment numbers 0055.06 and 0081.03. DOE-Richland Operations Office (DOE-RL) prepares an annual budget, which would include the budget required for the TWRS cleanup for that year. However, only Congress has the authority to appropriate funds.

Comment Number 0055.06

Martin, Todd

Comment On the costs more generally, I trust the costs in this document about as far as I can throw this document which needless to say without doubt is not very far. Most of the people in this room remember the Hanford Waste Vitrification Plant. This was a 1-ton a day high-level waste vitrification facility. This was the cornerstone of Hanford cleanup that as I recall is supposed to be running in about 3 years but we canceled the program. That was projected to cost about 1.3 billion dollars. Pretty hefty. I look at this EIS and I see that a low-level waste facility (vitrification facility) it is 20 mt per day. Twenty times the throughput is going to be built for 248 million dollars. I do not get it. I do not see the basis for those costs and I simply do not buy it. Further, to compare more of an apples to apples, we look at the high-level waste vitrification facility that is in the EIS. This a 1 metric ton a day facility, it is essentially HWVP. The 1.3 billion dollar facility. What is it in this EIS? 232 million dollars. I can not imagine that it can be built for that. In other words, total for the Phased Implementation alternative, DOE is going to built two low-level waste vitrification facilities with an agent pre-treatment on both of those and one high-level waste facility for 1.4 billion dollars. Essentially the cost of HWVP. I say no way. If that is true, why are we doing privatization? We can take the budget authority that has been given about 2 years and we have got the full cost of one of these facilities. This does not assume any efficiencies from privatization. These are government-owned, contractor-operated facilities, built under a traditional contracting mechanism. Essentially, until a formal credible data package has been done to support the Phased Implementation, the preferred alternative in this EIS, this EIS should go forward no further. Should go no further.

Response DOE and Ecology acknowledge this concern regarding the cost estimates and have reviewed and revised the Phased Implementation cost estimate as appropriate for the Final EIS. These revised cost estimates are shown in Volume One, Section 3.4 and Volume Two, Appendix B and are reflected in the Summary. The Hanford Waste Vitrification Plant (HWVP) cost estimate is not directly comparable to the capital cost estimate for the Phase 1 HLW facility because it includes support facilities and infrastructure that are estimated as separate components for Phased Implementation.

The Phased Implementation alternative was developed by scaling appropriate components from the Ex Situ Intermediate and Extensive Separations alternative. The capital cost was estimated using the "six-tenths rule" and the relative plant capacities for Phased Implementation were estimated in the absence of more definitive data. DOE and Ecology acknowledge that there is uncertainty introduced into the cost estimates by scaling and this is captured in the cost uncertainty analysis. The cost uncertainty analysis results in a cost range within which the final cost would be expected to fall. Total capacity cost breakdowns for a combined separations LAW facility and a detached HLW treatment facility are generally 35 percent equipment, 20 percent material, and 45 percent labor (WHC 1995j).

The cost estimates input data, methodology, and calculations are available in the reference documents included in the EIS and available for public review in DOE Reading Rooms and Information Repositories.

Comment Number 0057.06

Garfield, John

Comment There are a few other less important comments that I will make. One is with regard to the cost estimates for the combination case and to some degree the Phased Implementation case. Parsons has used 6/10ths power rule to arrive at those costs for lack of any conceptual design basis to make those estimates. That rule is applicable in the commercial industry for chemical processes because those plants are largely equipment-driven. 50 to 85 percent of those plant costs are equipment and when you vary the capacity that the capital cost of the facility does, as a rule, from varied by the 6/10ths power rule. Nuclear facility equipment costs only amounts to 10 to 20 percent of the total capital cost. That same 6/10ths power rule can not be used for a shielded nuclear processing facility. It makes no sense to do that and the cost have been skewed for using that. That adjustment should be made and can be made fairly easily.

Response The Phased Implementation alternative and combination alternatives were developed by scaling appropriate components from the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives. The capital cost was estimated using the "six-tenths rule" and the relative plant capacities for the Phased Implementation alternative in the absence of more substantive data. Some uncertainty is introduced into the cost estimates by scaling and this is captured in the cost uncertainty analysis presented in Volume Two, Appendix B. The cost uncertainty analysis results in a cost range within which the final cost would be expected to fall. Total capital cost breakdowns for a combined separations LAW facility and a detached HLW treatment facility estimated for the Ex Situ Intermediate Separations alternative are 35 percent equipment, 20 percent material, and 45 percent labor (WHC 1995j).

The cost estimating methodology has been reviewed and revised cost estimates have been completed for the Phased Implementation and combination alternatives, and for other alternatives as appropriate. These revised costs are shown in Volume One, Section 3.4 and in Volume Two, Appendix B.

Comment Number 0069.04

Pollet, Gerald

Comment The TWRS EIS skews the costs of the alternatives as well. This, coupled with the risks, presents a very biased picture in the EIS of the alternatives. First off, you see this is how their rank ordered in the EIS, as it will be presented to decision makers, and is being presented to you, the public. Leaving waste behind has a cost range of 23 to 28 billion. Extensive separation comes in close behind it, 27 to 36 billion. This is the Tri-Party Agreement path, called Phased Implementation, 32 to 42 billion, building just one plant basically with multiple melters, and calling it all high-level waste, glassifying it all, this astonishingly high price tag. Anyone rational would throw it out.

The repository fee, once it's removed ... excuse me, what I was saying was, the Nuclear Waste Policy Act does, indeed say how you should calculate a repository fee if your going to use it here.

It is not the way it is calculated here. Secondly, it should not be used at all because this waste will never fit into the proposed hypothetical repository at Yucca Mountain. So what is the fee for? It's a hypothetical fee the Department charges itself for a hypothetical repository that will not have room.

So all of a sudden, we have a drastic change in the order of the alternatives. In fact, what we get is, let me just present the conclusion, the Ex Situ/In Situ Combination goes from being least cost by 4 to 8 billion, to only being 1 to 7 billion dollar lower cost then getting all the waste out of there. The Extensive Separations goes from number 2 to number 4 and number 5. It goes from having a cost advantage of 5 to 6 billion dollars over the Tri-Party Agreement, to having a 5.4 to 6.4 billion dollar disadvantage over the Tri-Party Agreement path. It is an effort to skew the data here, and present it in a skew manner to decision makers. And the No Separations alternative, which gets wastes out of tanks fastest, with least research and development, actually shows up as having potentially the lowest range costs. Thank you.

Response The Phased Implementation alternative involves building two separations and LAW treatment facilities and one HLW vitrification facility during Phase 1 to demonstrate the treatment technologies. Following Phase 1, Phase 2 would be implemented, which would involve building full-scale treatment plants to treat the remainder of the tank waste. For a description of the Phased Implementation alternative, please refer to Volume One, Section 3.4.

The purpose of the Nuclear Waste Policy Act is to: 1) establish a schedule for the siting, construction, and operation of repositories that will provide a reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level radioactive waste and such spent nuclear fuel as may be disposed of in a repository; 2) establish the Federal responsibility, and a definite Federal policy, for the disposal of such waste and spent fuel; 3) define the relationship between the Federal Government, State and affected Indian Tribal governments with respect to the disposal of such waste and spent fuel; and 4) establish a Nuclear Waste Fund, composed of payment made by the generators and owners of such waste and spent fuel, that will ensure that the costs of carrying out activities related to the disposal of such waste and spent fuel will be borne by the persons responsible for generating such waste and spent fuel. The Nuclear Waste Policy Act does not provide a methodology for calculating the repository fee for disposal of HLW in a geologic repository. For the Final EIS, repository fees were recalculated. For more information, please refer to the response to Comment numbers 0004.01 and 0036.01.

Current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository. The current inventory of commercial spent nuclear fuel and defense HLW exceeds the statutory limit for the first repository. The disposal of all commercial spent nuclear fuel and defense HLW will require increasing the limit of the first repository or constructing a second repository. DOE is currently characterizing one site, Yucca Mountain, Nevada, for a geologic repository. The law requires that the Secretary of Energy report to the President on or after January 1, 2007, but not later than, January 1, 2010, on the need for a second repository. Within this context, none of the alternatives addressed in the TWRS Draft EIS exceed the capacity for geologic disposal, even though many of the alternatives would generate more canisters of HLW than the repository program is currently using for planning purposes. Based on revised canister size and other recalculations completed for the Final EIS, the EIS has been revised in Volume One, Sections 3.4 and 6.0, and Volume Two, Appendix B, to address the repository capacity issue relative to TWRS alternatives.

Failure to recognize that each of the ex situ alternatives would have cost impacts associated with HLW disposal would provide unequal information for the reader. Please see the response to Comment numbers 0081.01, 0081.02, and 0035.04.

Comment Number 0072.92

CTUIR

Comment P 3-36: PP 4: S 2: By what factor? Or by a factor of what?

Response Capital cost contingencies were included in the alternative cost estimates as described in Volume One, Section 3.4 and Volume Two, Appendix B. These contingencies are included to account for the uncertainty associated with the conceptual-level designs developed for analysis in the TWRS EIS. The contingency factors used ranged from 25 to 50 percent with a typical value of 40 percent. The higher contingencies were applied to the more conceptual facilities and the lower contingencies were applied to the more defined facilities. This is consistent with industry standards and practice. Please refer to the response to Comment numbers 0052.04, 0055.06, and 0057.06 for related information on the use of contingencies in cost estimating.

Comment Number 0072.93

CTUIR

Comment P 3-36: PP 6: Please explain how the R&D cost is to be assumed for the phased alternative.

Response Because Phase 1 would be a demonstration process, the research and development cost for the treatment process was assumed to be an integral part of the Phase 1 operating cost. The research and development cost associated with the waste retrieval and transfer function was included at the same level as the other ex situ alternatives. There are development programs currently ongoing at the Hanford Site that are covered under the TWRS program or other programs.

Comment Number 0077.04

ODOE

Comment Also, the cost analyses do not include the lost value of the lands or the costs from harm to future generations or the environment. Ultimately, the costs of these alternatives would prove to be much greater than removing and cleaning up the wastes, as called for by the preferred alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Analyzing the harm to future generations from an economic standpoint is not included in the EIS; however, lost habitat, health risks, health consequences, and probabilities of accidents to future generations were among the impacts analyzed by DOE and Ecology. Land use commitments are addressed in Volume One, Section 5.7, anticipated health effects in Section 5.11, and comparison of potential consequences from accidents in Section 5.12. For the Final EIS, a Native American scenario was added to the analysis presented in Volume One, Section 5.11. Please refer to the response to Comment numbers 0036.18, 0052.05, 0072.22, 0072.55, 0072.198, 0072.225, and 0072.34 for related discussions..

The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0081.01

Pollet, Gerald

Comment We are concerned that the Department of Energy falsely inflated the costs of waste removal and glassification options to justify leaving waste in the tanks. We are also concerned that the rate the costs have been presented would erroneously lead policy makers to the conclusion, when combined with the use of erroneous assumptions as to risk, lead to the conclusion that in fact it would be cost affected to leave waste behind.

Response The cost estimates are an equal analysis of the total life-cycle costs of each alternative and reflect the best available cost information given that the engineering is still at a conceptual stage. The estimates are available for inspection by the public in the TWRS EIS Administrative Record. Please refer to the response to Comment number 0081.02 for a discussion of how the repository costs were recalculated for the Final EIS. For responses to specific comments regarding risk assumptions, please refer to the response to Comment numbers 0069.08, 0069.09, 0069.03, 0069.06, 0069.07, 0081.07, and 0069.11.

Comment Number 0081.03

Pollet, Gerald

Comment And what is interesting is it has the least technical question. And the EIS is based, in terms of these costs, costs include a 30 to 50 percent capital cost contingency. This is pretty bazaar. We're spending 10's of millions of dollars on research development design phased approach.

We are spending 10's of millions of dollars on design, which ought to drive down contingencies. 30 to 50 percent contingency is the way Hanford has done business with capital construction projects in the past. It is sinful. It is not going to be able to continue. If we eliminate, and we use different factors for contingency, take a look at the fact that a no separation alternative means you build one plant with the simplest technology, vitrification. You vitrify everything. You don't try to separate. You just vitrify. You do not have to build a multi-billion dollar separation plant. You do not have to build separate low activity and high activity vitrification plants. You could, and this EIS fails to consider the alternative which was eliminated earlier in this process, of having a very simple separation of low activity and high activity, in terms of which melter waste is directed too, at the front-end of such a plant. If we look at the cost issue alone, the no separation option actually drives down into the cost range, and perhaps will compare more favorably than the Ex Situ/In Situ Combination even.

The cost assumptions, as with all other assumptions, are critical. Building in 30 to 50 percent contingencies for one set of options is not acceptable for this type of policy decision making. And we can't afford to continue with 30 to 50 percent contingencies for capital costs at Hanford.

Response As noted in the response to Comment number 0052.04, the use of contingencies in capital cost estimates is standard practice throughout the public and private sector. All of the alternatives presented in the EIS include contingencies in the capital cost estimates. During design development for the alternative selected, the cost estimate would be refined and the contingency reduced. The cost estimate for a large facility would typically have some contingency remaining at the start of construction. The capital cost estimate as well as the contingency estimated for the Ex Situ No Separations alternative is smaller than the Ex Situ Intermediate and Extensive Separations alternatives because one treatment facility is constructed instead of two. The contingency factor for the Ex Situ No Separations alternatives provides an equal presentation to the public and the decision makers. Capital construction costs are also discussed in the response to Comment numbers 0055.06, 0057.06, and 0081.03.

A single facility designed to vitrify both HLW and LAW would not be precluded by the EIS for any of the alternatives that include separation of the HLW and LAW. The impacts associated with a single treatment facility would be bounded by the alternatives presented in the EIS. The separations processes included in the EIS cover a reasonable range of representative technologies. The separation of the waste into HLW and LAW streams is bounded with no separations on the low end, extensive separations on the high end, and intermediate separations in the middle.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please also refer to the response to Comment number 0072.05 for a discussion of the development of the alternatives for analysis in the EIS.

Comment Number 0089.04

Nez Perce Tribe ERWM

Comment Purification and removal of sodium nitrate and other major wastes from tanks prior to segregation of LAW and HLW should be considered for volume reduction and cost savings. Possible removal of sodium nitrate for industrial or certain agricultural use should be considered. Another option may be reacting the sodium nitrate with an organic reducing agent to produce sodium carbonate, nitrogen, ammonia and water, greatly facilitating waste reduction. Options such as these need to be considered to reduce vitrification volumes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume reduction measures for the waste have been considered, including calcination and the clean salt process. These measures are addressed in Volume Two, Appendix B, Section B.3. Removal of sodium nitrate, such that this compound would be safe and suitable for industrial or agricultural uses would be limited because complete radionuclide removal to form a purified waste would be extremely difficult.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment number 0072.05 for related discussion.

Comment Number 0090.01

Postcard

Comment Please listen to us say no:

to falsely inflating the cost of glassifying Hanford's High-Level Nuclear Wastes by $211 billion.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment numbers 0004.01, 0009.04, 0008.01, 0038.10, 0081.01, and 0081.02, for discussions regarding how repository costs were calculated and presented in the EIS..

Comment Number 0092.01

Hanson, Mary

Comment I certainly feel that as a lay person, I have every right to the most conservative principles being used in this situation and I certainly, personally and I think I stand for others here, do not consider cost to be important. Money can be made, the environment can not be remade. Now the total defense budget for this country is somewhere around 260 billion dollars per year. That is a lot of waste. In my opinion, that it is throwing money at defense. Most of it. Playing games, testing this and that and so forth. This is a real problem. This is a real security problem and if it were up to me I would put probably half the defense budget on it. So I do not consider money to be something that you can quote, "balance against health." I do not think money is something you balance against the environment. You can not balance a nonrenewable resource like the environment against a renewable resource like money. So I am very strongly in favor that this be done in the economic, in a conservative manner, economically speaking but I certainly feel that if the public really was as aware as everyone in this room is of what the issues are, they would vote very high amounts of money to deal with this threat to our security.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Cost estimates presented in the Draft EIS have been reviewed and revised, as appropriate in the Final EIS.

The alternatives and impact analysis presented in the EIS were based on conservative principles, consistent with the requirements of NEPA to bound the potential impacts and to address a range of reasonable alternatives. For more information on this topic, please refer to response to Comment number 0072.05 or in the EIS Volume One, Section 3.3. Please also refer to the response to Comment number 0081.01 for a discussion of issues related to the presentation of costs.

Comment Number 0098.01

Pollet, Gerald

Comment The Department of Energy's presentation tonight and at prior meetings and in these materials show ... say ... claim that this unproven technology of so-called in situ vitrification, sticking electrodes into the ground and melting the ground into glass. The presentation said that this would comply with Washington State law. Nothing could be further from the truth. Washington State first off has in the model toxic control act and our dangerous waste regulations a presumption that we will favor removal. That is the law. Leaving it in place when you have an alternative of removal and retrieval is never allowable under Washington State law. We have a set of priorities for dealing with waste. Hanford does not get to make an exception for itself although it sure does try most of the time.

Response The disposal of HLW by ISV would comply with Washington State law if the hazardous waste components are adequately treated to remove the hazardous characteristics or immobilize the hazardous components. The treatment and disposal would be subject to review and permitting by Ecology. Washington State law does not apply to disposal of the radioactive components of the HLW. For a discussion of regulations applicable to the HLW, see Volume One, Section 6.1. For related discussion regarding technical uncertainty, please refer to the response to Comment number 0012.04. Because the information contained in the Draft EIS is correct, no change to the text was made.

L.3.4.2.3 Assumptions

Comment Number 0005.39

Swanson, John L.

Comment The paragraph beginning at the bottom of page 3-31 is interesting. It starts out by saying that the residual contaminants would be insoluble, and then goes on to make the conservative assumption that 1 percent of the water-soluble contaminants would also be present. This conservative assumption drives conclusions, as discussed in (18) above [Comment number 0005.18].

Response DOE and Ecology recognize the concern expressed in the comment regarding conservative assumptions used in the impact analysis and the extent to which these assumptions affect the calculated risk values. The analysis performed for the Draft EIS assumed, for the ex situ alternatives, that 1 percent of the original inventory would remain in the tanks as residual waste that could not be retrieved. This assumption is bounding (e.g., provides a reasonable upper limit) with respect to the impact analysis, because it includes 1 percent of the water soluble contaminants. The Final EIS has been revised to include Volume Five, Appendix K, which will provide a nominal case analysis using best estimate assumptions. The nominal case analysis was based on 1 percent residual volume that was modified to reduce the inventory of soluble constituents. Using this assumption will result in a risk range and will enable the reader to see the variation in the long-term risk as a function of nominal and bounding assumptions. Please refer to the response to Comment numbers 0072.59, 0072.51, and 0072.05.

Comment Number 0005.40

Swanson, John L.

Comment On page 3-34 it is said that the assumption of cullet in a matrix material as the waste form for onsite LAW disposal "--provides a conservative analysis of the long-term impacts--." This statement is true only if conservative assumptions were made regarding the performance of the matrix materials. Were those assumptions conservative? Are they spelled out somewhere? (Page 3-66 contains a statement in opposition to the one on page 3-34; "The potential benefits of a matrix material and glass cullet combination as a disposal form are reduced contaminant release rates and--." Thus, the assumption of cullet in a matrix material does NOT provide a conservative analysis of the long term impacts, as is stated on 3-34).

Response In order to bound the impacts associated with the LAW disposal vaults, the releases from the LAW vaults were calculated under the assumption that the matrix material provided no reduction in the release rates from the LAW disposal vaults. DOE and Ecology believe that using a matrix material with glass cullet would reduce the release rates from the LAW disposal system. The two statements do not conflict with each other. Cullet, as opposed to monolithic pours, would be more easily leached; therefore, cullet is considered the more bounding (higher) approach in the environmental impacts analysis. Assumptions associated with release rates and associated impacts to groundwater are discussed in Volume Four, Appendix F.

Comment Number 0005.42

Swanson, John L.

Comment The last sentence on page 3-35 says that it has been determined that a bleed stream would be required to avoid a continuous buildup of Tc-99 in the vitrification off-gas stream. I do not believe that is necessarily true, and wonder who made that determination (and on what basis). The data I have seen indicate that some melters can retain a significant fraction of the Tc in the glass; thus, Tc in the off-gas from such melters would stop building up when that in the feed plus recycle equals that in the glass.

Response DOE and Ecology acknowledge the concern regarding the constituents that would require the use of a bleed stream for the off-gas recycle system. The EIS discussion includes technetium-99 and mercury as representative examples of the type of volatile constituents that could build up in the off-gas recycle streams. The LAW vitrification processes addressed in the EIS are based on a combustion fired melter. This melter type raised the concern regarding retention of volatiles and semivolatiles in the glass during technical review of the Preliminary Draft EIS. The requirements for a bleed stream were noted and included in the EIS.

As indicated in the comment, a bleed stream may not be necessary to avoid a continuous buildup of technetium-99 in the off-gas recycle stream, but based on available information, it appears probable that a bleed stream would be required. The functional requirements and sizing of the off-gas recycle system would be developed during the detailed design phase following selection of an alternative.

Comment Number 0012.20

ODOE

Comment Vitrification of the wastes greatly reduces the risk to the public and the environment. Even the least capable glass waste forms represent a dramatic improvement over the current conditions. Wise selection of pretreatment and segregation options and glass specifications may greatly reduce the long-term costs and risks to the public. These should not however delay decisions to proceed with cleanup and vitrification of Hanford's tank wastes.

There is no assurance that any of the vitrified waste will leave Hanford. As a consequence, it is essential that the vitrified waste contain all of the radioactive wastes for so long as they remain hazardous.

The vitrification alternatives do not specify the physical or chemical properties or requirements for the glass products. There is no specification for how durable the glass waste form must be, or for how long the glass must contain the radioactive wastes. Specifications must require the product glass be durable enough to contain the radioactive components for as long as they remain hazardous. This requirement is relatively easy to meet for short half-life isotopes such as strontium-90 and cesium-137. It is more difficult for long half-life isotopes which easily migrate in water, such as cesium-135, iodine-129, technetium-99, and neptunium-237. These isotopes are volatile and are difficult to incorporate into glass. Additionally, the long lived actinides also must be retained until they are no longer hazardous.

The common glasses used for the immobilization of high-level nuclear waste are not durable enough to contain these materials for the times needed. The borate content of these glasses is often controlled at high levels to reduce the melt temperature of the glass and to lower its viscosity. As the borate content is increased, the durability of the glass decreases. Glasses are attacked by organic acids such as humic and fulvic acids from the decay of vegetation which are often found in surface waters. Because the repository is expected to be deep underground, the water which may reach the repository is unlikely to contain large amounts of organic acids. Accordingly, the performance and durability studies of waste glasses for disposal to a national high-level nuclear waste repository have not analyzed the impact of organic acid corrosion on glass wastes, however this is particularly important if the glass waste remains at Hanford and may be subject to corrosion by surface waters.

If the durability of the glass cannot be assured and other barriers provide inadequate protection for the glassified wastes which may remain at Hanford, the radioactive isotopes with half-lives over one thousand years should be removed from the water soluble fraction of the wastes. These should be incorporated into better waste forms, or blended and glassified with the waste which will be sent to the national high-level nuclear waste repository. These isotopes include cesium-135, iodine-129, technetium-99, neptunium-237, and all long half-life actinides.

The durability requirements for glassified wastes to be sent to the proposed national high-level nuclear waste repository are not sufficient to assure protection of human health and the environment at Hanford. The physical conditions onsite are vastly different, and the geologic isolation provided by a deep repository is not available. The EIS must consider changing climate conditions. Hanford cannot be assumed to remain an arid area for as long as these wastes remain hazardous.

As the geologic barrier is not present at Hanford, and the glass wastes may exhibit more rapid corrosion from surface water, additional barriers to contain the waste should be included. The containers for the glass should be of sufficient chemical resistance and durability to protect the glass from the environment for as long as the wastes remain hazardous. The containers should be resistant to corrosive attack and embrittlement from exposure to the glassified wastes. Welding or other sealing of the containers should be done in such a manner as to avoid creating brittle areas in the container. Embrittled containers are likely to fail far more quickly.

Type 309 and 304L stainless steels have been proposed for use at Savannah River and West Valley, New York for containing glassified waste. High-carbon 309 stainless steel is easily embrittled by chloride ions. It should not be used. Low-carbon 304L stainless steel has insufficient molybdenum content to allow long term corrosion protection from the waste. If corrosion resistant stainless steel is used, it should contain at least three weight percent molybdenum to minimize corrosion from chloride and fluoride. It should also be very low carbon steel. Other high resistance alloys should be considered.

Response The alternatives presented in the Draft EIS provide a range of treatment, including disposal of HLW onsite as part of the in situ and combination alternatives. To be consistent with current national policy, all ex situ alternatives that include retrieval and treatment of the tank wastes are based on the assumption that the HLW would be disposed of in a geologic repository. The EIS does analyze permanent near-surface disposal of LAW under the ex situ and combination alternatives and disposal of HLW in place under various in situ and combination alternatives. To address public concerns with the availability of the geologic repository, all ex situ alternatives have been revised in Volume One, Section 3.4 to include interim onsite storage of the immobilized HLW for 50 years.

The ex situ alternatives that produce borosilicate HLW glass comply with the DOE OCRWM Waste Acceptance Systems Requirements document, which requires that the waste form meet performance criteria. The alternatives that do not produce a borosilicate HLW glass are identified as non-conforming to the geologic repository and are potentially not as acceptable and require resolution to make them acceptable which would make them subject to delayed acceptance.

Alloy specification for the HLW canisters would be accomplished during final design of the waste package. Embrittlement, corrosion, and material incompatibility are issues that will be evaluated during canister design and material selection. However, please note that the HLW canister presently has no long-term disposal function. This function is allocated primarily to the waste package disposal container.

DOE and Ecology acknowledge that technical issues requiring evaluation remain before the long-term impacts associated with permanent near-surface disposal of canistered HLW can be assessed. Please refer to the response to Comment numbers 0008.01 and 0008.02.

Comment Number 0019.04

WDFW

Comment The author states that "for the analysis performed in this EIS, a Hanford barrier was used to bound impacts." At this point in time, a cursory effort to bound impacts (resources) of a Hanford barrier should only require volume of soil needed and/or potential acreage impacted. A supplemental EIS can discuss borrow sites and alternatives.

Response DOE and Ecology acknowledge the concern expressed in the comment. However, the Hanford Barrier is the most extensive system for a surface barrier proposed for use on the Hanford Site. The assumption to apply this multi-layered barrier technology serves as the basis for comparison of the impact of changes within an alternatives, as well as between alternatives. The selection of borrow sites is an issue that would be addressed for tank farm closure which will be the subject of a future NEPA analysis. Please refer to the response to Comment number 0019.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0027.11

Roecker, John H.

Comment Waste Oxide Loading

The use of a 20 percent waste oxide loading is overly conservative and biases the alternatives analysis. A waste oxide loading of 25 percent has normally been used for design and analysis purposes. Studies are also underway for loadings in the 30-35 percent range.

Response The TWRS EIS uses bounding assumptions for HLW oxide loadings for all ex situ alternatives to provide a comparable and bounding analysis in the absence of definitive information. DOE and Ecology are aware that higher HLW oxide loadings have been used for process design and acknowledge, in Volume One, Section 3.4 of the EIS, that current development work may result in higher waste loading factors. Given the uncertainty associated with the characterization data and assumptions made for separations efficiencies, DOE and Ecology believe that a 20 weight percent waste oxide loading is a reasonable assumption for the purpose of calculating impacts. Waste loading is also discussed in the response to Comment numbers 0035.04 and 0027.11. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0040.02

Rogers, Gordon J.

Comment The 100-year limit for retaining administrative control is ridiculous, and is not applied to any other human activity.

Response Federal regulations (40 CFR 191) state that to provide the confidence needed for long-term compliance with the requirements for the disposal of HLW, active institutional controls over disposal sites should be maintained for as long as is practical. However, institutional controls are limited to 100 years when considering the isolation of the wastes from the accessible environment. As is stated in Volume One, Sections 3.4.2 and 3.4.3, the 100-year period is an assumption that has been applied to all alternatives analyzed in EIS to provide an equitable basis for comparison of impacts among alternatives. As required by the regulations, the administrative controls would be maintained by DOE and Ecology as agencies of the Federal and state governments. For related discussions, please refer to the response to Comment numbers 0101.01 and 0040.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0052.01

Pollet, Gerald

Comment Going to start tonight by asking that a little more attention be paid in the materials and the Final EIS through the advice of the Tank Waste Remediation System Task Force. The Task Force urged the three agencies from our putting together this EIS to explicitly not utilize a hypothetical repository in assessing costs and it is nice to go right after someone else whose commented on the same issue.

The TWRS Task Force said we have to assume canisters stay at Hanford. That is not only a reasonable alternative, unfortunately it is the realistic alternative, and it is not appropriately considered in the EIS. So what we need to see is - what are the long-terms costs and impacts from having canister storage here at Hanford.

Response The Tank Waste Task Force report recommended that DOE "accept the fact that interim storage, at least, of the waste in an environmental safe form will occur for some time at Hanford." The report also directed DOE to "assume temporary storage will occur at Hanford but did not assume that all radionuclides should be here forever" (HWTF 1993). The EIS, for all ex situ alternatives, assumes interim storage at the Hanford Site in an environmentally safe manner for up to 50 years and ultimate disposal of HLW offsite at the potential repository. If HLW storage extended beyond 50 years, appropriate NEPA review would be required. Please also refer to the response to Comment numbers 0035.04, 0081.02, 0038.10, 0008.02, and 0004.01 for related information.

Comment Number 0062.03

Longmeyer, Richard

Comment We've talked a little bit about the new tanks that are being filled with wastes from current tanks that are leaking. That also raises a safety concern in that, as was stated, this sludge that remains behind in the single-shell tanks that did leak, actually becomes more dangerous than when there was water in the tank. Dangerous in terms of the material itself, and danger of actual exposure to the outside from explosions, and so forth. So that is a concern.

Response A description of the saltwell pumping program, which is a required action under the Tri-Party Agreement, is provided in Volume One, Section 3.4 and Volume Two, Appendix B. An analysis of safety issues is performed prior to removing liquids to ensure that removal can be performed safely. The SSTs in question that have been pumped have been included in the accident and consequence analysis presented in Volume One, Section 5.12 and Volume Four, Appendix E. The unit liter doses from these tanks were compared with the unit liter doses from the rest of the SSTs and all of the DSTs. The bounding unit liter doses were used to calculate the consequences to bound the analysis.

Comment Number 0064.01

Roecker, John H.

Comment The second point I'd like to bring out is what I call data manipulation. There are examples throughout the EIS where data has been, what I call, manipulated to present a specific case, or to present certain agendas. I can give you some examples, in fact I will give you written comments on the ones that I have found. But as an example, where you talk about the high-end and the low-end of the number of canisters for the two different processes. The low-end you reference a Westinghouse document, and for the high-end you reference a DOE document. Being a little suspicious, and having a little experience with what was going on, I went back to look at those specific documents. The Westinghouse document is an engineering document, which has some pretty good estimates in it. The DOE document is a review of a systems requirements document of DOE that had a high number in it to make some very specific points. To use those numbers in the EIS, I think, is misleading. Because they do not accurately represent the engineering and technical data that is available.

Response The EIS presents an unbiased assessment of the potential impacts associated with each alternative. Please refer to the response to Comment number 0027.02 for a discussion of this same issue and Comment numbers 0081.02, 0008.01, 0069.04, 0035.04, and 0038.10 for a discussion of cost estimates.

Comment Number 0072.85

CTUIR

Comment P3-31: PP1: It should be assumed that there will be leaks and more leaks from the SSTs and DSTs during the administrative control.

Response DOE and Ecology realize that it is difficult to accurately predict the number or severity of tank leaks that will occur in the future. There are factors that will increase the number of leaking tanks, primary of which is the age of the tanks. As the tanks get older, the probability of a leak increases. There also are factors that will decrease the number of leaking tanks. The primary factor in decreasing leaks is the interim stabilization of the tanks by removal of the free liquid from the pore space and other voids in the tank solids; sealing the entrances to the tanks to prevent fresh liquid from accidentally entering the tanks; and placing covers over the tanks to inhibit the infiltration of precipitation. Once these measures are in place, leaks from the tanks would be very small. Because there was no inherently accurate method of determining future leaks, the assumption was made that at some predetermined time in the future (after the loss of administrative control), all the tanks of a given type would leak. This assumption allows an equitable comparison of the long-term environmental impacts of the various proposed alternatives. Please refer to the response to Comment numbers 0005.37, 0029.01, and 0072.70 for related information.

Comment Number 0072.86

CTUIR

Comment P 3-31: PP: Is the required depth to ground water, in the case of leaking tanks, at the minimum to the bottom of the leakage? Or is the required depth from the bottom of the tank? Please explain this with a description of the reasoning involved.

Response Releases for the tanks, whether from in situ or ex situ alternatives, are assumed to be from the bottom of the tank. This is a bounding assumption that results in the highest predicted contaminant concentration in groundwater.

Comment Number 0072.88

CTUIR

Comment P 3-31: PP 6: The efficiency goal should state no more than 1 percent of the solid-dry tank inventory would remain as a residual and no more than .1 percent liquid tank inventory remain as a residual following waste retrieval activities.

Response The Tri-Party Agreement (Ecology et al. 1994) includes a milestone that directly impacts the TWRS program. Milestone M-45-00 requires tank residues not exceeding 10.2 m^3 (360 ft^3) in each 100 series tank, and tank residues not exceeding 0.85 m^3 (30 ft^3) in each 200 series tank. This milestone provides the basis for the TWRS EIS assumption of 99 percent removal for ex situ alternatives. An overview of retrieval and transfer from the tanks is provided in Volume Two, Section B.3.5.3. Further evaluation of the residual inventory would be performed in a future NEPA analysis on closure of the tank farms. Please refer to the response to Comment number 0089.03, 0089.07, and 0005.18 for related residual waste information. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.89

CTUIR

Comment P 3-34: PP 7: Assuming that a LAW activity waste cullet provides the basis of conservatism is wrong. The technical staff of the SSRP suggests that all LAW waste be vitrified into glass and poured into canisters for the lowest risk levels.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The referenced language in Volume One, Section 3.4 is a discussion of waste composition for the various alternatives. A disadvantage of cullet is its high surface to volume ratio, which results in lower long-term performance. Therefore, the calculations of leach rates are higher (more bounding from an impact assessment standpoint) for cullet than for other glass forms. In the area of long-term environmental impacts, this lower long-term performance manifests itself as greater amounts of contaminants leaching from the cullet. Changing to another waste form that would have potentially better long-term performance may be achieved during the final design of the alternative selected. Because the information contained in the Draft EIS is correct, no change to the text was made. Please refer to the response to Comment number 0005.40.

Comment Number 0072.90

CTUIR

Comment P3-3: PP 8: The public has stated numerous times that grout for use as a way of stabilizing tank waste in any form is unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Grouting liquid waste streams is included in Volume Two, Appendix B as a reasonable immobilization technology in the EIS; however, it is not a technology included in the preferred alternative. For a discussion of NEPA requirements to analyze reasonable technologies, please refer to the response to Comment number 0072.05. Grout is discussed in the response to Comment numbers 0005.18, 0009.03, and 0072.179.

Comment Number 0072.178

CTUIR

Comment P B-37: Sect.B.3.0.6: Please explain how soda lime glass can be upgraded to the standards of the only standard HLW form, borosilicate glass in terms of leachability, thermal-breakdown, expansion, and ability to capture and isolate radionuclides.

Response Soda-lime glass would have different characteristics than borosilicate glass in terms of leachability, thermal expansion, and physical processing parameters. As stated in Volume Two, Section B.3, borosilicate glass currently is identified as the only standard HLW form to be accepted at the potential geologic repository. Other types of glass could be selected for the vitrification of HLW or LAW; however, they would have to meet the NRC waste form requirements and support the repositories ability to meet long-term performance requirements.

Under the Ex Situ No Separations alternative, all of the sodium present in the tank waste would be included in the vitrified waste stream. Because of this, the glass more closely approximates a soda-lime glass. The repository Waste Acceptance Systems Requirements Document currently includes only borosilicate glass as an acceptable glass composition; however, it identifies that other waste forms may be addressed in the future. The acceptability of alternative glass compositions would be based on waste form performance testing. Please refer to response to Comment numbers 0012.20, 0012.11, and 0035.04 for a related discussion.

Comment Number 0072.179

CTUIR

Comment P B-38: The use of grout is unacceptable and has been thoroughly denounced by the public. The grouting of LAW which will contain discrete particles of hi-activity radionuclides is unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.90, which addresses the consideration of grout as a waste form in the EIS.

Comment Number 0072.194

CTUIR

Comment P B-157: Sect. B.5.0: The information on how closure activities would affect remediating the tank waste should include carrying all of the listed closure options through the alternatives process in order to adequately present the information. Simply choosing a single representative approach to tank closure (closure as a landfill) is insufficient and in the light of the importance of this retrieval EIS. The closure options presented must indicate whether they do or do not preclude one or more of the alternatives. Additionally the closure options must necessarily conform to the law ALARA conditions for the purposes of reducing risks to future generations. This information is simply not here and raises doubt that the representative approach is truly representative.

Response Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives cannot be assessed at this time and 0072.50 for information on alternatives that would preclude closure options. Closure of the tank farms will be addressed in a future NEPA analysis when sufficient information is available on past practice releases, releases during retrieval, and tank

residuals. Please refer to the response to Comment number 0101.06 for a discussion of issues related to analysis that would be required to support closure alternatives analysis. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.195

CTUIR

Comment P B-158: Sect. B.6.0: The inclusion of the Hanford Barrier and the exclusion of all other closure activities may preclude adequate justification of the alternative section due to the fact that providing one option is not providing a choice of options. Please insert the other closure activities options or remove section B.5.0 tank closure because it is not within the scope of this EIS.

Response Closure is not included in the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. However, Volume One, Section 3.3 and Volume Two, Section B.5 address how tank waste remediation and closure are interrelated because some of the decisions made regarding how to treat and dispose of tank waste may impact future decisions on closure. To provide information on how closure activities would be affected by remediating the tank waste, a representative approach to tank closure (closure as a landfill) has been included in each of the TWRS alternatives to allow an equitable comparison of the alternatives. The Hanford Barrier described in Volume Two, Section B.6 is included as a representative approach to tank closure. Please refer to the response to Comment numbers 0101.06, 0019.03, 0019.04, 0052.01, 0072.50, and 0101.05 for related discussions. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0081.04

Pollet, Gerald

Comment The Tank Waste Task Force, convened by the Department of Energy, U.S. EPA, and Washington Department of Ecology, urged that the Department of Energy abandon making decision making on the basis of high-level nuclear waste canisters, and their theoretical costs for being placed into a repository. Our advice was, now I need to turn to the appropriate page, on page 11 of the Task Force Report under Values, under Waste Form and Storage. Let the ultimate best form for the waste drive decisions, not the size or timing of the national repository. This EIS has failed to consider that advice.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0081.02, 0008.02, 0035.04, 0038.10, and 0052.01 for a discussion regarding task force advice.

Comment Number 0089.03

Nez Perce Tribe ERWM

Comment Listed below are our general statements regarding the EIS.

Some necessary topics are not properly considered in the EIS. An example is the proposal to leave 1 percent of the waste in the tanks. We believe that with the technology currently proposed, if 99 percent of the waste can be removed, then it is also possible to remove much of the remaining 1 percent of the tanks wastes. This question will definitely be pursued by ERWM during soil and groundwater remediation, which are not part of the EIS. For proper soil remediation, beneath the tanks following closure or tank removal, it is imperative that no waste be left in the tanks.

Response The amount of residual waste that ultimately remains after retrieval will depend on the effectiveness of the retrieval technology. For the purposes of NEPA analysis, the assumption that 1 percent of the waste would remain in the tanks was assumed in the EIS analysis. For a discussion of this issue, please see the response to Comment numbers 0005.18 and 0089.07. Further experience with waste retrieval will be required before the issue of the extent of retrieval can be fully resolved. Please refer to the response to Comment numbers 0101.06, 0072.08, and 0072.88 for related information concerning tank waste residuals, soil and groundwater contamination, and closure.

L.3.4.2.4 Miscellaneous Issues

Comment Number 0005.41

Swanson, John L.

Comment The word "grouting" at the start of the last paragraph on page 3-34 appears to be out of place, and appears to belong instead at the start of the first paragraph on the next page.

Response "Grouting" does belong with the paragraph at top of page 3-35 of the Draft EIS. The two sentences following the word "grouting" are out of place. The text of the Final EIS has been corrected.

Comment Number 0005.43

Swanson, John L.

Comment On page 3-36 is discussed the use of sodium from the FFTF to make sodium hydroxide for use during enhanced sludge washing. Is this really worthy of mention? Was the cost of conversion of sodium to sodium hydroxide (which has some safety problems) included in the cost estimates?

Response Fast-Flux Test Facility (FFTF) sodium disposal is worthy of mention because of the potential amount of material that may require disposal considerations in the near future. A cost analysis of the conversion facility and the process safety issues were not performed and would need to be addressed before a decision was made to use FFTF sodium as a source of material for separations chemicals. The use of sodium from FFTF was included in the EIS as an example of Sitewide waste minimization activities that could be considered.

Comment Number 0008.04

Evett, Donald E.

Comment On the subject of groundwater, I believe the method of retrieval using the articulated arm to reach into the tanks and recover waste would be an excellent method and it would reduce the amount of leakage, which is of paramount importance.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. As indicated in Volume One, Section 3.4, the articulated arm retrieval method would be used in situations where conventional technology is not effective or inefficient for the particular tank waste type or form. Using the articulated arm technique and others is also key to removing as much of the tank waste as possible to minimize or eliminate any materials that could be released to the environment. DOE and Ecology will analyze the data collected during the demonstration phase to select the most effective removal method for the tank and tank waste type.

Comment Number 0068.03

Martin, Todd

Comment The last point I want to make is that a clear lesson that we've learned from Hanford and from the nuclear weapons complex is that postponements and delays lead to greatly increased obligations in the future. We've learned that in spades, at least I hope we've learned that. And I'm not sure that the Federal government has learned that. The American people are certain of that. That means we need to get on with it now, otherwise it's going to cost that much more in the future.

Response DOE and Ecology share the desire to proceed with remediation at the earliest possible date. Delays can be costly. DOE intends to allow sufficient time to design adequate actions that are supported by factual information, that incur a reasonably acceptable level of technical risk (i.e., high probability that the action will work and accomplish the desired result), and that are implemented in a managed and cost-effective way. Please refer to the response to Comment numbers 0009.19, 0060.02, 0098.02 and 0078.07.

Comment Number 0072.82

CTUIR

Comment P 3-27: Sect. 3.4.1.1: First bullet: What exactly is "managing operations" and are these the operations included in the 1997 RDS for fail-safe management?

Response Managing operations, as listed in the first bullet in Volume One, Section 3.4, includes the activities listed in the bullets that follow as well as tank farms and associated facilities management (as a program), and the relationship of the TWRS program to the Hanford Site Operations system. Consequently, the management issues relevant to each activity (e.g., personnel, safety, quality, and milestone status) are relevant on a programmatic level across Tank Farm Operations. Tank farms management is one operation described in the 1997 Risk Data Sheet (RDS) for fail-safe management. The 1997 RDS was prepared for the Hanford Site as a single operation.

Comment Number 0072.83

CTUIR

Comment P 3-28: PP 4: how much exactly will these controls increase the cost of maintenance and monitoring activities.

Response The operating cost and schedule impacts associated with placing all 177 tanks under flammable gas controls (if this were to occur) is not fully known at this time. One of the factors that will influence the cost and schedule impacts would be resolution of the flammable gas safety issue for the tanks.

Comment Number 0072.87

CTUIR

Comment P 3-31: PP 4: How can you fill a tank full of liquid with rocks and not have liquid overflow?

Response As discussed in the description of the alternatives in Volume One, Section 3.4 and Volume Two, Appendix B, for the In Situ Fill and Cap alternative, as much water as possible would be removed from the liquid waste streams through evaporation at the 242-A Evaporator. The amount of water that can be removed from a liquid waste stream at the evaporator is limited by the saturation concentration of the evaporated waste stream. Following transfer of the evaporated liquids back to the tank, salt-cake formation would begin in the DSTs similar to what has already happened with the DSTs. This would allow for additional evaporation of the liquids. If the In Situ Fill and Cap alternative were selected for implementation, further analysis may indicate a need for additional evaporation using in-tank technologies for selected tanks.

Comment Number 0072.91

CTUIR

Comment P 3-36: PP 1: Exactly what is "some low temperature process"? How much will this process cost? Is this process figured in the privatization process, and what are the risks associated with this? How much extra waste is going to be generated with this process? What will this waste be classified as?

Response Calculations performed for the Ex Situ Intermediate Separations alternative off-gas recycle bleed stream resulted in an estimate of 3,500 m^3 (930,000 gallons) of liquid waste. This waste stream would be dilute and the volume could be reduced by evaporation. The stabilization of this waste stream would require a low-temperature stabilization and treatment technology such as encapsulation, hydraulic cements, or organic polymers to immobilize the waste and limit further volatilization. The development and selection of this process would occur during the detailed design phase. An individual cost estimate for this process was not included in the alternative cost estimates developed for the EIS. The cost would be minor compared to the total alternative cost and would be well within the estimated cost range.

Each of the alternatives that involve high temperature waste treatment technologies, such as vitrification, would have to deal with the volatile chemical and radionuclide emissions in the off-gas system. The risks during remediation are included in the analysis performed for each of the alternatives in Volume One, Section 5.11 for health impacts during remediation. The post-remediation risks that would result from disposal of the stabilized off-gas recycle bleed stream is assessed in the Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds.

An estimate for the total volume of immobilized waste that would be generated has not been made for the alternatives.

A volume estimate would be made during the detail design phase when the characteristics of the bleed stream were developed and the immobilization technologies were evaluated.

Following stabilization, this waste stream would be classified as LAW. The classification and handling of this waste stream would be consistent with established Hanford Site solid waste disposal practices.

Comment Number 0072.180

CTUIR

Comment P B-39: S 2: Please explain how the amount of tertiary waste generated would be primarily a function of the number of operating personnel.

Response The primary component of tertiary waste is personal protective equipment. Therefore, because the number of operating personnel required to wear personal protective equipment when the potential exists for contact with hazardous or radioactive substances is higher for the alternatives that include the more complex remediation activities, the amount of tertiary waste generated also would be higher.

Comment Number 0089.05

Nez Perce Tribe ERWM

Comment Offsite disposal of LAW should be considered in the EIS.

Response DOE and Ecology acknowledge the recommendation expressed in the comment. Offsite disposal of all waste at the potential geologic repository is addressed in the EIS under the Ex Situ No Separations alternative. Offsite disposal of the LAW was not considered to be a reasonable alternative because of the cost and human health impacts of transporting the waste and because there would be no compensating benefits to offsite disposal. Please refer to the response to Comment number 0005.03 for a discussion of the assumptions used in the alternative analyses.

Comment Number 0089.11

Nez Perce Tribe ERWM

Comment Page B-72, Paragraph 1

We have some questions about the plan for the cross-site transfer line. Apparently this line will be sloped to at least 0.25 percent grade to preclude accumulation of solids. ERWM questions the thought behind those plans, the elevations at 200 West and 200 East are nearly the same but 5 miles apart. How will the line be constructed and this slope engineered?

Response Specifications for the cross-site transfer line are not included in the scope of this EIS; however, the SIS Final EIS addresses the cross-site transfer line in detail (DOE 1995i). The SIS EIS was referenced during preparation of the TWRS EIS. According to the SIS EIS, the line would slope up from the 200 West Area to a midpoint, and then down to the 200 East Area to ensure that the line will drain.

L.3.4.3 No Action Alternative (Tank Waste)

Comment Number 0072.94

CTUIR

Comment P 3-40: Sect 3.4.2: No Action Alternative: Technical staff of the CTUIR do not agree that this alternative is a responsible action, given that the contents have half lives that number in the thousands.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, compliance to existing regulations, potential risk, or any other factor used in the analysis of alternatives. Furthermore, the CEQ requires that the TWRS Draft EIS identify and analyze a range of reasonable alternatives for the proposed action, as well as for the No Action alternative. All data that support the cost and impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and the public during the comment period. Please refer to the response to Comment numbers 0072.80 and 0072.10 for more information concerning the No Action alternative and NEPA requirements for reasonable alternative analysis.

Comment Number 0072.181

CTUIR

Comment P B-41: Sect. B.3.1: A one hundred year administrative control period does little to protect human health and environmental impacts from long lived (>10,000 year 1/2 life radionuclides).

Response Although DOE has no plans to abandon the Site after 100 years, it is not reasonable to assume that administrative controls will extend to 10,000 years. In order to show potential impacts that could occur if administrative controls were lost, a 100-year administrative control period was assumed. This assumption is consistent with standard impact assessment methods for hazardous and radioactive waste sites. Please refer to the response to Comment numbers 0072.80, 0040.02, and 0101.01 for discussions related to DOE assumptions associated with the 100-year administrative control period and the analysis of long-term impacts resulting from the loss of institutional controls.

Comment Number 0072.182

CTUIR

Comment P B-43: Sect. B.3.1.4: Please insert the statement 'some tanks may not last fifty years'.

Response Volume Two, Appendix B addresses actions that would be taken in the event that a tank leaks within the estimated design life of 50 years, as well as the integrity testing to be conducted within any applicable 50-year design life. "Continued management would include maintaining spare DST space to accommodate leak recovery in the event of a DST leak. Tank conditions would be continually monitored, and those tanks determined to be leaking would require recovery of the leakage from the tank annulus." Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.4 Long-Term Management Alternative

Comment Number 0038.01

Reeves, Merilyn

Comment I would like to point out that one of the things that the Hanford Advisory Board did was to commission a special report, a report to look at whether or not we should build six new massive tanks, double-shelled to hold waste because we were not looking at any other end point.

A report was prepared by Dr. Glen Paulsen, Dr Frank Parker, and Dr. Michael Cavanaugh, noted experts in the field.

And from this report it became clear that they recommended that no new monies be spent for the construction of new tanks to store the tank waste at Hanford.

The Board adopted this. This is a savings of approximately 300 to 400 million depending on which report you look at.

I think that this also puts in place the Long-Term Management alternative in the EIS that would have required replacement of all the double-shelled tanks in the year 2035, and again in the year 2085.

And so I believe that our consensus advice, which was listed as consensus advice number 22 in which we endorsed the recommendations of this report should put to rest whether or not we should embark on any scheme to just continue to build double-shell tank for storage of these wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. The range of alternatives must include a No Action alternative and then may include other reasonable alternatives to allow an analysis of a full range of alternatives. Within the range of considered alternatives is the Long-Term Management alternative, which contains the provision for building two sets of DSTs at 50 and 100 years in the future. Including this alternative in the EIS serves a useful purpose, because while it does not contain provisions for immobilizing the tank waste, it does contain provisions for maintaining the SSTs in a relatively dry condition and for retanking the wetter DST wastes on a periodic basis. Please refer to the response to Comment number 0072.05 for a discussion of how the alternatives were developed to comply with NEPA requirements to analyze a range of reasonable alternatives.

Comment Number 0072.95

CTUIR

Comment P 3-43: PP: The argument for long term management seems poor given that a large amount of SST waste has already leaked to the ground, and that the transfer of tank waste simply for maintenance reasons has inherent risks that are unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, compliance to existing regulations, potential risk, or any other factor used in the alternatives evaluation process, which would include the Long-Term Management alternative evaluated in the EIS. Please refer to the response to Comment numbers 0072.05 and 0038.01 for related discussions. All data that support the cost and impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and by the public during the comment period. DOE and Ecology are aware that the vadose zone has been contaminated beneath the tanks. Existing contamination is presented in Volume One, Section 4.2, and cumulative impacts of existing contamination, TWRS alternatives and other Hanford Site actions are presented in Volume One, Section 5.13. The potential risks associated with moving waste from one tank to another one are analyzed in the EIS in Volume One, Section 5.11 and Volume Three, Appendix D for routine operations during remediation and Volume One, Section 5.12 and Volume Four, Appendix E for accident risks.

Comment Number 0072.96

CTUIR

Comment P 3-45: Sect. 3.4.3.5: Post Remediation: this section needs to have an account of the remediation of the extra ground used.

Response This comment refers to the post remediation section for the Long-Term Management alternative. The extra ground would be the surface area overlaying the 26 new DSTs that would be constructed as part of this alternative. As explained in Volume One, Section 3.4.3.1, this alternative is similar to the No Action alternative in that administrative controls over the Hanford Site are assumed to be maintained for 100 years. No remediation activities would be performed. The consequence is stated in Section 3.4.3.5 that there would be no post-remediation activities associated with the Long-Term Management alternative. Because there is no remediation of the extra ground, no account of this activity has been provided in the EIS.

Comment Number 0072.183

CTUIR

Comment P B-44: Is there a sludge well pumping operation ongoing?

Response DOE and Ecology believe that the comment is referring to saltwell pumping. Saltwell pumping of the SSTs to remove interstitial liquids is an ongoing operation that is scheduled to be completed in the year 2000. Saltwell pumping is an activity that would be a part of continued operations under all alternatives as indicated throughout Volume One, Section 3.4.

L.3.4.5 In Situ Fill and Cap Alternative

Comment Number 0072.184

CTUIR

Comment P B-48: Sect. B.3.3: This alternative is unacceptable as are all in situ alternatives. Language clearly defining that in situ alternatives are against the law must be inserted here.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Summary, Section S.7, discusses regulatory compliance for each alternative and indicates which alternatives would fail to comply with applicable laws and regulations. Regulatory compliance also is addressed in Volume One, Sections 3.4 and 6.2 and Volume Two, Appendix B. In each of the sections cited, it is clearly stated that this alternative would not comply with certain laws and regulations. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.6 In Situ Vitrification Alternative

Comment Number 0014.01

Bullington, Darryl C.

Comment It is impossible to take seriously any document that includes a proposal to spend 16 to 23.8 billion dollars and use one-quarter of the available electricity of the Washington Public Power Supply System to vitrify 73 million curies of hazardous radioactive solids and surrounding soils contaminated with thousands of gallons of cesium-137 containing liquid (a volume of over 20,180 cubic yards per tank) to a depth of sixty feet by inserting electrodes and heating to 2,600 to 2,900 F. Before I would even waste the paper to evaluate such a scheme I would have to see some demonstration using noncontaminated materials at a place and in a way that would not be a hazard to the public and people involved. To design any system that could contain all of the gases that would be suddenly released from such an event or a heat shield needed to protect the operating deck above the tanks, and enclosed, should melting such a mass even be possible, is beyond all imagination. To perform such a full-scale demonstration for $70 million is also highly suspect.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. ISV is a commercially available technology that has been successfully demonstrated on a smaller scale and is a reasonable alternative for analysis in the TWRS EIS. The EIS does discuss the technical uncertainties associated with implementing this alternative in the Summary, Section S.7, Volume One, Section 3.4, and Volume Two, Appendix B. Please refer to the response to Comment numbers 0072.80 and 0072.05 for discussion of NEPA requirements for reasonable alternatives analysis.

Comment Number 0023.01

Geosafe

Comment The ISV alternative should provide an objective evaluation for selecting the size of the tank farm containment facility. The confinement facility as shown in Figure 3.4.5, which encloses an entire tank farm, may have some distinct advantages but it poses significant design and construction difficulties. A smaller containment facility could be more easily constructed that encloses only one tank at a time. The smaller facility could be moved into position using a crawler system similar in design to that proposed for the decommissioning of the 100 Area Reactors (WHC MLW-SVV-037106). Two sets of crawlers could be used to move multiple containment facilities. Although not stated in the EIS, it is presumed the need to enclose an entire tank farm was based on the premise that a structural load could not be supported by the dome structure of the tanks and would result in their collapse. For the ISV alternative, the void spaces in the tanks will be filled with sand or other material and can be made suitable for load bearing. The smaller confinement facility would be significantly easier to construct, maintain and decontaminate after project completion. In addition, the smaller facility should significantly reduce the degree of technical difficulty in implementing the ISV alternative and potentially lower its cost as well.

Response Alternative configurations for the tank farm confinement facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the TWRS EIS. This proposed size reduction ultimately could result in a confinement facility that would be mobile, and could be moved from tank to tank within a tank farm. A large facility would not impose a bearing load on the individual tanks because its perimeter would lie outside of the tank farm. Because a smaller confinement facility potentially would impose a bearing load on adjacent tanks, a design solution to this problem would have to be formulated before the smaller confinement facility could be considered practicable. Filling the adjacent tanks with sand would be among those considered.

One potential problem area not discussed in the comment is the off-gas collection and treatment equipment and facilities. With a large confinement facility, the off-gas would be ducted to stationary treatment facilities. With the smaller, mobile confinement facility, the solution might be to move the off-gas treatment facility when the confinement facility is moved, or alternately, to re-route the off-gas ducting when the confinement facility is moved. This is one of a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion in the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers.

The Draft EIS addressed the full range of reasonable alternatives. The alternative is bounded by the alternatives addressed in the Draft EIS, and DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. For a discussion of the approach used in the EIS to develop and analyze alternatives, please see Volume One, Section 3.3 and refer to the response to Comment number 0072.05.

Comment Number 0023.02

Geosafe

Comment An objective evaluation should be provided for selecting the size of the ISV equipment. The evaluation should discuss the advantages and disadvantages of using a large ISV system versus using a smaller system more closely resembling commercially available equipment.

The concept of treating a tank with extremely large melts significantly increases the difficulty and the technical Implementability of the ISV alternative. The ISV system proposed in the EIS is 40 times larger (4 Mw vs. 160 Mw) than existing equipment and is capable of treating a tank in one setting. Geosafe believes treating tanks in large settings may pose significant operational problems. We believe a more workable approach is to treat tanks with smaller multiple ISV settings so as to have better control on the release of vapors from in and around the tank.

Another factor to consider with a large-scale ISV systems is power level fluctuations caused by startup or shut down. It is envisioned that power line fluctuations caused by a 160 Mw system may be unacceptable for the regional power grid unless special arrangements are provided.

In summary, smaller ISV units that treat tanks in multiple settings would greatly increase the technical Implementability of the ISV alternative and potentially reduce costs. Schedule requirements could be maintained by using multiple ISV systems operating simultaneously at various tank farms. In addition, the research and development time required for the smaller ISV unit would be significantly shorter than the 160 MW unit.

Response Alternative configurations for the power supply facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the EIS. A large facility potentially could impose load fluctuations on the regional power grid, although with proper planning these fluctuations could be effectively managed. Because a smaller power supply facility potentially would melt only a portion of a tank and its contents, a solution to this problem would need to be formulated before the smaller power supply facility could be considered practicable. Using multiple power supply units would be one solution among those considered. That multiple smaller power supply units potentially would reduce costs may be premature. For the majority of process equipment, purchasing a single large unit rather than multiple smaller units is generally more economical. To state that the research and development time required for the smaller power supply facility would be significantly shorter than for the larger unit also may be premature. Using multiple ISV settings would allow better control on the release of vapors from in and around the tank also would be considered premature until further studies have been completed. These are a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment numbers 0023.01 and 0072.05.

Comment Number 0023.03

Geosafe

Comment Two techniques should be evaluated for reducing the processing depth of ISV which is specified in this document as 60 ft. Implementation of one or both of these techniques will decrease the technical difficulty of implementing the ISV alternative.

The first option would involve the removal of overburden to expose the dome structure of the tank. The overburden could be subsequently added to the tanks to eliminate internal void spaces. This would decrease the required processing depth of ISV to approximately 45 ft for the largest volume tanks.

The second option would involve the intentional lowering of the tank dome structure into the tank to reduce the effective processing depth from 45 ft to 33 ft for the largest tanks. This would be accomplished by first covering the contents of the tanks with an adequate depth of soil to provide radiation shielding. Next the center portion of the tank would be cut into pieces and lowered into the tank on to the soil. Following the removal of the dome structure, additional soil would be placed in the tank to provide a level surface to begin ISV operations. It is recognized that cutting into a tank will present some added risk that will need to be evaluated.

Response Further research and investigation associated with ISV is possible. This particular comment deals with potential solutions to the problem of having ISV operate at depths of approximately 60 feet. The suggestions for using the tank overburden to reduce tank voids; and subsequently lowering the tank dome into the tank before vitrification are examples of areas where further investigation may prove to be of value; however, substantial safety considerations would need to be overcome. Added risk from exposing and cutting into the tanks has not been evaluated. These are several areas where further detailed study could potentially result in an improved process. To address this issue, the cost estimate includes additional costs for technology development for this alternative. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers. Please refer to the response to Comment number 0023.01.

Comment Number 0023.04

Geosafe

Comment Following treatment of the tanks with ISV, there is no need for the tanks to be capped with the Hanford barrier. A simpler and less expensive cover to minimize the downward percolation of water could be used. The Hanford barrier is designed to provide plant, animal and human intrusion into a waste zone using a thick zone of crushed rock and to prevent the downward percolation of water. Since the ISV monolith is already a rock "cap" of considerable structural strength the need for a biointrusion zone is unnecessary.

Response ISV will leave the tank contents in a form unique to that alternative. However, the remaining waste form is still radioactive and some means must be employed to prevent access by humans, animals, and plants. The Hanford Barrier was used for this purpose as a potential form of closure, which is applicable to all the alternatives. Closure or dispositioning of the tanks is further discussed in Volume One, Section 3.3 and in Volume Two, Section B.5.0 of the EIS. Tank waste remediation and tank farm closure issues cannot be separated; therefore, an assumption common to all alternatives was included in the alternatives evaluation, but not evaluated as a single, specific action. Because the information contained in the Draft EIS is correct, no change to the text was made. Please also refer to the response to Comment number 0019.04 for a discussion of the Hanford Barrier.

Comment Number 0023.05

Geosafe

Comment The ISV cost estimate should discuss the following costing assumptions: (a) are individual tank depths being taken into consideration for estimating treatment volumes, e.g. the 500,000 gal tanks are 18 ft deep and the million gal tanks are 32.5 ft deep, (b) is the area between tanks being vitrified and (c) is soil beneath the tanks being treated.

Response DOE and Ecology have presented life-cycle cost estimates for each alternative. These estimates are based on conceptual designs for the alternatives. Because of the conceptual nature of the alternatives, there is a level of uncertainty associated with the life-cycle cost estimates. To account for the variations cited in the comment, such as variations in tank sizes and variability of the volume of treated material, an uncertainty analysis has been completed for the tank waste alternatives. The resultant cost range for each alternative is shown in Volume Two, Section B.8.0 of the EIS. Other information on the cost estimates is contained in Volume One, Section 3.4.1.7 and Volume Two, Section B.3.0.8 of the EIS. Only the contaminated soil between the tanks and immediately around and below the tanks is assumed to be vitrified. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.06

Geosafe

Comment Page 3-52, 4th par. "Each vitrification system ... consuming 160 Mw of power." Power consumption rates should be discussed for all alternatives and not be specifically limited to the ISV alternative. ISV is an extremely efficient vitrification technology. On average ISV consumes 800 Kw-hrs of electricity to vitrify a ton of material which is considerably lower than other vitrification technologies. The power consumption rates as listed in Table B.11.0.3 for the ISV alternative is 7,690 Gwh, which is less than the "ex situ no separation" alternative (8,800 Gwh) and the "ex situ extensive separation" alternative (41,600 Gwh).

Response The preliminary calculations used in the EIS show that ISV has a power consumption lower than other alternatives. To provide a side-by-side comparison of the resource consumption of the alternatives, DOE and Ecology have presented the material in summary form in Volume Two, Table B.11.0.3. To provide a complete narrative description in Volume One, Section 3.0, the EIS presents the information for each alternative under six headings:

Process Description; Construction; Operation; Post Remediation; Schedule, Sequence and Costs; and Implementability. The Process Description for each alternative describes the major pieces of equipment for each process, giving a description of some of the major equipment used in the process. The section to which the comment refers is the Process Description for ISV, and the power supply was described as one of the major equipment items of this process. For other alternatives, the major equipment items will be different because the process is different. Because this section is a process description, it should not be interpreted as attempting to portray ISV as having obvious advantages or disadvantages. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.07

Geosafe

Comment Implementability: 1st bullet, The degree of uncertainty of the ISV alternative will be significantly reduced by using smaller ISV units as discussed above.

Response The concept of treating tank waste with large-volume melts may have more technical issues associated with the implementability of the ISV alternative. The configuration proposed in Comment number 0023.01 is smaller in size than the facility depicted in the EIS. This is one of a number of areas where further detailed study potentially could result in an improved process with fewer issues regarding technical implementability. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding.

Comment Number 0023.08

Geosafe

Comment Implementability: 2nd bullet, We agree that substantial research and development activities would be required to implement the 160 MW ISV system and for this reason have recommended using smaller ISV units closer to the scale of our commercial 4 MW system. Geosafe has already proposed a concept to DOE for treating the single shell and double shell storage tanks using our 4 MW ISV system (see attached white paper dated December 1995). The 60 ft depth limitation for processing the large volume tanks can be reduced by implementing the techniques discussed in comment A 3. [Comment number 0023.03]

Response Alternative configurations for the power supply facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the EIS. It should not be inferred that the use of a smaller power supply is a feature of any particular vendor or that the use of a smaller power supply constitutes an endorsement by DOE or Ecology. Because a smaller power supply facility would potentially melt only a portion of a tank and its contents, a solution to this problem would have to be formulated before the smaller power supply facility could be considered to be practicable, and substantial research, development, and demonstration activities still would be required. There are a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts presented to the decision makers as bounding. The EIS analysis bounds the information suggested by the commentor. For a discussion of the technique of reducing the depths of the tanks, please refer to Comment number 0023.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.09

Geosafe

Comment Implementability: 3rd, bullet, The possibility of an uncontrolled reaction occurring in a tank is mainly limited to 38 tanks containing organics or ferrocyanide material. The DOE Radioactive Tank Waste Remediation Focus Area is currently evaluating the explosive issue concern. Potentially, ISV treatability testing will be required to fully address this concern.

Response Further treatability testing will be required to fully address the concern of uncontrolled reactions in the tanks if the contents were vitrified. There may be answers to the situation that are inherent with ISV, which is that extensive mixing of contents of different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been limited, and it may be premature to state that the problem is mainly limited to 38 tanks containing organics or ferrocyanide material. Until further investigations have been completed, DOE and Ecology believe that the statement in the EIS that further analysis is required remains correct. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.10

Geosafe

Comment Implementability: 4th bullet, We agree that the tank farm containment facility is highly conceptual and recommend that it be scaled down in size from the proposed 500 ft wide by 600 ft long facility to an approximately 120 ft square facility which covers only one tank. The technical difficulties of constructing the smaller facility are minimal.

Response The large tank farm confinement facility is highly conceptual in nature. The area discussed at this point is that further development would be required before any confinement facility, regardless of size, would be expected to comply with current DOE facility design requirements. A confinement facility that is 120 feet on a side is still sufficiently large that additional design study would be required. The technical difficulties that may be expected in designing and constructing the smaller confinement facility would be less than those expected in designing and constructing a much larger confinement facility. It may be optimistic to state that these technical difficulties would be minimal. This is one of a number of areas where further study potentially could result in a process with fewer issues regarding technical implementability. In these areas, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers. The EIS bounds the information suggested in the comment. Please refer to the response to Comment number 0023.01 regarding the use of smaller ISV units.

Comment Number 0023.11

Geosafe

Comment Implementability: 5th bullet, The use of a smaller tank containment facility will eliminate most of the construction difficulties. Using a smaller mobile containment facility will allow construction activities to take place in a clean area, thereby eliminating the risks and added expense of working in or around a tank farm exclusion zone.

Response The large tank farm confinement facility may be more difficult to construct. The area being discussed in the EIS at this point is the atypical nature of the design of the large confinement facility and restrictions associated with working in and around the tank farms. While a smaller confinement facility could be constructed adjacent to the tank farms and then moved into position to assume that this will eliminate the risks and added expense of working around the tank farms would be considered premature. This is one of several areas where additional design study potentially could result in process improvements and potentially could result in a process with fewer issues regarding technical implementability. In these areas, the configuration used in the EIS represented a bounding condition, resulting in environmental impacts that also were bounding. Please refer to the response to Comment number 0023.01 regarding the use of smaller ISV units.

Comment Number 0023.12

Geosafe

Comment Implementability: 6th bullet, Inspection of the final waste form can be done by core drilling through the vitrified monolith after a period of cooling. Core drilling is routinely performed on commercial ISV projects to verify waste treatment for project closure. In the past, core drilling has been used to sample untreated tank wastes and should be easily adaptable to sampling a vitrified waste form which is easier to handle. Secondary wastes generated from the drilling can be recycled to future melts. If a core sample fails to meet waste acceptance testing, the area from which it was taken can be retreated by ISV.

Response Methods exist for the sampling of the in situ vitrified product. Many cores would likely be necessary for each tank and the cuttings from the core would require special handling and disposal. While the secondary wastes generated can be returned to the untreated tanks, other problems may be encountered during the development and operating phases of the core drilling system. The core drilling of vitrified HLW is an area that would require additional research and development to investigate further and determine its workability. If core drilling becomes an accepted technique for determining the acceptability of the waste form, the design of the confinement facility would include provision for equipment to accomplish the core drilling. Inspection and potential pretreatment of the final waste form are implementability problems that remain to be solved.

Comment Number 0023.13

Geosafe

Comment Implementability: 7th bullet, Use of the proposed smaller tank confinement facilities will be significantly reduce decontamination and decommissioning problems.

Response The large tank farm confinement facility may be difficult to decontaminate and decommission and these difficulties should be fewer for a smaller facility. Further study could result in an improved process. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.14

Geosafe

Comment B-53, 3rd par., last sent., A reference should be provided for the current research which is addressing depth-enhancement techniques.

Response A reference has been added to the last sentence of the referenced paragraph in Volume Two, Appendix B.

Comment Number 0023.15

Geosafe

Comment B-53, 4th par., Elimination of interstitial spaces between soil particles is not the only mechanism for volume reduction. During ISV treatment a significant volume of tank wastes will be vaporized due to the decomposition of nitrates, nitrites, carbonates and sulfates. This will result in a volume reduction that is expected to exceed 50 percent by volume. In addition, the ISV process will not produce significant quantities of No_x that require special off-gas treatment. The high operating temperature of the ISV melt and its reducing environment will decompose nitrate and nitrite into N_2 and O_2 gas.

Response Elimination of interstitial spaces between soil particles is not the only mechanism for volume reduction. A reduction in volume due to decomposition of the tank wastes will occur. However, at this time, no ISV facilities have been designed for use at the Hanford Site. Until design and testing have been completed, to consider that the ISV process will not produce significant quantities of nitrogen oxides requiring special off-gas treatment is premature. ISV most closely resembles a batch process, where the nature of the reacting materials and the reaction products change as a function of time. Temperature also changes with time during ISV, starting with the cool tank wastes and glass formers and ending with molten glass at a very high temperature. Therefore, while extremely high temperatures will enhance the dissociation of nitrate and nitrate, nitrogen oxides will be produced until those temperatures are reached, and the off-gas treatment system must be able to treat all of the vapors evolved. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the

alternatives.

Comment Number 0023.16

Geosafe

Comment B-56, Figure B3.4.3., The NO_2 burner is configured as a lime spray dryer.

Response The essential function of the nitrogen oxide burner is correctly depicted on the flow diagram in Volume Two, Appendix B. The streams entering and leaving the unit are shown correctly. Because the essential function of the unit has been depicted, no changes to the EIS have been made.

Comment Number 0023.17

Geosafe

Comment B-57, 1st par., Treating the area between the tanks unfairly increases the cost of the ISV alternative and should not be included unless other alternatives address this concern. Potentially, an ISV option could be included which addresses the treatment of contamination below and around the tanks.

Response The inclusion of extra material in the zone of vitrified material is unique to the ISV alternative. Treating the area between the tanks would occur as a consequence of the nature of the ISV process, and doing so would not unfairly increase the cost of the ISV alternative. Because of the in situ nature of the process, ISV must have a vitrified zone that extends beyond the tank dimensions to ensure that the tank and its contents have been vitrified. This zone would not exist for the ex situ alternatives, for which retrieval activities will be performed that would be bounded by the tank walls. Because of the technical uncertainty in determining the dimensions of the zone of vitrified material during the melting operation, the preparers of the engineering data package (WHC 1995f) made the assumption to extend the dimensions of the vitrified zone beyond the tank dimensions to include the extent of the tank farms. Using this assumption ensured that the preconceptual costs, energy consumptions, and glass former usages were reasonable. For use in the EIS, these conservative assumptions and resulting calculations form a bounding condition. The use of this bounding condition will result in environmental impacts that are likewise bounding. NEPA requires that bounding conditions be equally compared for the environmental impacts that potentially may result from all alternatives evaluated. Please refer to the response to Comment numbers 0023.01 and 0001.01 for other discussions of subsurface barriers.

Comment Number 0023.18

Geosafe

Comment B-63, last par., The ISV flow diagram (Figure B.3.4.3) does not show a water quench system, venturi scrubber, solids separator, chiller or mist eliminator, which are the standard ISV off-gas treatment system components.

Response Figure B.3.4.3 depicts the major features of the ISV process. At the point when further engineering design potentially would be done, an expanded set of process flow diagrams would be developed. Because the description of the process in Section 3.4.3 of Appendix B refers to the water quench, scrubber, solids separator, chiller, and mist eliminator, no changes to the EIS have been made. These treatment systems were included in the design for the process, but were considered too much detail for presentation in the EIS. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.19

Geosafe

Comment B-64, 3rd par., The degree to which organics and ferrocyanides present an explosive issue in the tanks is presently unknown and is currently being researched by DOE. At most an estimated 38 tanks potentially contain high enough concentrations of these contaminants to be of concern (PNL 10773).

Response The degree to which organics and ferrocyanides present an explosive issue currently is under investigation. There may be answers to the situation that are inherent with ISV, which is that extensive mixing of the contents of different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been limited, and it may be premature to state that the problem mainly is limited to 38 tanks of organics or ferrocyanide material. Until further investigations have been completed, the statement in the EIS that safely treating reactive materials requires further analysis is correct. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.20

Geosafe

Comment 1st bullet, Geosafe agrees that the proposed ISV alternative is more conceptual in design than the ex situ vitrification alternative but has made the following recommendations to significantly decrease the degree of uncertainty associated with cost, schedule and resource requirements.

- Use smaller ISV equipment and multiple melts to treat tanks
- Use a smaller moveable tank containment building
- Reduce tank effective height to lower treatment depth and volume.

Response Additional areas for further research and investigation associated with ISV are possible. Using smaller ISV equipment and multiple melts, smaller, moveable confinement facility, and tank overburden to fill voids and lowering the tank dome into the tank are areas where further investigation may be valuable. The configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that also were bounding. These bounding impacts were presented to the decision makers. Please refer to the response to Comment numbers 0023.01, 0023.03, and 0023.11. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.21

Geosafe

Comment 2nd bullet, The degree of uncertainty for the ISV alternative can be reduced by using smaller equipment which is considered highly feasible given the current understanding of the technology.

Response Alternative configurations for the tank farm confinement facility for ISV are possible. The configuration proposed in Comment number 0023.01 includes a confinement facility that is 120 feet on a side. The area under discussion in the EIS is the higher degree of uncertainty for the exact equipment required for ISV versus ex situ alternatives. The 120-foot confinement facility is still several times larger than that used in current development work for ISV. To state that this configuration is highly feasible could be considered premature. Comment number 0023.01 discusses concerns related to the movement of a smaller confinement facility and its off-gas facilities. Because these concerns remain as issues and problems to be resolved, the EIS is correct in referring to the degree of uncertainty involved. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.22

Geosafe

Comment 3rd bullet, Implementing the recommendation to use a smaller containment facility will eliminate all these concerns except for the need to characterize the tanks. Tank waste characterization is a generic concern that is applicable to all treatment alternatives and is not limited to the ISV alternative.

Response Vitrifying one tank at a time will not require the characterization of an entire tank farm if a smaller, mobile confinement facility were to be used. ISV by its very nature does not retrieve the tank contents. Consequently, there is no opportunity to advantageously blend the tank contents, as would be the case if several tanks were retrieved at the same time as in the ex situ alternatives. To consider the smaller confinement facility will eliminate all these concerns except the need to characterize the tanks would be premature. Still, ISV is basically a batch process (or potentially a semi-continuous process). One characteristic of a batch process is the changing nature of the reactants and products as a function of time. The system must be able to process the expected products, and this requirement does not change with the size of the confinement facility. Further detailed study would result in an improved process; however, no changes to the information presented in the EIS are required. Please refer to the response to Comment number 0023.01.

Comment Number 0023.23

Geosafe

Comment 4th bullet, An estimated 20 tanks potentially contain organics at concentrations that may represent an explosive concern. Research on treating these problem tanks could be conducted while other non-effected tanks are being processed.

Response The degree to which organics present an explosive issue is currently under investigation. Extensive mixing of waste from different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been very limited, and it may be premature to state that the problem mainly is limited to 20 tanks containing organics. Concurrent research and testing on treating these problem tanks could be conducted while other non-affected tanks are being processed. This research must be successfully completed before this method could be used to remediate tanks that may present an explosive concern. Until further investigations have been completed, the statement in the EIS that the safety of drying some waste types is uncertain remains correct, and as a result, no changes to the EIS have been made. The potential for fires and explosions in the tanks is addressed in Volume One, Section 5.12 and Volume Four, Appendix E. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.24

Geosafe

Comment 5th bullet, Geosafe recommends using smaller ISV units which should significantly reduce the uncertainties associated with off-gas treatment. The high operating temperature of ISV has been demonstrated to effectively decompose nitrogen compounds without the formation of NO_xS and greatly reduces off-gas treatment concerns. The calcium sulfate waste stream should not be recycled because the sulfates will be reintroduced back into the off-gas.

Response There is the potential for the production of a secondary waste stream of potentially contaminated calcium sulfate from ISV. This waste stream should not be recycled because the sulfates may not be incorporated into the melt and may be reintroduced into the off-gas. However, at this time, no ISV facilities have been designed for use at the Hanford Site and none have been designed of the size needed to vitrify the tank waste anywhere in the world. Numerous ISV facilities have had problems with off-gas treatment and fires. Until development work has been completed, to state that the high operating temperature of the ISV process would effectively decompose nitrogen compounds without the formation of nitrogen oxides and greatly reduce off-gas treatment concerns would be considered premature. ISV most closely resembles a batch process, where the nature of the reacting materials and the reaction products change as a function of time. Temperature changes also occur with time during ISV, starting with the cool tank wastes and glass formers and ending with molten glass at a very high temperature. So while extremely high temperatures will enhance the dissociation of nitrate and nitrate, nitrogen oxides will be produced until those temperatures are reached. The off-gas treatment system must be able to treat all of the vapors that are evolved. Because these uncertainties will remain regardless of the size of the ISV units, no changes to the EIS have been made. Please also refer to the response to Comment number 0023.01 for a discussion of smaller ISV units.

Comment Number 0023.25

Geosafe

Comment 6th bullet, The 60 ft depth limitation is overly conservative and can be reduced by removing overburden from the tanks and lowering the effective height of the tank as discussed in comment A 3. [Comment number 0023.03]

Response Please refer to the response to Comment numbers 0023.03 and 0023.08.

Comment Number 0023.26

Geosafe

Comment 7th bullet, The use of the proposed smaller tank containment facility (120 ft by 120 ft) will eliminate structural design and costing uncertainties.

Response The EIS addresses only the uncertainty that remains in the design of the large (i.e., 500- by 600-foot) confinement facility. At this time, no ISV facilities have been designed for use at the Hanford Site. Until additional technology development has been completed, it would be considered premature to state that the use of the smaller confinement facility will eliminate structural design and costing uncertainties. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.27

Geosafe

Comment 8th bullet, Verification of the ISV monolith can be performed by core sampling which is a well demonstrated technology. Allowances will have to be made for coring of a radioactive glass monolith but it is feasible given an enclosed system and sufficient concern for safety issues. Secondary wastes generated from coring can be directly recycled to future melts thus eliminating waste disposal concerns.

Response DOE and Ecology agree with the comment that methods exist for the sampling of the in situ vitrified product. The core drilling of vitrified HLW is an area that would require additional research and development to determine its workability. If core drilling becomes an accepted technique for determining the acceptability of the waste form, the design of the confinement facility would include provision for equipment to accomplish the core drilling. While the comment is correct in stating that the secondary wastes generated can be returned to the untreated tanks, it is possible that other problems will be encountered during the development and operating phases of the core drilling system. The text referred to in the comment discusses the fact that inspection and potential pretreatment of the final waste form are problems of implementability that remain to be solved. Despite the fact that methods are available for sampling the vitrified waste form, the technical problems associated with this issue remain to be solved. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.28

Geosafe

Comment 9th bullet, The use of the smaller ISV system will eliminate concerns regarding movement of the off-gas system.

Response The EIS addresses the uncertainty that remains in the design of the off-gas treatment facilities. Until additional technology development has been completed, to state that the use of the smaller ISV system will eliminate concerns regarding movement of the off-gas system would be considered premature. Please refer to the response to Comment number 0023.24. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.29

Geosafe

Comment 10th bullet, The use of a smaller ISV system will greatly reduce the time needed to retreat a specific area in a tank if it fails to meet the treatment criteria.

Response The EIS addresses the uncertainty that would occur in the operations schedule if an area as large as a complete tank has to be retreated as a result of unsuccessful ISV. Until additional technology development has been completed, to state that the use of the smaller ISV system will greatly reduce the time needed to retreat a specific area in a tank if it fails to meet the treatment criteria would be considered premature. The time required to retreat a tank is not a function of the size of the confinement facility. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.30

Geosafe

Comment 11th bullet, The concern of mixing fluxants into deep zones of the tank can be reduced by implementing the treatment depth reduction techniques recommended in comment A 3 (See Comment number 0023.03). Geosafe has already demonstrated the mixing of fluxants at full scale with excellent results.

Response Thermal mixing is well known in conventional electric furnaces and should work well for ISV. Because thermal mixing in electric furnaces is a natural phenomena, its presence does not constitute an endorsement of the application of a particular technique or equipment. The statement in the EIS refers to further development work that may be required. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.97

CTUIR

Comment P 3-48: Sect. 3.4.5: In Situ Vitrification Alternative: this section does not adequately discuss how all of the vitrified ground and waste is to be verified for vitrification, and how this verification process will include leakage, migration, below the area of impact. This process has not been adequately explained for the purposes of this EIS.

Response Further technology development regarding the implementation of the ISV alternative may be required. Volume One, Section 3.4.5.7 and Volume Two, Section B.3.4.4 discuss the issues applicable to the implementability of this alternative including inspection of the final waste form to confirm that all of the waste is stabilized and the waste form is acceptable. One possible method of verification would be drilling through the vitrified mass to ensure that vitrification was complete, but these drill holes would not necessarily confirm any potential migration that may exist below the vitrified mass. Migration in the vicinity of the vitrified mass could be verified by drilling additional boreholes near each tank farm when ISV had been completed. Please refer to a related discussion on verification in the response to Comment number 0023.12.

Comment Number 0072.98

CTUIR

Comment P 3-54: Sect. 3.4.5.7: Implementability: How is excess melting going to be addressed, Please describe the fractionation process of the melt? What are the anticipated cooling times, and how have these times been calculated, are they based on the fractionation process? If the times are not based on the fractionation process what exactly are they based on? What is the verification process for the vitrification, the fractionation, the cooling, the immobilization?

Response Many crucial questions must be answered before the ISV alternative can be implemented. Volume One, Section 3.4.5.7 contains discussions of the substantial research, development, and demonstration activities that would be required. Inspection of the final waste form to confirm stabilization of the waste is one area requiring more information. The implementability of this alternative is not known at this time. To account for these uncertainties, additional technology development time and costs were incorporated into the analysis of these alternatives. The information requested is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives. Implementability was one factor analyzed for the technologies included in the alternatives analysis.

Comment Number 0072.99

CTUIR

Comment P 3-54: The technical uncertainties associated with this process are just as great for the MUSTs because the contents of the MUSTs have been inadequately described within this EIS.

Response As is explained in Volume Two, Section A.2.3, definitive characterization data do not currently exist for the inactive MUSTs. Because they received the same waste products that are contained in the tanks, the concentration of constituents is expected to be approximately the same. Volume Two Table A.2.3.1 lists the current estimated waste volumes for the MUSTs and briefly comments on the use of each tank. ISV of the small MUSTs may present less of a technical challenge because the size of the melt more closely conforms with previously demonstrated vitrification processes. Please refer to the response to Comment numbers 0012.14, 0072.169, 0029.01, and 0060.02 for a discussion related to MUST contents.

Comment Number 0072.185

CTUIR

Comment P B-53: Sect. B.3.4: Same comment as above. [Please refer to the response to Comment number 0072.195.]

Response Please refer to the response to Comment number 0072.195.

Comment Number 0102.01

Eister, Warren

Comment The Draft Environmental Impact Statement for the Hanford Site Tank Waste Remediation System - Summary (DOE/EIS-0189D) seems to suggest the choice system would be In Situ Vitrification (Figure S.6.2 along with Tables S.7.2 and S.7.3).

It is very reassuring that decisions made more than twenty years ago continue to be re-evaluated. Unfortunately those decisions have been extremely difficult to implement.

However, in spite of the continuing unresolved difficulties, this EIS Summary reports that DOE has already adopted the Phased Implementation System which is dependent on potential geologic repositories and involves extensive process and transportation activities.

Is the In Situ Vitrification technology being developed with the same level of effort as the Phased Implementation?

Would this In Situ Vitrification System be applicable to the:

- Savannah River site?
- Spent fuel from the nuclear power reactor program?
- TRU waste?
- Low-level wastes?

Are there other technologies being sought that would allow the spent fuel from the nuclear power program to remain in the vicinities of the current power plant sites?

Response The preferred alternative for tank waste identified in the Draft EIS and Final EIS is Phased Implementation not ISV. DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.05 regarding NEPA requirements for the analysis of alternatives and Comment numbers 0055.03 and 0005.07 for a discussion of the role of the EIS in the decision making process. Repository costs and uncertainties analysis results for each alternative have been included in Volume Two, Appendix B and Volume Five, Appendix K, respectively, in the Final EIS.

The TWRS EIS focused on tank waste remediation alternatives. Technology evaluation was limited to those technologies currently available or for which sufficient development information was available. DOE is not currently developing any remedial technologies. Potentially-applicable ISV technologies are under commercial development. Technologies development and/or evaluation would be conducted during the detailed design and demonstration phases of the preferred alternative. Issues related to ISV technology applicability at other DOE sites, for commercial nuclear power programs, or to other radioactive waste types beyond those required for the alternatives evaluation were not considered because they are beyond the scope of the EIS.

Please refer to the response to Comment number 0037.03 for more information concerning interim onsite storage of HLW and compliance issues related to the Nuclear Waste Policy Act.

L.3.4.7 Ex Situ Intermediate Separations Alternative

Comment Number 0005.45

Swanson, John L.

Comment Page 3-59 contains a sentence regarding the Tri-Party Agreement requiring the retrieval function to remove waste to an extent based on volume or as much as is technically possible, WHICHEVER IS LESS. I believe you mean to say remove the MOST, leaving the LEAST - but that is not what the sentence says.

Response The cited text has been revised as follows, "The Tri-Party Agreement (i.e., Milestone M- 45-00) requires that the removal function remove waste to the extent that SST waste residuals meet specific volume requirements based on tank type, or that as much waste is removed as technically possible, whichever action results in the least residual waste volume" (Ecology et al. 1994).

Comment Number 0005.46

Swanson, John L.

Comment Page 3-67 defines an off-gas stream from a vitrifier as a "gaseous air stream containing combustion gases." This is true for a combustion-fired melter, but how about a joule-heated melter?

Response Volume One, Section 3.4.6.2 states that fuel-fixed melters have been included for analysis in the EIS. It is further stated that future evolution may result in another melter configuration. With either the joule-heated or fuel-fixed melter, a large quantity of off-gas with contaminants such as SO_x and NO_x must be treated. The total volume of gas with a fuel-fixed melter would be greater with the use of kerosene and oxygen for the fuel, but the total amounts of SO_x and NO_x would not differ greatly. The fuel-fired melters considered provide a more conservative analysis in the design and treatment of the off-gas for discharge to the environment. Please refer to the response to Comment numbers 0005.42, 0072.91, 0023.01, 0023.15, 0023.24, 0023.28, and 0072.101 for discussions of issues related to off-gassing. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0005.47

Swanson, John L.

Comment Page 3-67, last paragraph of 3.4.6.2 ("Driving heavy equipment--") seems to be out of place. This same paragraph appears in similar locations for other alternatives too; the same comment applies in those sections as well.

Response Because this is an issue common to many of the alternatives, a better location for a one-time entry to the section has been determined. This discussion on mitigating a potential accident has been moved to a discussion of elements common to the alternatives in Volume One, Section 3.4 and Volume Two, Appendix B. This statement of concern appears on several pages within Volume One, Section 3.0 and Volume Two, Appendix B.

Comment Number 0027.10

Roecker, John H.

Comment Technical Uncertainty

To state that the technical uncertainty of the intermediate and extensive separations alternatives are both moderate is erroneous and misleading to those who are not familiar with the technologies involved. Intermediate separations requires three technologies, all of which have been demonstrated, while extensive separations requires at least ten, most of which have not been demonstrated. This misleading information needs to be corrected.

Response The degree of technical uncertainty provided in the Summary assigns a high, medium, or low ranking for the entire remediation alternative. DOE and Ecology acknowledge that there is a higher level of technical uncertainty with extensive separations than with intermediate separations. However, overall, both alternatives fall into the moderate category. Additional discussion regarding technical uncertainty is provided in Volume One, Section 3.4 and Volume Two, Appendix B and the response to Comment number 0005.03.

Comment Number 0036.16

HEAL

Comment The EIS states that intermediate separations would reduce the waste going to the repository. It adds, "The other goal of separations would be to limit the generation of additional waste during the separations processes" (p. 3-65). What does this passage mean?

Response Limiting the generation of additional waste during the separations process means that design and implementation of the HLW/LAW separations processes would consider the volume of LAW along with the volume of HLW that would be generated. One means of accomplishing this would be to limit the introduction of sodium hydroxide during the enhanced sludge washing process, which would limit the overall amount of sodium in the resulting LAW form.

Comment Number 0057.03

Garfield, John

Comment With respect to primarily the cost, the EIS references the document from '94 Boomer et al. That document compares two alternatives that are nearly identical to intermediate separations, then extensive separations is called clean and enhanced sludge washing in that document. It shows a cost penalty for using clean of $7 billion dollars compared to enhanced sludge washing. Those same alternatives show a $3 billion dollar advantage in the Environmental Impact Statement Draft. That is a $10 billion dollar swing. That deserves investigation. The repository comments convey part of that. The rest relates back to my earlier remarks about the headquarters influence.

Response The cost estimates were reviewed and revised for the Final EIS. The waste loading and blending assumptions that impact the volume of HLW have been revised to reflect the recommendations of an independent technical review team. The size of the HLW canisters has been revised to reflect recent DOE-RW findings that a longer canister for Hanford HLW is technically feasible. These changes, as well as the resulting cost impacts, were revised and are included in Volume One, Section 3.4 and Volume Two, Appendix B. For more information on issues relating to HLW canisters and repository costs, please refer to the response to Comment numbers 0081.02 and 0008.01.

Comment Number 0057.05

Garfield, John

Comment The next comment I would like to make is that the chosen case built around the extensive sep..or excuse me the intermediate separations data of without repository cost shows it $30 billion dollars. That estimate assumes a stand-alone high-level waste treatment facility which would cost in the vicinity of $1 to $2 billion dollars and add another equivalent amount in operating costs. There is some recent data developed using a single facility but which can be - its mission can be modified both in terms of scope and capacity to accommodate both low-level treatment at a smaller scale through the 200-ton per day capacity 1 to 200-ton per day capacity for the full scale low-level treatment and then can be converted for high-level treatment. That is the only sane approach to this problem. Building three demonstration plants and two full-scale plants is a lunacy that will cost us $30 billion dollars. A simpler facility approach that I just described would cut those costs in approximately half and, in fact, the studies release from the DOE reading room suggests that cost is about $16 to $18 billion dollars. That should be the basis for the EIS intermediate separations case.

Response DOE and Ecology recognize that there are opportunities for optimizing the costs estimated for each of the alternatives addressed in the EIS. As discussed in the EIS, the alternatives were developed to bound the impacts associated with remediating the tank waste. Process and facility design optimization would not be precluded with the selection of any of the alternatives presented in the EIS. For more information on the topic, please refer to response to the Comment number 0072.05.

The Draft EIS addressed the full range of reasonable alternatives. The alternative identified is bounded by the alternatives addressed in the Draft EIS, and DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers.

Comment Number 0072.100

CTUIR

Comment P 3-56: Sect. 3.4.6: Ex Situ Intermediate Separations Alternative: The separation of the Waste streams into HLW and low activity waste seems confusing. Low activity waste is waste that is a subset of HLW? What are the legal requirements for classifying waste as LAW? Have the Affected Tribes been consulted regarding this?

Response LAW is the waste remaining after removal of as much of the radioactivity from HLW as practicable. The definition of LAW is provided in Volume One, Section 1.0. DOE and the NRC have had formal discussions on tank waste classification and LAW regulation; however, DOE would need to formally solicit an opinion from the NRC regarding the classification of LAW. Volume One, Section 6.2 provides additional information on tank waste classification and the results of the discussions between DOE and the NRC. Criteria must be formalized as to the extent to which the HLW in the tanks must be separated for the residual waste to meet requirements for incidental waste, LAW, as well as the DOE and Washington State definitions of LLW and hazardous waste requirements of the State of Washington. Design specifications for HLW and LAW treatment will require that waste forms meet applicable criteria for disposal in the potential geologic repository or as LAW for onsite disposal, respectively.

DOE plans for onsite near-surface disposal of LAW date back to the 1988 Hanford Defense Waste EIS ROD (DOE 1987). That NEPA process, as well as subsequent consideration of onsite disposal of LAW during the 1989 and 1994 Tri-Party Agreement negotiations, and the Tank Waste Task Force process (HWTF 1993), provided interested parties as well as Tribal Nations with the opportunity to comment on the planned onsite disposal of LAW. The TWRS EIS and the public involvement process for Tri-Party Agreement amendments associated with the privatization initiative provided additional opportunities for Tribal Nation input into the decision-making process related to this issue. The Tribal Nation consultation process is discussed in the response to Comment number 0072.149.

Comment Number 0072.101

CTUIR

Comment P 3-56: PP 3: The LAW is to be quenched into a 'cullet', this indicates that there is going to be an additional secondary waste stream generated from the reaction of molten silicates, nitrates, hydroxides, oxides, metals and water. What will be done with this waste stream. Will this waste stream be classified as High level liquid waste? The off gasses that are produced are supposedly going to be treated in some fashion, please explain how this is to be accomplished including feed rates, volume of off gas produced, filter failure rates, retrievable useable material, and indicate where this process has been proven including references.

Response The technical data that served as a basis for developing the Ex Situ Intermediate Separations alternative are referenced in the EIS (WHC 1995 n, j, i and Jacobs 1996) and are available for review as part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories.

Quench water is a secondary waste stream that would contain contaminants as a result of quenching the molten LAW glass in order to produce the cullet. This quench water would be recycled extensively either as quench water or back to the front of the process to be added to the LAW stream for vitrification. This liquid waste stream would not be expected to be classified as HLW.

The amount of secondary waste generated during operations of the Ex Situ Intermediate Separations alternative would consist primarily of off-gas and liquid effluent emissions identified in Volume Two, Table B.11.05. The off-gas and liquid effluents would be treated to remove contaminants to the maximum extent possible before being discharged. The HLW vitrification process would result in gas flows out the stack of approximately 3,500,000 metric tons (mt) over the life of the facility. The radiological and chemical concentrations to be released from the stack were calculated and used in the routine risk assessment. The liquid effluent from the HLW vitrification facility was estimated to be 1,200,000 mt (before recycle) based on material balance calculations. Volume Two, Section B.3 describes the liquid effluent processing of secondary radioactive waste streams for all alternatives. In addition to these emissions, secondary waste consisting of contaminated filters and spent ion exchange resins would be generated during treatment operations.

The generation of off-gas during the vitrification process would result from the evaporation of water, thermal destruction of chemical compounds, evolution of volatile compounds, and the entrainment of particulates in the off-gas stream. A detailed description of the off-gas system is provided in Volume Two, Section B.3. Control technologies that would be employed to reduce emissions include: quench towers, venturi scrubbers, chillers, demisters, high-efficiency particulate air (HEPA) filtration, sulfur recovery, and NO_x destruction. The off-gas emissions from the vitrification plants are included in the risk assessment. The off-gas treatment processes that would be used are the same technologies that have been successfully used in commercial and defense nuclear industry as well as the chemical processing industry.

Comment Number 0072.102

CTUIR

Comment P 3-56: PP 5: What is the amount of secondary waste generated from this process? Will there be material that can be recycled? Will the secondary waste stream have to be reprocessed for additional radionuclide removal?

Response Secondary waste streams will include treatment for removal of radionuclide and chemical contaminants to the maximum extent possible before discharge. Off-gas streams will include various technologies to treat chemical and radionuclide emissions during operations. Liquid effluents would be collected and sent to the onsite Liquid Effluent Treatment Facility for treatment. Please refer to the response to Comment numbers 0072.101 and 0072.109.

Comment Number 0072.103

CTUIR

Comment P 3-59: top of the page: Where does the strontium end up with this process, in the liquid or the solids phase?

Response The strontium will be mainly in the HLW solid phase during the enhanced sludge washing process used for the Ex Situ Intermediate Separations alternative. A small amount, approximately 6 percent of the strontium and decay product activity, would end up in the LAW.

Comment Number 0072.104

CTUIR

Comment P 3-59: Sect. 3.4.6.2: What was the process for determining the average feed stream, and what are the expected ranges for this feed stock in relation to the glass content and characteristics? What will be the process for determining what to do, in the case of 'out of operating' mode? Will this process entail stocking waste from the other tanks in order to blend the feed mixture? If this is the case, has this information been costed out to show how many and how large these out of ground tanks will be?

Response The technical data that served as a basis for developing the Ex Situ Intermediate Separations alternative is referenced in the EIS (WHC 1995i, j, n and Jacobs 1996) and available for review as part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. Additional details regarding the facility layout, including the melter feed system and associated tankage, are provided in Volume Two, Section B.3.

The average feedstream was developed by taking the average overall chemical and radiological inventory including dilution water that would be added during waste retrieval operations. The material balance calculations assumed that the tank waste would be adjusted to 5 molar soluble sodium during retrieval and transfer. It is expected that there will be some variation in the feed stream composition during the waste treatment process. Compositional limits for waste feed would be established during the detail design phase and would take into consideration the affect of variability in the waste feed on the vitrification process, the acceptability of the glass, as well as safety concerns. Blending of the waste during retrieval and the ability to sample and blend waste in the lag storage area would minimize the variance in the waste feed. The lag storage and melter feed system would provide further opportunity for waste feed conditioning. The engineering data developed include the necessary equipment and processes to blend the waste feed and no additional out of ground tanks are required.

Comment Number 0072.105

CTUIR

Comment P 3-61: Sect. 3.4.6.2:. PP 3: S 1: The figure 3.4.9, depicts a sluicing module at the end of the end effector. If sluicing has to be discontinued because of tank leakage, please describe this sluicing module, and why it is depicted.

Response The sluicing module referred to in the comment would minimize the amount of water introduced to the tank during retrieval as compared to articulated arm method of sluicing. The articulated arm would be deployed when there was concern about the integrity of the tank or a potential for tank leakage. Other types of engineered modules, such as mechanical end effectors, could be used for selected retrieval operations with the articulated arm. Please refer to the response to Comment number 0029.01 for additional information concerning sluicing.

Comment Number 0072.106

CTUIR

Comment P 3-66: PP 1: S 7: Within this sentence there is a reference that silica is sand. Silica is not sand. Sand can consist of many things, including silicon dioxide.

Response Sand is commonly defined as loose, fine particles of disintegrated rock. The sentence that is referred to in the comment is describing glass formers, some of which may be either silica or sand (depending on the desired composition of the glass).

Comment Number 0072.107

CTUIR

Comment P 3-66 PP 2: S 1: Quenching molten glass will not necessarily make gravel sized pieces, in addition the pieces formed will have a high percentage of fractures, and necessarily a very large surface area, please explain how these cullets are better at resisting aging, and weathering, and where are the references for this process?

Response The treatment facilities that would produce glass cullet as a waste form would have equipment in place to produce uniform-sized cullet. Glass fines would be screened and recycled back to the melter and oversized cullet would pass through a roll crusher to produce cullet of acceptable size for handling. Glass cullet would have a larger surface area-to-volume ratio as compared to monolithic pours of glass (e.g., glass logs) in canisters. This discussion is included in Volume Two, Section B.3 of the EIS. Glass cullet would have higher leach rates than monolithic pours of glass due to the higher surface area-to-volume ratio. The acceptability of HLW glass cullet produced under the Ex Situ No Separations alternative is identified in Volume One, Sections 3.4 and 6.2 and Volume Two,

Appendix B. The increased leaching for cullet was taken into account when the impacts associated with the immobilized LAW were analyzed in the EIS in Volume One, Section 5.2 and Volume Four, Appendix F. Please refer to the response to Comment numbers 0035.04, 0012.11, and 0052.11 for a discussion of waste form and storage issues.

Comment Number 0072.108

CTUIR

Comment P 3-67: PP 2: What does partial recycle of off gas mean? Does this mean that there is going to be a substantial amount of off gas released to the environment? Has this been incorporated into the risk section? Have the impacts of this off gas been assessed as to their affects to Native Americans?

Response Each tank waste alternative that uses high-temperature processing (vitrification or calcination) would make extensive use of recycle streams to recycle back into the treatment process volatile radionuclide and chemical constituents captured in the off-gas system. These recycle streams would minimize the generation of secondary waste. It has been determined that a bleed stream would be required for each alternative to avoid a continuous buildup of certain volatile radionuclides and chemical constituents, namely technetium and mercury, in these recycle streams. Complete recycle of the more volatile constituents is not possible. The off-gas emissions estimates used for risk assessment were developed considering volatility and the ability of the off-gas treatment system to capture and recycle individual constituents.

Please refer to the response to Comment numbers 0072.207 and 0072.91 for discussions on assessment of Native American risk resulting from routine air emissions during remediation. The Tribal consultation process is discussed in Comment number 0072.149.

Comment Number 0072.109

CTUIR

Comment P 3-68: PP 4: Bottom of the Page: One 22 metric ton per day HLW does not seem like enough, especially since there is going to be down times for change outs, plugging, melt inconsistencies, spills, and other process related problems. Wouldnt it be more prudent to plan for additional melt capacity above and beyond the 20 mt as allowances for capacity needs? Additionally, what is the total amount of secondary waste generated with his process? How will this compare to the global vitrification process already in use in France, and the United Kingdom? What are the expected off gases, and what are the treatment process being proposed? Are these gasses being addressed in the risk portion of this document?

Response The 20 mt (22 ton) melter capacity for HLW vitrification under the Ex Situ Intermediate Separations alternative was calculated using a 60 percent overall operating efficiency along with a 13-year operating duration. The

60 percent overall operating efficiency takes into account down time due to process-related problems.

The amount of secondary waste generated during operations of the Ex Situ Intermediate Separations alternative would consist primarily of off-gas and liquid effluent emissions identified in Volume Two, Section B.11, Tables B.11.05 (radiological) and B.11.06 (nonradiological) The off-gas and liquid effluents would be treated to remove contaminants to the maximum extent possible before being discharged. The HLW vitrification process would result in gas flows out the stack of approximately 230,000 mt over the life of the facility. The radiological and chemical concentrations that would be released from the stack were calculated and used in the routine risk assessment. The liquid effluent from the HLW vitrification facility was estimated to be 72,000 mt based on material balance calculations. Volume Two, Section B.3 describes the liquid effluent processing of secondary radioactive waste streams for all of the alternatives. In addition to these emissions, secondary waste consisting of contaminated filters and spent ion exchange resins would be generated during treatment operations.

A discussion of foreign vitrification technologies can be found in Volume Two, Section B.9. A comparison of secondary waste generation at foreign vitrification facilities was not made; however, the generation of gaseous and liquid effluent streams would be expected to be the same for similar waste types and processing rates. Regulatory requirements for gaseous and liquid discharges would control the number and type of treatment technologies employed to reduce the risks to human health and environment. These requirements would be different in foreign countries. The Hanford Waste Vitrification Plant Foreign Alternatives Feasibility Study indicated that plants operating in foreign countries would require additional process equipment for treating melter off-gas and other effluents to meet United States environmental requirements.

The generation of off-gas during the vitrification process would result from the evaporation of water, thermal destruction of chemical compounds, evolution of volatile compounds, and entrainment of particulates in the off-gas stream. A detailed description of the off-gas system is provided in Volume Two, Section B.3. Control technologies that would be employed to reduce emissions include: quench towers, venturi scrubbers, chillers, demisters, HEPA filtration, sulfur removal, and NO_x destruction. The off-gas emissions from the vitrification plants are included in the risk assessment.

Comment Number 0072.110

CTUIR

Comment P 3-70: Sect. 3.4.6.5: Post Remediation: this section has to be, either removed or changed to reflect the clean closure option. Additionally during closure, the tanks are not supposed to have residual equal to 1 percent but should be less than 1 percent. The MUSTs, pump pits, valve boxes, and diversion boxes, final disposition has not been firmly established within this EIS. If these ancillary equipment are to be dealt with under clean closure conditions then they need further definement in terms of their contents, their extent of contamination and their disposal.

Response Closure is not included in the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. However, Volume One, Section 3.3 addresses how tank waste remediation and closure are interrelated because some of the decisions made regarding how to treat and dispose of tank waste may impact future decisions on closure. There are three representative types of closure addressed. These include clean closure, modified closure, and closure as a landfill. The referenced paragraphs are included in Volume One, Section 3.4 to illustrate the type of activities following remediation rather than specifying the type of closure. The value of, "... a residual equal to no more than 1 percent ...," was used to bound the impacts from the tank residuals. Closure of ancillary equipment also is not included in the scope of this EIS. Issues related to tank farm closure are discussed in Comment number 0072.08. Please refer to the response to Comment numbers 0012.14, 0072.50, and 0101.06 for MUST characterization and issues related to closure. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.111

CTUIR

Comment P3-72: Sect. 3.4.6.7: Implementability: bullets 3,6: If Low Activity Waste has not been thoroughly described, and permitted, how does this EIS propose to deal with the enormous amount of uncertainty involved throughout all the process stages? This is not the easiest way of dealing with the waste. Because the Nuclear Regulatory Commission has not finished with the negotiations, why in Section 3.4.6.5., does it mention that this LAW be buried under the Hanford Barrier? Burying this waste in a cullet form under the Hanford Barrier is the same as saying DOE made the waste, used their contractors to partially treat it, buried it and then walked away leaving the Affected Tribes to deal with the consequences. This is not acceptable. The ex situ intermediate separations alternative therefore is not acceptable. Changes made to this alternative, such as determining the LAW disposal criteria will necessarily need CTUIR input.

Response DOE and Ecology acknowledge the concerns regarding uncertainty expressed in the comment. To develop engineering data required to perform impact analyses for each of the alternatives, assumptions were made regarding the technologies that have been configured to create a remediation alternative, including process stages and waste form. Also, for the purposes of comparing alternatives, a single and consistent method of closure was assumed for all of the alternatives. Closure as a landfill covered by a Hanford Barrier was chosen as the representative closure method for analysis. This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. Please refer to the response to Comment number 0072.08 for more information regarding closure. Although these assumptions were based on best information available, applications of a similar technology, or engineering judgement, there are uncertainties associated with each of the alternatives. Major assumptions and uncertainties are addressed in Volume One, Section 3.4. Additional uncertainty analyses were completed for the Final EIS, and are included in Volume Five, Appendix K.

DOE and Ecology acknowledge the concerns regarding LAW expressed in the comment. LAW is the waste remaining after removal of as much of the radioactivity from HLW as practicable. DOE and the NRC had formal discussions on the way tank waste is classified and how the LAW portion might be regulated in the context of the previously planned grouted LAW. 58 FR 12344, March 1993, states that disposal of residual waste from the DST waste would only be a small fraction of the reprocessing wastes originally generated at the Site; residual waste material should be classified as incidental waste, since they are wastes incidental to the process of recovering HLW; the residual activity of these incidental wastes would be below the concentration limits for Class C wastes under the criteria of 10 CFR part 61; and the disposal of the residual would not be subject to NRC licensing. Section 6.2 provides additional information on tank waste classification, and the results of the discussions between DOE and the NRC. However, criteria must be formalized as to the extent to which the HLW in the tanks must be separated for the residual waste to meet requirements for incidental waste (LAW) as well as the DOE definition of LLW and State of Washington definition of hazardous waste. Design specifications for HLW and LAW treatment will require that waste forms meet applicable criteria for disposal in the potential geologic repository, or as LAW for onsite disposal.

LAW disposal in onsite near-surface vaults was incorporated into the Ex Situ Intermediate Separations alternative, as well as all other ex situ alternatives except Ex Situ No Separations, because that is the current planning basis for the TWRS program as represented in the Tri-Party Agreement. The planning basis assumes that LAW will be vitrified and disposed of onsite in near-surface vaults. Further, it assumes that LAW will meet NRC criteria for incidental waste based on the extent of separations of LAW from HLW during the pretreatment process.

The disposal criteria for incidental waste is determined by the NRC and is well-established criteria. For the TWRS program, the issue at hand is whether the LAW waste stream, when vitrified, will be classified as incidental waste on the waste specifications. In the requests for proposals for Phase 1 of the privatization initiative, DOE defined the waste specifications for LAW that contractors would be required to meet. The waste specification was prepared to produce a waste that would be classified as incidental waste. DOE will consult with NRC to ensure that the waste meets applicable standards for incidental waste.

DOE and Ecology acknowledge the concerns regarding burial of vitrified cullet expressed in the comment. Cullet has a high surface area-to-volume ratio which results in lower long-term performance, including susceptibility to leaching. However, assuming vitrified LAW in cullet form for all of the ex situ alternatives provides a conservative analysis of the long-term impacts resulting from onsite retrievable disposal of LAW in near-surface vaults. Risks associated with retrievable disposal of LAW in vaults have been analyzed and these are presented in Appendix D.5. In addition, a

Native American Scenario has been added to the Final EIS in Volume One, Section 5.11 and Appendix D. DOE and Ecology acknowledge the recommendation regarding consultation with Tribal Nations in determining LAW disposal criteria. Please refer to the response to Comment numbers 0035.04, 0012.11, and 0052.11 for related information.

Comment Number 0072.186

CTUIR

Comment P B-66: Sect. B.3.5: LLW is not the same as LAW, yet it appears that these terms are being used interchangeably. Because of this short time period for the review of this particular EIS. Please check for additional similar situations and correct them as is appropriate.

Response LLW is not the same as LAW. LAW is the waste remaining after removing as much radioactivity as practicable from HLW. The definition of LAW is provided in Volume One, Section 1.0, and addressed in more detail in Section 6.2. The term LAW used in Volume Two, Appendix B on page B-66 describes the waste stream after removal of the HLW components. The term is used correctly so no change to the EIS is warranted. Please refer to the response to Comment numbers 0005.25, 0072.118, 0072.117, and 0072.100 for issues related to regulatory definitions of Hanford tank wastes.

Comment Number 0072.187

CTUIR

Comment P B-95: PP 2: How will the insoluble sludges be suspended in the solution of soluble waste? How much volume of additional chemicals must be added? Will this be done in tank or in a receiving tank?

Response Following retrieval, where the sludges will be mobilized and suspended, the insoluble sludge particles will remain in suspension in the aqueous solution as long as the sludge particles have sufficient velocity. This velocity can be produced by such mechanical devices as pumps and mixers. The additional volume of chemicals to be added and the location of the addition point will be determined during the testing phase for this alternative.

Comment Number 0072.188

CTUIR

Comment P B-95: PP3: Why is it assumed that Cs is the only soluble radionuclide to be removed?

Response The engineering data package used in developing this alternative (WHC 1995j) assumed that only well-documented technologies would be used in developing the Ex Situ Intermediate Separations alternative. Cesium recovery by ion exchange is at present the sole technology that is well-documented for the recovery of soluble radionuclides. This assumption was then carried forward into the EIS. Removal of additional soluble radionuclides was included in the Phased Implementation and Ex Situ Extensive Separations alternatives.

Comment Number 0072.189

CTUIR

Comment P B-107: Sect. B.3.6: Calcining tank waste will result in a form not acceptable at the permanent waste repository.

Response The calcined HLW form would not meet the standard waste form (i.e., borosilicate glass) specified in the current waste acceptance requirements for the potential geologic repository. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not be in compliance with laws and regulations. Please refer to the response to Comment number 0072.80 for a discussion of the NEPA requirement to consider reasonable alternatives regardless of their ability to comply with regulations. Volume One, Sections 3.4 and 6.2 and

Volume Two, Section B.3 address regulatory compliance issues related to each of the alternatives. Please refer to the response to Comment number 0012.20 for a discussion of glass types and regulatory licensing issues.

Comment Number 0089.09

Nez Perce Tribe ERWM

Comment Page 3-66, Paragraph 2

It states that, with ex situ vitrification, LAW will be melted and flow into a water bath to break the glass formed into cullets, later the cullets will be bonded in a matrix material before onsite disposal. The EIS does not indicate what matrix material will be used to hold the cullets together. It is a concern that the matrix may not be as resistant to degradation as the vitrified glass allowing breakdown and waste surface area to increase. Whatever the matrix material is it will than also become LAW along with the glassformers used to create the product. Why not leave the LAW as a full size molded product rather than increasing the surface area for chemical breakdown by forming cullets. Surely a suitable configuration can be found for the molded LAW, that will not require forming cullets.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Matrix material composition and final waste form would be evaluated during the detailed design phase that would follow selection of this specific remedy, if this selection occurs. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified low-activity cullet form. Cullet would provide processing and material handling advantages for high-capacity processing facilities; however, cullet has a high surface area-to-volume ratio, which results in lower long-term performance. Please see the response to Comment numbers 0005.40 and 0072.89 for a discussion of how the cullet waste form provides a bounding impact analysis. The response to Comment numbers 0035.04, 0052.11, and 0012.11 contain discussions concerning waste form.

L.3.4.8 Ex Situ No Separations Alternative

Comment Number 0005.48

Swanson, John L.

Comment The second paragraph under "Vitrification Process" on page 3-74 appears to be garbled. On balance, it appears to be addressing LAW vitrification, but it specifically says HLW glass.

Response The second paragraph under Vitrification Process on the referenced page may appear to discuss LAW vitrification, but the section heading is Ex Situ No Separations alternative, meaning that all of the glass waste produced is HLW. The first paragraph under Vitrification Process states that the HLW facility capacity is provided by two melters operating in parallel. The paragraph identifies HLW glass because this paragraph discusses only the HLW process as the only applicable process for discussion under this alternative. The text has been revised to clarify the discussion regarding vitrification under the Ex Situ No Separations alternative in Volume One, Section 3.4.

Comment Number 0057.07

Garfield, John

Comment Other things like the calcination case mentioned two calciners at a processing rate of 200 tons per day. You may be able to accomplish a solidified moltent sodium process at those rates but drying the waste to a calcine form would require something on the order of 20 to 40 calciners. The physics are not there to do it at a 100 tons per calciner. That is a technical error that should also be fixed.

Response A more detailed description of the conceptual calciner is discussed in Volume Two, Section B.3. The discussion in Volume One, Section 3.4 is a summary level discussion. The calciner design is modeled after available laboratory data. Additional details including mass and energy balances for the calcining process are available for review in the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.112

CTUIR

Comment P 3-73: Sect.3.4.7: PP 4: Because this is a retrieval EIS not a closure EIS, this paragraph should be removed, or the language strengthened to indicate that there are several closure options.

Response Cost estimates for the removal and treatment alternatives included several Site closure assumptions (e.g., the Hanford Barrier), which are discussed in Volume One, Section 3.4.1.4, Major Assumptions and Uncertainties to provide an equal basis of comparison among alternatives. The text is considered appropriate within the context of the section and therefore no revisions to the text are required. For an extensive discussion of all issues related to closure, please refer to the response to Comment numbers 0072.08, 0019.03, 0019.04, and 0101.06.

Comment Number 0072.113

CTUIR

Comment P 3-74: Calcination Process: This process results in an unacceptable waste form for the permanent repository and thus this section should be removed or edited to clearly state the consequences of producing an unstable waste form that will spread to the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The information requested in the comment is in the EIS. The Summary, Section S.7.1, Volume One, Section 3.4.7.7, and Volume Two, Section B.3.6.4 discuss the fact that the calcined waste form would not meet the current waste acceptance criteria for the potential geologic repository. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not be in compliance with laws and regulations. For a discussion of this requirement, see the response to Comment number 0072.80. Volume One, Section 6.2 and Volume Two, Appendix B.3 also address regulatory compliance issues related to each of the alternatives. The radiological impacts of transporting the calcined HLW are analyzed in Volume Four, Section E.7.4.1.1.

Comment Number 0072.114

CTUIR

Comment P 3-76: PP 2: This paragraph relates to a process that produces a product that is unacceptable for the permanent waste facility, this paragraph should be removed or edited to clearly state the consequences.

Response Please refer to the response to Comment number 0072.113.

Comment Number 0072.115

CTUIR

Comment P 3-76: PP 3: S 2: This sentence refers to the closure process which is not within the scope of this EIS and should be removed or edited to clearly state the reasoning and the consequences and additional closure alternatives associated with this action.

Response Please refer to the response to Comment numbers 0072.112 and 0072.08.

Comment Number 0072.116

CTUIR

Comment P 3-77: Sect. 3.4.7.5: This section refers to the closure process and should either be removed or edited to reflect additional closure options such as the clean closure option of removing the tanks and the contaminated underlying soils as not to preclude all closure options.

Response Please refer to the response to Comment numbers 0072.112 and 0072.08.

L.3.4.9 Ex Situ Extensive Separations Alternative

Comment Number 0005.49

Swanson, John L.

Comment The first paragraph on page 3-80 refers to "--multiple complex chemical separations--." It appears to me that the use of the word "complex" is editorializing, and that word should be deleted. The last sentence of that paragraph says "--fewer radioactive contaminants--"; a more accurate statement would be "--lower concentrations of radioactive contaminants--"

Response It is true that the term "fewer radioactive contaminants" would mean less radioactive isotopes in the LAW and "lower concentrations of the radioactive contaminants in the LAW." The text in Volume One, Section 3.4 has been revised to reflect lower concentrations of radioactive contaminants in the LAW.

The term "complex" is intended to give the reader a feeling for the number, complexity, and level of development for the multiple separations processes used for the Ex Situ Extensive Separations alternative; therefore, the term conveys accurate and useful information.

Comment Number 0005.50

Swanson, John L.

Comment The second paragraph on page 3-80 includes Jacobs Engineering as a Site M&O contractor, which is incorrect.

Response The cited statement references information obtained from the Site Management and Operations contractor documents, one of which was prepared by Jacobs Engineering Group Inc. (i.e., Jacobs 1996), and does not state, nor is meant to imply, that Jacobs is the Site Management and Operations contractor. Therefore, the statement has not been revised.

Comment Number 0036.13

HEAL

Comment The EIS is inaccurate in addressing technical risk.

As noted above, DOE has conducted many analyses of the alternatives for treating and disposing Hanford tank wastes. Compared with many of these analyses, the EIS is relatively useless in communicating varying degrees of technical risk.

For example, following is a quote from the EIS on the technical risk involved with the intermediate separations technology: "Performance of key processes (e.g., solid liquid separation) has been assumed in the absence of substantive data" (p. 3-72). Next is a quote addressing the technical risk involved with extensive separations: "The key implementability issue associated with this alternative is that the performance of key separations processes has been assumed in the absence of substantive data" (p. 3-85).

The two above quotes say exactly the same thing: There is no qualitative difference between the technical risk involved in intermediate separations and the technical risk involved in extensive separations. Extensive separations is a complex, essentially science fiction technology that has little chance of becoming practical for use on tank waste. It has not been utilized except on a laboratory scale. Intermediate separations, on the other hand, has been used in several places and is relatively simple. The key concern is whether intermediate separations will work on the scale that it must to be useful to the tank program. The list of concerns with extensive separations is almost as long as the TWRS EIS. The approach in the EIS is tantamount to saying that building a car that can go 250 miles per hour involves the same amount of technical risk as building one that can go 2,500 miles per hour.

The position of the Northwest's stakeholders on this issue is clear: The TWRS Task Force stated:

The high cost and uncertainty of high-tech pretreatment and R&D threatens funding for higher performance low-level waste form, vitrification, and cleanup. Use the most practicable, timely, available technology, while leaving room for future innovation. Keep a folio of technological options and make strategic investments over time to support a limited number of promising options. Give up further research on unlikely options.

The lack of honest, frank text concerning technical risk seriously misleads the public and decision makers and unfairly prejudices judgement on the separations issue.

Response In response to the issue of assessment of technical risk; the EIS discusses the ability to implement the alternatives to provide additional information to decision makers. The implementability of a remedial alternative is a function of its history of demonstrated performance and its ability to be constructed and operated. In the case of both the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives, there is no history of demonstrated performance on the Hanford tank wastes. Bench-scale testing is currently underway for the Ex Situ Intermediate Separations alternative. No testing is underway for the Ex Situ Extensive Separations alternative at the Hanford Site; however, a process that is similar to the Intermediate Separations alternative is being used on the tank wastes at the Savannah River Site. It would be premature to state that intermediate separations has been used in several places and is relatively simple, especially with the operation problems that have occurred at the Savannah River Site. To provide the engineering information required for the EIS, the engineering data packages for both alternatives (WHC 1995e and WHC 1995j) assumed the performance of key processes in the absence of substantive data, leading to the same essential statement in the EIS. The inclusion of both the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives is the result of providing a range of reasonable alternatives to the decision makers, and no change has been made to the EIS. DOE and Ecology believes that the uncertainties are expressed in an unbiased and accurate manner.

Regarding the issue of alternatives that should or should not be considered in the EIS, NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. This range of alternatives must include a No Action alternative, and may then include other reasonable alternatives to allow an analysis of a full range of alternatives. Among the four major categories of alternatives examined in the EIS was a category involving extensive retrieval of the wastes from the tanks. Following retrieval, the HLW is separated from the LAW. The degrees of separation of these two types of wastes may range from no separations, to intermediate separations, to extensive separations. For more information on how the EIS developed alternatives consistent with the recommendation of the Tank Waste Task Force, see the response to Comment numbers 0072.05 and 0038.05. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0055.09

Martin, Todd

Comment The EIS is somewhat inaccurate in addressing technical risk for pretreatment. If you look at the language addressing the intermediate separations essentially sludge washing which we have a pretty good idea of how to do and the extensive separations which I have often characterized as science-fiction technology, the language is almost identical. It basically says there is uncertainty here because these are first of the time processes. I agree with that but one is much more technically uncertain the extensive separations than the other and I think the EIS should reflect that.

Response Please refer to the response to Comment number 0036.13.

Comment Number 0072.117

CTUIR

Comment P 3-81: PP 2-5: the LAW form as described here, is not an acceptable form because it does not meet the regulatory criteria, and the process results in a waste form that is very susceptible to leaching of high activity components. This section also needs to be redone to assume a glass form as the final waste product.

Response The Ex Situ Extensive Separations alternative would meet the requirements for disposal of HLW and LLW. However, residuals left in tanks would not meet the water protection standards if additional closure is not performed. Closure is not included in the scope of this EIS; however, closure for the tanks and residuals would be addressed in a future closure plan. The EPA is considering a rule to further regulate LLW disposal facilities; and the final design of the onsite LAW disposal facility may be impacted by EPA rule 40 CFR 193. A discussion of the ability of each tank waste alternative to enable DOE to comply with Federal and State regulations is included in Volume One, Section 6.2. Specifics of the matrix material and waste form would be final design issues. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified LAW cullet form.

Please refer to the response to Comment numbers 0005.40, 0072.89, and 0072.107 for discussions of the cullet waste form and how cullet provides a basis for a conservative analysis of long-term impacts. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.118

CTUIR

Comment P 3-83: Sect. 3.4.8.4: Operation: The LAW description needs to be edited, removing the last two bullets.

Response Specifics of the matrix material and waste form would be final design issues; however, for the purposes of analyzing the ex situ alternatives in this EIS, LAW was assumed to be produced in vitrified cullet form. The referenced text correctly describes the operations involved in producing this type of waste form. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified LAW cullet form. Cullet would provide processing and material handling advantages for high-capacity processing facilities; however, cullet has a high surface area-to-volume ratio, which results in lower long-term performance. Assuming vitrified LAW in cullet form for all of the ex situ alternatives provides a conservative analysis of the long-term impacts resulting from onsite disposal of LAW. No change to Volume One, Section 3.4 is required.

For a discussion of regulatory requirements for onsite disposal of LAW please refer to the response to Comment number 0072.111.

Risks associated with retrievable disposal of LAW in vaults have been analyzed and these are presented in Volume Three, Appendix D.5. In addition, a Native American Scenario has been added to the Final EIS in Volume One, Section 5.11 and Appendix D.

Please refer to the response to Comment numbers 0005.40, 0012.11, 0072.11, 0035.04, 0052.01, 0072.89, 0072.107, and 0072.117 for related information. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.119

CTUIR

Comment P 3-84: Sect 3.4.8.5: Post Remediation: second and third paragraphs: these two paragraphs need to be removed because this EIS is a retrieval EIS and closure options are not within the scope. If closure options were within the scope of this EIS then the option would necessarily be clean closure and removal of the tanks, underlying soil contamination, ancillary equipment, and MUSTs as not to prejudice future options for closure.

Response Please refer to the response to Comment numbers 0072.08 and 0072.112.

Comment Number 0072.190

CTUIR

Comment P B-115: Sect. B.3.7: The definition of LAW indicates that there will be a HLW component. This is unacceptable in terms of long term risk.

Response Volume Two, Section B.3.7.1 describes the extent to which the treatment processes are used to separate HLW from the tanks waste. LAW is the waste remaining after removing as much of the radioactivity as practicable. The definition of LAW is provided in Volume One, Section 1.0, and tank waste classification (e.g., Class A, B, C) is addressed in more detail in Section 6.2. NRC Class A waste contains the least amount of radioactivity. Long-term risk has been analyzed for each of the alternatives and waste forms, and this is presented in Volume One, Section 5.11, and addressed in more detail in Volume Three, Appendix D.4.7. Because the information contained in the Draft EIS is correct, no change to the text was made.

For more information on LAW, LLW, and HLW definitions, please refer to the discussions contained in the response to Comment numbers 0072.100, 0072.111, 0072.117, and 0072.118.

Comment Number 0072.191

CTUIR

Comment P B-119: Fig. B.3.7.2: This figure, to be acceptable, should have LLW exchanged for LAW and interim on site storage exchanged for on site disposal.

Response Figure B.3.7.2 accurately depicts the process flow of the Ex Situ Extensive Separations alternative described in Volume Two, Appendix B, Section B.3.7. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.10 Ex Situ/In Situ Combination 1 Alternative

Comment Number 0005.09

Swanson, John L.

Comment The two combined ex situ/in situ alternatives discussed in the EIS speak of remediating a large fraction of the risk while remediating only a small fraction of the tanks. Such statements imply a knowledge of tank-by-tank inventory data that is much better than that given in the EIS. What data (or assumptions) were used for these alternatives? What accuracy do they have? Without evaluation of these factors, it is not possible to evaluate whether these combined alternatives are worth considering. Thus I feel that the current presentation of these combined alternatives is very biased in their favor.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The TWRS EIS addresses many potential criteria that could be used to develop a selection process and acknowledges that additional waste characterization and analysis would be required to implement this alternative (Volume Two, Appendix B, page B-127). Please also refer to the response to Comment number 0072.192. The data used for tank-by-tank analysis were based on SST and DST inventory data presented in summary form in Volume Two, Appendix A. DOE and Ecology believe that the existing historical data, laboratory data, and characterization reports, which provide the basis for the tank waste inventory used in the EIS, are adequate for detailed evaluation of impacts. The EIS acknowledges the uncertainties associated with the tank waste inventory, and accordingly uses a bounding approach to impacts assessment based on the available data.

The ex situ/in situ alternatives were developed to assess the impacts of combining two or more of the tank waste alternatives. Recognizing that tank waste differs greatly in the physical, chemical, and radiological characteristics, it may be appropriate to implement different alternatives for different tanks. These alternatives were developed to bound the impacts that could result from a combination of alternatives and are intended to represent a variety of potential alternative combinations that could be developed to remediate the tank waste. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the response to Comment number 0005.03 for a discussion of assumptions and uncertainty ranges used in the alternatives analyses.

Comment Number 0072.120

CTUIR

Comment P 3-86: Ex Situ/In Situ Combination Alternative: Technical staff agree that it may be necessary to implement an alternative treatment process for Tank wastes due to their varied contents, but the alternative of in situ treatment is unacceptable. The people of the CTUIR have been made involuntarily responsible for the waste DOE produced on CTUIR ceded land, and do not and should not, have to bear the responsibility of the enormous excess risk from in situ process. Therefore this alternative is unacceptable both in idea and in implementation.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. The Ex Situ/In Situ Combination alternative was developed to assess the impacts that would result if a combination of two or more of the tank waste alternatives were selected for implementation. Because the tank waste differs greatly in its characteristics, it may be appropriate to implement different alternatives for different tanks. The Ex Situ/In Situ Combination alternative represents a combination of the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives, and as such can be considered as one of the reasonable alternatives for evaluation. It is intended to represent a variety of potential alternative combinations that could be developed to remediate tank waste. Because this alternative is one of the full range of alternatives developed in the EIS, the document has not been changed. For the Final EIS, a second combination alternative that was presented in the Draft EIS, has been fully described and impacts have been analyzed. This alternative is described in Volume One, Section 3.4 and impacts of the alternative are described in Volume One, Section 5.0 and associated appendices.

Comment Number 0072.192

CTUIR

Comment P B-126: Sect. B.3.8: This alternative is unacceptable in that there is an illegal in situ component. Additionally the characterization process has not adequately justified that they know where 90 percent of the contaminants that contribute to long term risk are located, or how to get at them for treatment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The Ex Situ/In Situ Combination alternative was developed to represent a variety of potential alternative combinations that could be developed to remediate the tank waste. Existing uncertainty associated with the tank waste inventory data must be resolved and additional tank characterization is required before final design of any alternative. Please refer to the response to Comment number 0005.09. Several activities that involve collecting and analyzing data on tank contents are ongoing, including the Tank Characterization program. Data obtained from this program would be used for refining remediation process design. Please refer to the response to Comment numbers 0012.14 and 0072.07 for discussions on characterization of tank inventory. Volume Two, Appendix A,

Section A.3 and Volume Two, Appendix B, Section B.1 address tank inventory data and ongoing waste characterization programs, and Volume Three, Appendices D and Volume Four, Appendix E address anticipated risk and accidents. Volume Five, Appendix K addresses the uncertainties associated with human health risks associated with this and other alternatives.

L.3.4.11 Phased Implementation Alternative

Comment Number 0005.51

Swanson, John L.

Comment Page 3-94 says "Separations prior to LAW processing--." I believe that the word IMMOBILIZATION or VITRIFICATION should be substituted for the word PROCESSING.

Response The Phased Implementation alternative description has been revised as follows, "Separations prior to LAW immobilization would be performed to remove the cesium, strontium, technetium, TRU elements, and entrained sludge particles from the waste stream to the extent required to meet LAW product specifications."

Comment Number 0005.52

Swanson, John L.

Comment The first two paragraphs on page 3-99 appear to be "lifted" from a privatization write-up, in that they talk of what functions are to be performed by DOE. This EIS assumes that all the functions will be performed by DOE.

Response Volume One, Section 3.4 has been revised as follows for the Phased Implementation alternative, "The waste (mainly DST liquid waste) would be retrieved and transferred to receiver tanks for LAW treatment." The cited text in Volume One has been revised as follows, "Separated cesium and technetium radionuclides would be stored at the treatment facilities or packaged for interim onsite storage at the Canister Storage Building."

Comment Number 0005.53

Swanson, John L.

Comment On page 3-99 it is stated that Phase 2 sludge washing will be performed in-tank. Is that really the intent?

Response The text regarding sludge washing has been revised in Volume One, Section 3.4 to remove the reference to in-tank sludge washing.

Comment Number 0005.54

Swanson, John L.

Comment I do not understand how the Phased Implementation approach can have R&D costs of only $190,000,000 (page 3-100) when those costs are $820,000,000 (page 3-71) for the intermediate separations alternative, which involves fewer pretreatment steps. Can you explain this?

Response Because Phase 1 of the Phased Implementation alternative would be a demonstration process, the research and development cost for the treatment process was assumed to be part of the Phase 1 cost. Research and development cost associated with the waste retrieval and transfer function was included at the same level as the other ex situ alternatives. Development programs currently are ongoing at the Site that are covered under the TWRS program or under other programs.

Comment Number 0032.05

Heacock, Harold

Comment In regard to the Department's currently planned method of implementing this program which is based upon the privatization of the work performance, we are not addressing that issue at this time. However, we have previously supported the privatization concept in other statements.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Comment numbers 0032.06, 0043.04, and 0060.01 contain information concerning privatization and associated issues related to privatization.

Comment Number 0032.06

Heacock, Harold

Comment Funding of the privatization program through the proposed budgeting set-aside at the expense of other Hanford Site cleanup programs and the concurrent failure to meet all Tri-Party Agreement commitments is not acceptable.

Response Changes to the TWRS program were incorporated into the Phased Implementation alternative, as required by the proposed 1996 Tri-Party Agreement amendments; therefore, Phased Implementation would not deviate from the Tri-Party Agreement or any other applicable regulation. DOE and Ecology intend to comply with all Federal, State, and local regulations and ordinances applicable to tank waste remediation. Funding for privatization is outside the scope of the TWRS EIS. The response to Comment number 0043.04 contains a discussion of privatization issues.

Comment Number 0035.06

Martin, Todd

Comment More specifically, I do not trust the costs just in general in the EIS. For example, the EIS assumes that for about 250 million dollars, the DOE can build a 20-ton a day low-level vitrification facility.

Everybody who has been in Hanford circles for years remembers that the Hanford waste vitrification plant, a one to three metric ton a day facility was going to cost one point three billion dollars.

What does the EIS say DOE can build essentially the same facility now for? About 232 million, about one-fifth the cost.

In totality, in the preferred alternative for phase one the EIS says that the two 20-ton a day vitrification facilities, two pretreatment facilities tied onto the side, and one HLW vitrification facility, in total five facilities, can be built for about one point four billion.

Again, I refer back to the one relatively small vitrification facility that DOE said that it would take one point three billion to build. I say no way can DOE build these facilities for that cost.

Are these costs due to privatization savings? The answer to that is no. The EIS does not deal with privatization. It assumes that these are traditional DOE facilities.

Further, if these costs are actually correct, there is not a need for privatization. The privatization set-aside account that everybody has been wrangling over the last couple of months has more than enough money in it right now to start building these facilities and get on with cleanup.

Either these numbers need to be changed, or we need to switch paths and start building vitrification facilities.

Response Please refer to the response to Comment numbers 0055,06 and 0057.06 for a discussion of the approach used to develop the cost estimate for this alternative.

The HWVP capital cost estimate is not directly comparable to the capital cost estimated for the Phase 1 HLW facility because it includes support facilities and infrastructure that are estimated as separate components for Phased Implementation.

The cost estimating methodology has been reviewed and revised cost estimates have been completed for the Phased Implementation and combination alternatives. These revised costs are shown in Volume One, Section 3.4 and in Volume Two, Appendix B.

Comment Number 0035.07

Martin, Todd

Comment Just in my cursory look at some of the other costs in the EIS things jump out at me. For instance, in the preferred alternative, phase one, basically DOE has to retrieve about 36 tanks to vitrify in that phase.

How much does the EIS say this will cost? Zero dollars. Not a penny. I think there are some retrieval costs there. There must be.

Response During Phase 1, readily retrievable and well-characterized DST waste would be retrieved and transferred to two DSTs used as receiver tanks for the demonstration facilities. This retrieval effort was assumed to be accomplished by using the existing tank farm work force and infrastructure, in the same manner that wastes currently are transferred. The cost associated with DST waste retrieval during Phase 1 was assumed to fall within continued operations. Continued operations costs of $1.58 billion, including 10,000 person-years of labor, were included in the cost estimate for Phased Implementation. The Draft EIS also states that selected SST wastes could be processed during Phase 1. It was assumed that wastes retrieved under retrieval demonstrations (e.g., tank 106-C) could be transferred to the demonstration facilities. Because the cost associated with these retrieval demonstrations is included in other programs, it is not included in the estimate for Phase 1, but is accounted for in the estimate for continued operations of the tank farms. The cost involved would be small in comparison to the overall project costs.

The Phased Implementation alternative identified in the TWRS Draft EIS would produce, during Phase 1, approximately 11 percent of the total LAW volume. Waste retrieval would not be required from 36 tanks during Phase 1.

DOE and Ecology have reviewed and revised the cost estimates for the Phased Implementation alternative for the Final EIS. These revisions are shown in Volume One, Section 3.4 and Volume Two, Appendix B, and are reflected in the Summary.

Comment Number 0036.03

HEAL

Comment The costs in the EIS are incredible and must be redone. The EIS should not be finalized until a formal, credible data package for the preferred alternative is completed.

The EIS assumes the following for Phase 1 of the preferred alternative:

1. The cost of a 100 metric ton per day vitrification facility is half the cost of a 200 ton per day facility. There is no engineering data to support this assumption. In fact, there is data to refute it. About 15 percent of the cost of a vitrification facility is dependent upon its throughput (the rate at which it makes glass). Therefore, the cost of a 100 metric ton per day facility would be less than a 200 ton per day facility -- but not much less -- and certainly not 50 percent less.
2. The "six tenths rule" is an engineering rule used for extrapolating the cost differences between chemical facilities of different sizes. The EIS uses this to determine the costs of vitrification facilities of different sizes. This is a wholly inappropriate use of the rule. Again, it applies for facilities where about 85 percent of the facility cost is dependent upon processing equipment -- primarily chemical facilities. Vitrification facilities only have about 15 percent of their cost dependent on processing equipment. Therefore, vitrification facility costs are

not particularly sensitive to sizing differences -- which means use of the "six tenths rule" results in grossly underestimated costs.

These two assumptions have resulted in grossly underestimated costs for the preferred alternative. The EIS estimates the cost of the Phase 1 facilities as follows:

- A 20 metric ton per day LAW vitrification facility can be built for $248 million.
- A 1 ton per day HLW vitrification facility can be built for $232 million.

Comparing these numbers to much more rigorously developed cost estimates we can see exactly how far off the EIS's numbers are. The Hanford Waste Vitrification Plant, which was designed to produce between 1 and 3 tons per day of glass, was estimated to cost $1.3 billion. This is almost exactly the same facility that the EIS says DOE can build for $232 million.

The EIS claims that for Phase 1 the total capital cost will be $1.4 billion. In other words, DOE is going to build two 20 ton per day LAW vitrification facilities, a one ton a day HLW vitrification facility and two pretreatment facilities for about the same cost as the one ton per day Hanford Waste Vitrification Plant!

Response Please refer to the response to Comment numbers 0035.04, 0035.06, 0055.06, and 0057.06.

Comment Number 0036.04

HEAL

Comment If the costs in the EIS are indeed accurate, there is no need for privatization.

If DOE's cost estimates are accurate, there is no need to take the extra risks of privatization. All of DOE's cries that there is not enough money to build vitrification facilities are false. The money DOE is currently putting in a set aside fund for privatization is more than enough to build these vitrification facilities.

Response Phased Implementation approach reduces the technical risk associated with tank waste remediation over a full implementation alternative. Phased Implementation also provides a greater opportunity to reduce overall program costs by applying lessons learned and experience gained during Phase 1 to the design and construction of the full-scale Phase 2 treatment facilities. The cost estimates developed for the TWRS EIS were developed using common assumptions. The Phased Implementation alternative cost estimate assumed the same contracting strategy, government-owned and contractor operated, as the other alternatives. As discussed in Volume One, Section 3.3, the EIS does not address the contracting strategy that would be used to privatize tank waste remediation. Please refer to the response to Comment number 0043.04 for more information.

Comment Number 0036.05

HEAL

Comment A cursory review of the cost estimates identified many other problems. Following are just a few: The EIS assumes that tank farm operation costs will be the same for both the Phased Implementation and Ex Situ Intermediate Separations alternatives. This is a faulty assumption. The Intermediate Separations alternative would begin treating waste in 2004 at a relatively high rate, resulting in tanks being emptied. This would allow DOE to dramatically reduce its tank farm operation costs. The estimate for operations for Intermediate Separations is $8.6 billion.

The operations estimate for the Phased Implementation alternative is also $8.6 billion. It should be much higher. Phased Implementation will treat waste at a much slower rate than Intermediate Separations, requiring DOE to fund operations programs for a longer period of time and thus at a higher level.

Response A difference in the rate at which the cost declined for different rates of processing is expected. Many of the factors that would control the ongoing tank farm operations cost would be the monitoring and maintenance requirements and how these requirements were reduced for individual tanks and tank farms. The monitoring and maintenance requirements for a tank farm may not be appreciably lower until all of the tanks within that tank farm are empty. The tank retrieval sequencing and blending strategy, which have not been finalized, would identify when waste retrieval from individual tanks and tank farms would be complete.

Because of the conceptual level of development, it was assumed for the purposes of the TWRS EIS that continued tank farm operations cost for Phased Implementation would be the same as for the Ex Situ Intermediate Separations alternative. In fact, the difference between level funding and the annual reductions in operating cost associated with the Ex Situ Intermediate Separations alternative for the years 2004 through 2011 totals $141 million or approximately 1.6 percent of the total $8,600 million used in the TWRS EIS for continued tank farm operations.

DOE and Ecology have reviewed and revised the cost estimates appropriately for the Phased Implementation alternative. These revised cost estimates have been presented in the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B.

Comment Number 0036.06

HEAL

Comment To support the Tri-Party Agreement, DOE must retrieve waste from 36 tanks in Phase 1 of the Phased Implementation alternative. The EIS estimates that this will cost $0. Surely there is a cost associated with retrieving the high-level waste from 36 tanks.

HEAL finds the estimates in the EIS to be utterly devoid of credibility and insists that the EIS not be finalized until a credible, formal data package for the preferred alternative is completed.

Response Please refer to the response to Comment number 0035.07 which addresses a similarly worded comment.

Comment Number 0036.11

HEAL

Comment The EIS must require vitrification as technology for tank waste treatment.

For all alternatives, except the Phased Implementation alternative, the EIS assumes vitrification will be the immobilization technology. The EIS provides no rationale as to why this alternative does not also require vitrification. Given that it is the preferred alternative, this is even more disturbing.

Vitrification has been the technology that stakeholders have found acceptable. It balances the concerns for a safe waste form with a relatively available technology that allows DOE to "get on with it." Any changes to the assumed use of vitrification must be accompanied by a compelling argument outlining any emerging technologies that better respond to stakeholder values. HEAL has not seen such an argument, and strongly doubts that one could be made.

The TWRS privatization initiative, upon which the Phased Implementation alternative was designed, also fails to require vitrification as a technology. It appears that this EIS has been designed to "fit" the decision to not require glass as a waste form in the privatization Request for Proposals.

Response Please refer to the response to Comment number 0035.02 which addresses a similarly worded comment.

Comment Number 0036.15

HEAL

Comment EIS does not show any effects of privatization.

DOE has spent over a year in an unsuccessful attempt to sell its privatization plan to the public. Cost is one of the many concerns that the public has raised with DOE. DOE has consistently held that privatization would cost 30 percent less than a traditional approach. DOE has been unable to furnish the public with any information that supports the above assertion.

The EIS continues the information void concerning the benefits of privatization. The EIS refers to privatization in the description of the Phased Implementation alternative, "under Phased Implementation, either DOE or a private contractor would design, build, and operate ... (the facilities)" (p. 3-23). As was pointed out above, DOE has held that the differences between a traditional government-owned, contractor-operated approach, and the contractor-owned and operated privatization approach were "revolutionary." Yet the EIS fails to show the different impacts of this revolutionary approach. Worse, the EIS is not explicitly clear about which approach -- privatization or traditional GOCO -- is being analyzed.

The EIS does allude to how the cost estimates for Phased Implementation were reached. It was developed by, "... combining applicable components from other ex situ alternatives and applying rations as required to account for differences in facility sizes and capacities and the degree of separations in LLW and HLW" (p. 3-99). Engineering data in the TWRS program over the years has shown that facility capacity and size do not have a large impact on facility cost.

The cost savings that DOE claims are virtually guaranteed are not evident in the EIS. The Tri-Party Agreement case is estimated to be $30-41 billion and Phased Implementation $32-42 billion. Where are the savings?

Response The EIS addresses the potential environmental impacts associated with a Phased Implementation approach to tank waste remediation. It was assumed for cost estimating purposes that the Phased Implementation alternative would use the traditional government owned-contractor operated contracting strategy. This was done to allow the reader to make an equitable comparison among the alternatives. A potential exists to reduce the cost for tank waste remediation by allowing the market place to establish, through the competitive bidding process, the cost for waste treatment. Cost savings projections that might result from privatization are not included in the EIS in an effort to maintain the competitive bidding process.

The fact that privatization is not addressed in this EIS is discussed in Volume One, Section 3.3. DOE believes that privatization will result in an overall cost savings for the project but has not published an estimate of savings that may result. The 30 percent figure identified in the comment is reasonably consistent with the cost savings resulting from other activities the federal government has privatized. Privatization is not within the scope of the EIS. Please refer to the response to Comment numbers 0036.05, 0036.04, 0055.06, and 0057.06.

Comment Number 0037.05

Elredge, Maureen

Comment Mostly I am concerned with further cost estimates throughout the EIS. They seem to be questionable. And I am particularly concerned that the preferred alternative is widely perceived as a privatization alternative which is supposed to save money, and yet this is not made evident in the document.

I want to urge you to use extreme caution both in assuming that the preferred alternative will be cheaper, and even more so in assuming that a privatization scheme will be a success.

When the cleanup program was being pummeled in Congress and the media last year, privatization was held up as the Holy Grail, sort of along the lines of please give us another chance. We will bring in corporate America. They will fix everything. We will be fine. Please give us our money.

We do not need Holy Grails. We need progress. We need action on the ground now. If privatization efforts fail it will be a disaster not only for Hanford but for the entire cleanup program. Thank you.

Response Please refer to the response to Comment number 0036.15, which addresses a similarly worded comment.

Comment Number 0038.06

Reeves, Merilyn

Comment The Board is troubled by some aspects of the preferred alternative, and where the EIS has not considered the impacts of privatization as a contractor mechanism.

Response Please refer to the response to Comment numbers 0036.15, 0036.05, 0036.04, and 0057.06 for discussions related to this issue.

Comment Number 0038.07

Reeves, Merilyn

Comment The concerns the Board has voiced have to do with liability in privatization, budget, regulatory, logistics, and public participation issues.

The Board has been dubious of DOE's ability to privatize, and has been disappointed in DOE's lack of responsiveness to the Board's concern.

Response Because the issues identified in the comment are not within the scope of the EIS, no modification to the document is warranted. Please refer to the response to Comment numbers 0036.04, 0036.05, and 0036.15.

Comment Number 0038.08

Reeves, Merilyn

Comment In regard to the specific technical approach, the Board has not been adverse to Phased Implementation. DOE has not made a case for that, privatized or not.

Response The TWRS EIS does not address privatization. The Phased Implementation alternative is based on the same common assumptions as the other alternatives to ensure comparability of the environmental impacts. However, the Phased Implementation alternative does address the technical requirements of remediating tank waste with a phased approach and impacts associated with that approach. Please refer to the response to Comment numbers 0043.04 and 0035.15, for more information.

Comment Number 0038.09

Reeves, Merilyn

Comment Phased Implementation can save money over the course of the program. The Board does remain dubious that Phased Implementation will save money, and will likely be more expensive. Again, our main concern has been with DOE's particular program of privatization.

Response The costs estimates developed for the TWRS EIS were developed using the same basis for all alternatives. The Phased Implementation alternative represents the traditional government-owned contractor-operated contracting strategy as described in Volume One, Section 3.3. Please refer to the response to Comment number 0036.15 for more information.

Comment Number 0038.11

Reeves, Merilyn

Comment The Board is concerned by the preferred alternative's effect on the Tri-Party Agreement. The Board has been and remains a staunch supporter of the Tri-Party Agreement.

The Phased Implementation approach has resulted in an unfavorable impact to the Tri-Party Agreement. The Tank Waste Task Force stated the following about the Tri-Party Agreement, quote, Tri-Party Agreement is in need of strengthening and improvement.

The Tri-Party Agreement should increase meaningful public and tribal involvement in all key Tri-Party Agreement decisions, with the public and the tribes as a partner in the goals, scope, pace, and oversight of the cleanup.

The process of the goal in the site specific advisory board and ongoing oversight of the agreement and improving pubic involvement is essential to achieving successful and satisfactory cleanup.

And our Board is trying to carry on these traditions. As we stated earlier, amendment four to the Tri-Party Agreement was judged to be very responsive to the above concerns.

Unfortunately concurrence in yet to be completed negotiations that will once again change the Tri-Party Agreement are somewhat or may be seen to be reversing the progress made in amendment four.

The Tri-Party Agreement changes that are being made in order to support the Phased Implementation alternatives are very disconcerting. The Tri-Party Agreement will go from a long list of interim and long-term enforceable milestones to only a handful of milestones, many of them not enforceable.

The changes will not increase meaningful public involvement or really involve site specific boards, the Hanford Advisory Board, in ongoing oversight of the TWRS program. And this is a step in the wrong direction.

Response The amendments referenced in the comment were based upon the privatization initiative. The Phased Implementation alternative merely bounds the technical approach of staged remediation of the tank waste and analyzes the potential impacts to support a comparison among alternatives. DOE and Ecology are cognizant of the Hanford Advisory Board's concerns regarding the remediation schedule and stakeholder and Tribal Nation participation in decision making. DOE is committed to meeting milestone commitments in the agreement and to effective and meaningful public and Tribal Nation involvement in the cleanup of the Hanford Site. Please refer to the response to Comment number 0012.19 (public involvement), 0072.149 (Tribal Nations consultation), and 0043.04 (privatization relationship to the Tri-Party Agreement).

Comment Number 0055.08

Martin, Todd

Comment Secondly, I think that the chart that Carolyn showed that had to do with the technical uncertainty of the various options was misleading on Phased Implementation. The rationale is that the technical uncertainty for this alternative is low because we are starting small and we are building. We will be able to employ learning. I think that is a very subjective call and I do not buy it. That option includes pretreatment processes have never been done before. Technetium removal. That is not low on the technical uncertainty scale.

Response The phased approach allows information to be collected and analyzed concerning retrieval, separations, and vitrification technologies before constructing full-scale plants. Lessons learned from the demonstration phase would be applied to the full-scale phase, which should improve the efficiency of operations of the second phase. This may reduce construction and operating costs during the second phase. The process of building demonstration plants to verify that technologies function effectively before building full-scale plants is a standard practice used in many industries where new technologies are being used. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0057.02

Garfield, John

Comment With respect to the summary slide, Todd made this same comment, the high-waste complex separations and treatment processes involved uncertainties that will be reduced by implementing the phased approach. I concur with the basic finding of the EIS in terms of the alternative chosen, however, instead of emphasizing the need to demonstrate technology, the emphasis should be on spreading early capital dollars and using a single facility to accomplish the mission. That should be the emphasis more than demonstration. There is no technical justification for demonstration philosophy with this process. The functions of sludge washing, cesium removal, and vitrification are not unknown technologies and any uncertainty with them can be demonstrated either radioactively hot at a laboratory scale or at large-scale cold with simulants much more efficiently than two low-level demos and one high-level demo. That will set the program back 5 to 10 years treated under 5 percent of the waste and cost something on the order of $3 billion dollars. That is a waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The demonstration process provides the opportunity to reduce overall program costs while completing remediation of the tank wastes within Tri-Party Agreement requirements, especially considering the uncertainty associated with the tank waste inventory. The lessons learned and process knowledge gained during Phase 1 would be incorporated into the design and operation of the full-scale treatment facilities during Phase 2. Please refer to the response to Comment number 0055.08.

Comment Number 0068.02

Martin, Todd

Comment Further, another one that is very easy for anybody to understand is you look at the EIS, and you see in Phase 1 they need to retrieve and vitrify the waste from about 36 tanks. How much would that cost? How much would it cost to pump the nuclear waste out of this auditorium if it were full? According to the EIS, zero dollars. Won't cost a penny. Surely there's a cost there. But the EIS doesn't reflect it. Again, the costs need to be fixed.

Response Please refer to the response to Comment number 0035.07 which addresses a similarly worded comment.

Comment Number 0072.121

CTUIR

Comment P 3-92: Sect. 3.4.10: This alternative is unacceptable if the implementation consists of decommissioning any process that produces waste acceptable to the HLW permanent repository, the added push of continuing to operate the test facility will reduce the time it take to finish the job.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Decommissioning of facilities for this alternative is addressed in Volume One, Section 3.4.

Comment Number 0072.122

CTUIR

Comment P 3-92: Phase 1: The selection of the SST waste is an integral component and effort has to be taken that this section include language reflecting that waste from all SSTs be test reacted as to ensure complete acceptability.

Response The waste processed during Phase 1 could include selected SST waste. As explained in Volume One, Section 3.4, the retrieval and treatment of the remaining DST and SST waste will be completed in the following stages of the alternative (Phase 2) following completion of the demonstration phase (Phase 1). Before any waste is retrieved it would be characterized and analyzed to ensure compatibility. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.193

CTUIR

Comment P B-132: Sect. B.3.9: This alternative, while good for a conservative industry approach does not take into account the uncertainties associated with the characterization program. Unless the demonstration phase proved beyond a doubt it could handle waste forms from all the tanks.

Response Considerable uncertainty associated with the tank waste inventory data remains, and additional tank characterization is required before final design of any alternative. Please refer to the response to Comment numbers 0012.14, and 0072.07 for discussions of characterization of tank inventory and characterization in programs. Phase 1 of the Phased Implementation alternative would include technical evaluation, demonstration, and detailed design for the separations and immobilization processes for various categories of waste feed. Following the successful implementation of Phase 1, Phase 2 would be implemented to complete the tank waste remediation according to the technical approach most appropriate to the tank waste categories. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0088.05

Porter, Lynn

Comment One of my concerns about the preferred alternative and privatization is who decides when it's a success or not. Is this strictly going to be the DOE deciding, or will the Tri-Parties together decide on this? And there need to be enough milestones in this, spaced closely enough together that the public interest groups can track this and know whether it's succeeding or failing, whether it's on track where it should be. Because otherwise this could go on for years, and all of a sudden, as it has before, all of a sudden we find out hey it's not working and we have to start over.

Response Privatization is a contracting mechanism that is not within the scope of the EIS. DOE and Ecology have agreed on a set of criteria that will be used in making a decision on whether privatization is achieving its intended goals or failing, which would cause a change from the primary path to the alternate path. Under this agreement, should Ecology determine that compliance with the primary path is unlikely, it will inform DOE of such an opinion. DOE will respond within 30 days whether a change from the primary to the alternate path is necessary. If DOE determines that a change is not necessary, it will provide Ecology with a written rational for continuing with the primary path. Ecology will have the authority at any time to require DOE to evaluate the viability of the primary path. These activities will be among the issues routinely statused, discussed, and reviewed by the Hanford Advisory Board and its Health Safety and Waste Management Committee. Additional review, input, and comment by Tribal Nation regulator and stakeholder representatives is encouraged. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

L.3.4.12 Ex Situ/In Situ Combination 2 Alternative

Comment Number 0005.05

Swanson, John L.

Comment As an example of some of my concerns related to (3) and (4), I cite the "last minute" addition of the "Variation of the Ex Situ/In Situ Combination alternative." I do not see that this is a bounding case at all, and I see no evidence that it is based on anything more than some assumed characterization data (perhaps on computer predictions based on a set of assumptions). Thus, I feel that you got carried away by even proposing this as a separate variation; wouldn't it be better to discuss it in the context of being in the "noise level" of the very uncertain characterization data on which I am assuming the original ex situ/in situ alternative was based? (I am assuming this because you do not tell me the source of the "currently available characterization data" that you are basing this on, and I am not aware of any sound data bank that would allow this alternative to be factually based). (See Comment 0005.09).

Response The variation of the Ex Situ/In Situ Combination alternative (known as the Ex Situ/ In Situ Combination 2 alternative in the Final EIS) referenced in the comment was added to provide a range of alternatives that includes a combination of the in situ and ex situ alternatives. Without this alternative, there would have been only one alternative to represent partial retrieval, and it is important to show the public and the decision makers the relationship between environmental impacts and the extent of retrieval. This alternative provides one more alternative on the continuum from no retrieval to minimal retrieval to partial retrieval to extensive retrieval.

The variation of the Ex Situ/In Situ Combination alternative presented in the TWRS Draft EIS was based on limited data analysis and was therefore included in a brief preface to the Draft EIS, which provided general information on the levels of impacts that would occur as a result of implementing the alternative. This alternative has been developed and analyzed to the same extent as the other alternatives in this Final EIS. The variation is known as Ex Situ/In Situ Combination 2 alternative in the Final EIS. The information is presented in Summary, Sections S.5, S.6, and S.7; in Volume One, Section 3.4, and throughout Section 5.0. More detailed information on the alternative may be found in Volume Two, Appendix B.

Comment Number 0012.08

ODOE

Comment The EIS includes an attachment which describes a variation of the Ex Situ/In Situ Combination alternative. This alternative was not analyzed in the EIS and should be excluded from consideration for that reason.

Response The variation of the Ex Situ/In Situ Combination alternative analyzed in the Draft EIS was identified very late in the process of preparing the Draft EIS. DOE and Ecology choose to include a brief summary of this alternative as an attachment to the EIS. This alternative has been fully developed and incorporated into the Final EIS. DOE and Ecology believe the Ex Situ/In Situ Combination 2 alternative provides another alternative between the no retrieval and extensive retrieval, and, as a result provides useful information to the public and decision makers. Please refer to the response to Comment number 0005.05 for more information.

Comment Number 0047.04

Ahouse, Lorretta

Comment I am very concerned that an "attachment variation of the Ex Situ/In Situ Combination alternative" was added at the last moment to the Draft EIS. As I understand, this alternative would only remove 26 percent of the total tank waste volume and would not meet the Tri-Party Agreement. This is not acceptable to me as a citizen of Washington State. Why was this alternative even added so late in the process if its does not meet the Tri-Party Agreement? Does the Department of Energy have any plans to seek an exemption from the Tri-Party Agreement? Why are we wasting taxpayers dollars to examine alternatives that are not legally acceptable? Please, just get on with the cleanup.

Response Please refer to the response to Comment numbers 0005.05 and 0012.08 which address similarity worded comments. Please refer to the response to Comment number 0072.80 for a discussion of the NEPA requirement to analyze reasonable alternatives, even when they do not comply with regulations. In the Final EIS the Summary, Section S.7 and Volume One, Section 6.2 address the ability of the alternative to comply with Federal and State regulations and the Tri-Party Agreement.

L.3.4.13 Miscellaneous

Comment Number 0005.11

Swanson, John L.

Comment I am quite sure that the alternatives involving in situ disposal will require more extensive/costly characterization activities than the other alternatives, but I do not see that reflected in the cost comparisons. Isn't that a bias in their favor? (I learned at the May 2 hearing that characterization is not included in this EIS, but my statement re biasing of comparisons stands. Also, shouldn't the omission of characterization from this EIS be highlighted, along with the omission of closure, so that it will be clear how limited in scope this EIS really is?)

Response Additional characterization requirements for in situ alternatives have been considered. Volume One, Section 3.4 acknowledges that additional characterization would be required for the in situ alternatives have been considered. The cost estimates completed in support of the Draft EIS included an additional $903 million for the in situ alternatives to cover additional characterization activities. These cost estimates are available for review in the TWRS EIS Administrative Record and DOE Reading Rooms and Information Repositories The relationship between closure and the alternative is presented in the Summary and Volume One, Section 3.3 and the impact in Section 5.0. For a discussion of the closure issues, please refer to response to Comment numbers 0072.08, 0101.06, and 0072.50.

Comment Number 0035.09

Martin, Todd

Comment Lastly, I would like to address the issue of mortgage reduction. This is something at Hanford that we have been dealing with for two years.

It has been a very high priority, and it has to do with putting money into old facilities for the purpose of closing them down in such a way that we could free that money up for real cleanup.

The tanks are the greatest mortgage reduction opportunity at Hanford we have. If we get the waste out of the tanks, we will reduce the budget by, as Dick said, about 300 million dollars. It is time to get on with it. It is time to do the job.

Response Cost associated with continued monitoring and maintenance activities at the tank farms would be reduced as the number of tanks containing waste was reduced. Remediation of Hanford tank waste is a needed investment to environmental well-being of the Hanford area and is required to protect human health and the environment.

L.3.5 CESIUM AND STRONTIUM CAPSULE ALTERNATIVES

L.3.5.1 Preferences for Capsule Alternatives

L.3.5.1.1 Specific Preferences

Comment Number 0006.01

Skyes, Megan

Comment As a scientist involved in biomedical research in the area of bone marrow transplantation, I am writing to express my support for the production of Cs-137 sources at the Hanford Reservation. It is my understanding that this is the only world producer of large Cs-137 sources other than the Russian laboratories at Mayak. In view of the high prices of Cs-137 sources that results from the existing monopoly, it will be nearly impossible to purchase sources in the future, as funding for biomedical research is becoming more and more limited. Therefore, the production of Cs-137 sources (at a lower cost) would be a major benefit to the biomedical research community. There are numerous other investigators, not only in the field of bone marrow transplantation, but in immunology who are dependent upon the availability of these irradiators in order to carry out their research. I hope that it will be possible for the Department of Energy to deal with the existing Cs-137 at Hanford in a cost-effective manner and in so doing to serve a vital need for the medical research community.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. For the Final EIS, DOE has identified the No Action alternative as the preferred alternative and has modified the Summary Volume One, Section 1.3 accordingly.

The TWRS EIS addresses alternatives for management and disposal of encapsulated cesium and strontium. The encapsulated cesium and strontium are included in the EIS primarily because they were originally extracted from the stored high-level tank waste to reduce the thermal heat generation in the tanks and would be considered HLW for purposes of disposal. DOE is actively seeking commercial interest in the beneficial applications for the encapsulated cesium and strontium, and DOE remains committed to pursuing any viable commercial or other beneficial uses; at this time, the preferred alternative is No Action. These uses would not be without substantial cost for reprocessing and repackaging since the current encapsulation was designed principally for storage purposes. If viable commercial or beneficial uses are not implemented, the capsules would be designated as waste at some point in the future and would be disposed of using methods consistent with one of the alternatives identified in the EIS or a new NEPA analysis would be completed. Under no action, the capsules will be stored and maintained under current operations at the WESF, which includes a comprehensive monitoring program. This program is described in Volume One, Section 3.2.

Comment Number 0008.03

Evett, Donald E.

Comment Secondly, S.5.2 Cesium and Strontium Capsule Alternatives: I personally would prefer to select alternative (4) physically mixing the capsule contents with the high-level tank waste, which would then be vitrified and disposed of at a potential geologic repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium waste and strontium capsules.

Comment Number 0029.02

Bartholomew, Dale C.

Comment I believe that cesium capsules should be left in a condition for possible future commercial irradiation. At the public hearing on May 2, 1996, we were advised that only one capsule leaked, but no one at the hearing was able to identify the mode of failure. If the mode of failure was a bad weld, I believe that it is premature to dispose of all capsules, because there still may still be some interest in commercial irradiation. It would be imprudent to waste all of the previous time, effort, and cost that went into the separation and concentration of the cesium-137 and strontium-90 isotopes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. For the Final EIS, DOE has identified the No Action alternative as the preferred alternative and has modified the Summary and Volume One, Section 1.3 accordingly. Please refer to the response to Comment number 0006.01.

Comment Number 0032.07

Heacock, Harold

Comment A secondary issue addressed in the Draft EIS is the disposal of the cesium and strontium capsules currently stored in the WESF facility at the B Plant.

We believe that any action to dispose of the capsules should be deferred at this time, so long as an adequate degree of environmental protection is maintained in their storage.

These capsules represent a resource that may have significant future use in irradiation programs. Pending the determination of their potential future utilization, we believe this potential asset should be retained.

This position is consistent with the Draft EIS since the high-level waste ex situ vitrification plant operation is at least 10 years away.

Ultimate disposal of these capsules with the other high-level waste is the preferred solution to the disposal of the capsules.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0040.05

Rogers, Gordon J.

Comment The cesium and strontium capsules should be transferred into air-cooled storage in the facility now being built for the Spent Nuclear Fuel project. In the meantime serious efforts should be made to see if there is a market for commercial use as radiation sources. Permanent disposal plans can wait.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0043.05

Hanford Communities

Comment The Hanford Communities would also like to comment on the plans for disposition of the cesium and strontium capsules currently stored in the B Plant. We believe that any action to dispose of the capsules should be deferred at this time. These capsules represent a resource that may have significant value. Rather than pay to dispose of these materials, the Department should actively explore opportunities for commercial use and sale.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

L.3.5.1.2 General Preferences

Comment Number 0012.13

ODOE

Comment The second issue addressed by the EIS is what to do with the cesium and strontium capsules stored at Hanford. The cesium capsules contain cesium-135 and cesium-137. These two isotopes present different hazards. Cesium is very soluble in water. Cesium-135 has a long half-life. If it is disposed at Hanford, it presents an unacceptably large risk to public safety and health and the environment. Oregon supports disposal of the cesium and strontium from capsules in a suitable form to the national high-level nuclear waste repository. The waste form selected should ensure that cesium-135 will not endanger public health and safety or the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0060.05

Davenport, Leslie C.

Comment I do not feel that a final choice can be made between the proposed alternatives yet. The No Action alternative of continued storage in WESF is acceptable during the next 10 years while DOE selects an alternate storage method for the capsules or determines if there is a use for them. I do not like the Onsite Disposal alternative because I feel that the capsules, if discarded, belong in the proposed geologic repository. Similarly, it makes little difference other than cost if the capsules are Overpacked and Shipped, or Vitrified with Tank Waste if a HLW vitrification facility is operational at Hanford.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0089.02

Nez Perce Tribe ERWM

Comment ERWM endorses the Overpack and Ship alternative for the strontium and cesium capsules.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

L.3.5.2 No Action Alternative (Capsules)

No comments were submitted for this topic.

L.3.5.3 Onsite Disposal Alternative

No comments were submitted for this topic.

L.3.5.4 Overpack and Ship Alternative

No comments were submitted for this topic.

L.3.5.5 Vitrify with Tank Waste Alternative

No comments were submitted for this topic.

L.3.6 BORROW SITE SUMMARY

Comment Number 0019.03

WDFW

Comment WDFW is concerned by stating specific (potential) borrow sites in this document future decisions will be steered by the mentioning of such locations now. Statements are made in this document without the word "potential" even mentioned. Example, section B.6.1, paragraph discussing first and second layers, last sentence, which states "The proposed topsoil would be obtained from the McGee Ranch quarry site of the Hanford Site." This document appears to be trying to steer future decisions prior to exploring alternatives for borrow sites.

Throughout the document, the author states "future NEPA documentation will specifically address in detail impacts and mitigation of post-remediation tank closure where, for example most impacts of borrow site activities would occur" (page 5-258). The summary states "The impacts of closure cannot be meaningfully evaluated at this time. U.S. Department of Energy (USDOE) will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future." Since a meaningful analysis of impacts to potential borrow sites for post-remediation activities is not being undertaken by this EIS, WDFW requests all references to potential post-remediation borrow sites be deleted from the document (i.e., figures, tables, and text).

Response The TWRS EIS frequently states that the final selection for the borrow sites must be evaluated in the document for waste site and tank farm closure. The Summary states that, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future." This question was also contained within the Notice of Intent to prepare the TWRS EIS.

Volume One, Section 3.6, states that, "The final selection of borrow sites for earthen material has not been made; however, the locations indicated represent potential borrow sites that would support each of the alternatives in both volume and location. Future borrow site decisions will be made in the ROD for the Hanford Remedial Action EIS."

Volume One, Section 4.5, states that, "The potential Vernita Quarry and McGee Ranch borrow sites have potential for both historic and prehistoric materials. Surveys have identified prehistoric or historic sites at both Vernita and McGee Ranch. The McGee Ranch area has been determined to be eligible for nomination to the National Register of Historic Places as the McGee Ranch/Cold Creek District. No prehistoric sites are known at the potential Pit 30 borrow site, although one structure from the homestead era is located at Pit 30." These statements are reiterated in Section 5.5 where it is stated that, "Archaeological surveys of the three potential borrow sites have identified a variety of prehistoric or historic artifacts and sites at the Vernita Quarry and McGee Ranch. The likelihood of disturbing additional archaeological sites in these areas is considered high." In addition, the archaeological importance of historic and prehistoric sites is reiterated in Volume One, Sections 5.5.1, 5.5.2, and 5.5.3.

Volume One, Section 5.17 identifies the potential Vernita Quarry and McGee Ranch borrow sites as undeveloped areas on the Hanford Site Development Plan's Future Land-Use Map. Further, using the potential Vernita Quarry site would involve expanding an existing quarry, while using the potential McGee Ranch borrow site would essentially be a newly developed site (though a small, old borrow area does exist). It is further stated that, "Planning for possible borrow sites for the TWRS program is still in its early stages and the CLUP and Hanford Remedial Action EIS address future land uses for the Site as a whole." Section 5.5.3 explains that any disturbance of the land surface, such as would occur in borrow site activity, is not compatible with the relationship between the Native Americans and the land.

Volume One, Section 5.20.1 states that, "Although much of the area proposed for the remedial activities is in areas currently disturbed, activities in some areas [primarily the Vernita and McGee Ranch borrow sites] have the potential to impact historic, prehistoric, or cultural sites. These areas have not been fully surveyed because they are potential borrow sites subject to change during final design. The final selection of borrow sites would be made through the Site Comprehensive Land Use Plan."

The discussion of alternatives uses these borrow sites as example locations for the materials that may be required for closure. Certainly, gravel and sand sources are required for construction of the facilities required for the various alternatives. In WHC-SD-WM-EV-103 and WHC-SD-WM-EV-104, Tables 6-12 and 9-12, respectively, state the assumption that an onsite gravel plant would provide crushed aggregate for concrete construction at a location 5 kilometers (km) (3 miles [mi]) from the construction site, the potential borrow site known as Pit 30.

Considering the earlier discussion, which states that the decisions for the borrow sites will be made elsewhere, that the prehistoric, historic, and cultural significance must be thoroughly evaluated, and the undeveloped status given to portions of the area land relationship with the Native Americans, DOE and Ecology do not believe that including these potential borrow sites alternatives for borrow sites. Using these named potential borrow sites provides only a basis to more completely discuss the potential impact of each of the alternatives covered in the TWRS Final EIS in terms of potential for traffic accidents with distance traveled, construction and operation emissions to the environment, a comparison between the alternatives, and an interrelated closure discussion for each of the various alternatives.

Comment Number 0019.07

WDFW

Comment Page 3-116, Tables 3.6.1, 3.6.2, and 3.6.3 If I were to open this EIS to this page, I would conclude from the titles of thee tables that a decision has been made on borrow site locations when in fact this document does not perform adequate NEPA analysis, i.e., a range of alternatives, for sources of different material types needed. WDFW requests all references to borrow site locations be deleted from the document since the impacts to borrow sites will require NEPA review.

Response Please refer to the response to Comment numbers 0019.03, 0072.08, and 0101.06. The EIS has been reviewed and revised as appropriate to clarify the assumed borrow sites as "potential" sites.

Comment Number 0072.123

CTUIR

Comment P 3-116: Tables 3.6.2. and 3.6.3.: These tables present figures that are for closure options. Because this EIS is a RETRIEVAL EIS, the tables are inappropriate and should be removed, or all of the closure options be equally presented.

Response The tables identified in the comment represent borrow materials required for the assumed closure scenario presented in the EIS. For more information on the closure assumption, please refer to the response to Comment numbers 0072.08 and 0019.03. As identified in the Draft EIS in Volume One, Section 3.3 closure is not within the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. The amount and type of waste that remains in the tanks after remediation also may affect closure decisions. Closure as a landfill was included in all of the alternatives except the No Action and Long-Term Management alternatives so the alternatives could be meaningfully compared. This does not mean that closure as a landfill has been proposed or would be selected for final tank closure. Because the information contained in the Draft EIS is correct, no change to the text was made.

L.3.7 COMPARISON OF ACTIVITIES ASSOCIATED WITH ALTERNATIVES

Comment Number 0005.15

Swanson, John L.

Comment I find it strange that system costs is the only metric included in the summary description of each alternative in Section 3.0 ("Description and Comparison of Alternatives"). People are certainly interested in the costs, but the major concern on the part of the public appears to me to be in the perceived risk to their health and well-being. Couldn't/shouldn't summary data of some sort in that area be included in this section along with the cost data? If this is not done, I feel that you should change the title of this section to "Description and COST Comparison of Alternatives."

Response Volume One, Section 3.0 provides a description and comparison of the alternatives based on the characteristics of the alternatives themselves. These characteristics include cost. However, the section also provides a comparison of the processes inherent to each alternative; construction, operations, and post-remediation features of each alternative; the schedule, sequence of activities, and costs of each alternative; the amount of waste to be retrieved from the tanks, treated, and disposed of onsite verses offsite for each alternative. The potential environmental impacts associated with each of the alternatives are presented in Volume One, Section 5.0. In Volume One, Section 5.14, a summary table is provided that lists each alternative and all of the associated impacts as presented in Section 5.0. Additionally, a summary of those impacts was presented in the TWRS EIS Summary, Section S.7, which was prepared to accompany the EIS or to be read separately by individuals who did not want to read the entire EIS. The level of data and summarization of the data, as well as the presentation of the data and summary information provided the public and decision makers with the appropriate level of information in a format that was accessible considering the complexity of the proposed action and associated impacts. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0005.55

Swanson, John L.

Comment Why is the number of HLW shipments required for the Extensive Separations alternative ~50 percent as large as that for the Intermediate Separations alternative (page 5-146), when the ratio of the number of canisters is only ~10 percent as large?

Response The average rail trips per year calculated and reported in Volume One, Section 5.10, Trail Traffic Volumes, for the number of canisters generated as result of the Ex Situ Extensive Separations alternative has been modified in the Final EIS.

L.3.8 ALTERNATIVE CONSIDERED BUT DISMISSED

No comments were submitted for this topic.

L.3.9 MISCELLANEOUS

Comment Number 0005.59

Swanson, John L.

Comment Page vii of Volume Two contains incorrect definitions/descriptions of B Plant and T Plant.

Response According to two references, Hanford Tank Clean Up: A Guide to Understanding the Technical Issues (Gephart-Lundgren 1996), The Hanford Site: An Anthology of Early Histories (Gerber 1993), and T Plant (DOE 1994l), T Plant and B Plant were both constructed as plutonium removal facilities. Both facilities used the bismuth phosphate separation process. In later years, B Plant was used to remove cesium and strontium from acid waste pumped from the Plutonium-Uranium Extraction (PUREX) Plant. T Plant is currently used as a decontamination and repair facility. According to DOE 1994l, these plants, along with Z and U plants, for example, were given alphanumeric names due to 1940's wartime secrecy. These descriptions are provided in the Volume One Glossary. B Plant and T Plant were deleted from the Acronyms and Abbreviations list in Volume Two, Appendix B.

Comment Number 0005.60

Swanson, John L.

Comment On page B-9, an incorrect date is given for the start of the PUREX plant.

Response According to two references, Hanford Tank Clean up: A Guide to Understanding the Technical Issues (PNL 1996) and The Hanford Site: An Anthology of Early Histories (WHC 1992), the correct date for the PUREX Plant hot start up was January 1956. All applicable, incorrect references have been revised.

Comment Number 0022.04

Sims, Lynn

Comment There is no argument that Cold War Clean Up is extremely expensive. But inadequate clean up will be more expensive. Choosing less expensive options now will probably result in contaminated soils and water, serious loss of quality of life and health and perhaps loss of land use, trade, and commerce. Our costs now are a result of military production. Perhaps military clean up should be built in up front in the military budget since that is the department which seems to receive more funds than requested while DOE monitoring and clean up funds are slashed.

Finally, it must always be of paramount importance to remember that bomb production was implemented to protect this nation and that to skimp on efforts to clean up puts our homeland at serous risk forever.

Response Comment noted.

Comment Number 0025.01

Heart of America

Comment *A public interest group distributed a questionnaire at the Spokane and Seattle, Washington public meetings. Listed below are the questions and a tally of the totals from the 33 individuals who submitted surveys. The agency responses follow after the summary of the questionnaire. Below each question in bold is the ranking system contained in the questionnaire (using a scale of 1 to 10). In parenthesis following the rank are the number of individuals who circled the number on this questionnaire.*

Please tell us the degree to which you agree or disagree with the following proposals for Hanford's high-level nuclear wastes on a scale from one to ten with #1 being Strongly Disagree; #5 No Opinion; and #10 being Strongly Agree.

1. The current Tri-Party Agreement calls for retrieving 99 percent of the wastes from all of Hanford's high-level nuclear waste tanks by the year 2028 and turning it into some form of glass (vitrification). To what degree do you agree/disagree with the Tri-Party Agreement?

Rank: 1 (3) **2** (1) **3** (1) **4 5 6** (1) **7** (1) **8** (8) **9** (3) **10** (14) . **N/**A (2)

2. Leaving 75 percent of the high-level nuclear waste in the tanks forever, and filling them with cement or gravel after removing the most radioactive 25 percent would cost less than retrieving and vitrifying 99 percent of the waste. This is the Ex Situ/In Situ Combination alternative.

a. The cost savings claimed by USDOE for this option justify leaving most of the high-level nuclear waste in the tanks:

Rank: 1 (23) **2** (1) **3** (3) **4** (1) **5 6 7** (1) **8** (2) **9** (1) **10** (2)

b. USDOE has fully considered in the EIS the evidence that waste from tank leaks is moving towards groundwater and the risks this may pose to the Columbia River and future exposed populations from this alternative:

Rank: 1 (18) **2** (1) **3 4 5** (2) **6 7** (4) **8** (2) **9** (2) **10** (1) **N/**A (4)

c. Any alternative that leaves high-level nuclear waste in the tanks and in the soil beneath the tanks poses an unacceptable risk to the Columbia River and future generations.

Rank: 1 (1) **2 3** (1) **4 5 6 7 8** (2) **9** (3) **10** (27)

d. For the same reasons that the public voted in 1986 against Hanford being an underground high-level nuclear waste dump, leaving high-level nuclear waste in tanks or threatening groundwater is NOT acceptable:

Rank: 1 (2) **2 3** (1) **4 5 6 7 8** (4) **9** (2) **10** (25)

3. USDOE's Tank Waste Task Force (public interest groups, local governments, Tribes,...) urged USDOE to base decisions assuming that the wastes, after being vitrified, will stay at Hanford for a very long time, and not to assume USDOE will move the waste to its proposed Yucca Mountain repository. Do you agree/disagree with the advice:

Rank: 1 (6) **2** (1) **3** (2) **4 5** (5) **6 7 8** (1) **9** (7) **10** (11) **N/**A (1)

4. a. USDOE should use conservative assumptions that tank leaks move down to groundwater in less than 40 years, instead of claiming that leaks will stay close to the tanks and not reach groundwater for over 100 years:

Rank: 1 (1) **2** (1) **3** (1) **4** (1) **5** (1) **6** (1) **7 8** (3) **9** (2) **10** (23)

b. Because this EIS assumes tank leaks do not move quickly to groundwater, the EIS wrongly creates a bias in favor of delaying retrieval of all wastes from leaking single-shell tanks:

Rank: 1 (3) **2** (1) **3 4 5** (2) **6 7** (3) **8** (3) **9 10** (22)

5. a. Should the EIS drop (not include) the "repository fee" in its presentation of costs and as a basis for decision making?

Rank: Yes (22) **No** (12)

b. Does the inclusion of the repository costs appear to have biased the consideration of alternatives, including how one would weigh each alternative's risk versus costs?

Rank: Yes (26) **No** (4) **N**/A (3)

c. If the cost of the No Separations alternative (make all the waste into glass logs) were in the same price range as other alternatives when the hypothetical repository fee was not added onto it, would you urge that it be considered as a reasonable alternative to building multiple vitrification and separations plants:

Rank: Yes (19) **No** (10) **N**/A (5)

Response

Comment item number 1: Please refer to the response to Comment numbers 0047.03 and 0009.01.

Comment item number 2a: Please refer to the response to Comment number 0072.05.

Comment item number 2b: Please refer to the response to Comment number 0012.15.

Comment item number 2c: Please refer to the response to Comment number 0072.08.

Comment item number 2d: Please refer to the response to Comment numbers 0072.08, 0072.100, and 0072.111.

Comment item number 3: Please refer to the response to Comment numbers 0081.02.

Comment item number 4a: Please refer to the response to Comment numbers 0012.15 and 0030.02.

Comment item number 4b: Please refer to the response to Comment numbers 0012.15 and 0030.02.

Comment item number 5a: Please refer to the response to Comment numbers 0081.02 and 0004.01.

Comment item number 5b: Please refer to the response to Comment numbers 0081.02 and 0004.01.

Comment item number 5c: DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0081.01 and 0004.01.

Comment Number 0027.03

Roecker, John H.

Comment Systems Engineering

In 1993 DOE proudly and loudly stated that it was going to use systems engineering to establish the requirements for both TWRS and also the Hanford Site. To my knowledge that has not been done in either case, yet here we are reviewing the EIS for implementing a very specific TWRS action. Looks to me as if the systems engineering commitment lasted about as long as the January 1994 Tri-Party Agreement. Two fundamental systems engineering actions are required to correct this situation. First, a top down requirements allocation from the site level to the program level is needed. Secondly, the TWRS Functions and Requirements Document, along with an integrated alternatives systems analysis, must be finalized and issued. I would request that issuance of the Final TWRS EIS be deferred until such systems engineering and analysis has been completed. Without such one cannot be sure that the right work is being performed or that the best alternative has been selected.

Response Since 1993, two systems engineering documents, TWRS Functions and Requirements (DOE/RL-92-60) and TWRS Systems Engineering Management Plan (DOE/RL-93-106) have been prepared. DOE conducted an independent Systems Requirements Review (SRR), submitted in November 1994, to validate the TWRS Functional Requirements Baseline. The SRR evaluated selected representative TWRS activities and identified the need for improvement in the implementation of systems engineering, quality of supporting documentation, and timeliness of testing assumed solutions and competitive alternatives. In response to the SRR, the TWRS System Requirements Review Action Plan (DOE/RL-95-74) was prepared, which addressed the findings presented in the SRR and presented the methodology for revising the Functional Requirements Baseline and developing the infrastructure required to support the functional requirements. Because the EIS and the TWRS Functions and Requirements have been developed concurrently, the conclusions of the TWRS Functional Requirements are anticipated to be consistent with the recommended alternative presented in the Final EIS. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives. Please refer to the response to Comment number 0101.07 for further discussion of systems engineering.

Comment Number 0027.04

Roecker, John H.

Comment Technical Balance

I wish I was more interested in the projected cost of housing in the Tri-Cities in the year 2040 because there sure is plenty of computer printout data on that and other similar items, but I am just not. Instead, I would like to see more of the technical data that supports such items as operating efficiency, number of canisters, process design, alternative costs, etc. I would like to request that the reams of computer printout data and modeling contained in the appendices be restrained a little and more of the basic technical data that really establishes how an alternative is going to perform be put into the EIS.

Response The technical data that support the areas of interest indicated (i.e., operating efficiency, number of canisters, process design, and alternative costs) are contained in the TWRS Administrative Record and are available for review. The data to support the performance capability of the recommended alternative will be contained in the detailed design document for that alternative, which will be prepared following the Final EIS. The evaluation criteria used in the EIS are defined by NEPA and are confined to impacts to the environment only. As such, the requested evaluation of alternative performance data is beyond the scope of this EIS, but will be contained in future documents.

Comment Number 0027.06

Roecker, John H.

Comment Use of Non-Optimized Alternatives

The alternatives described in the EIS represent first cut approaches and do not represent optimized alternatives that have been tuned utilizing good engineering principles. More recent optimized process design flowsheet and facility design data is available and should be used in the Final EIS. This optimized design will significantly reduce the estimated cost.

Response The purpose of the EIS is to examine bounding alternatives, including a No Action alternative. It is anticipated that the optimized process design flowsheet will be used during the detailed design of the waste retrieval, transfer, treatment, and storage facilities conducted during the demonstration phase of the preferred alternative. The TWRS baseline flowsheet is continually updated and optimized. In order to support the EIS schedule, the baseline data used for development of the Draft EIS was frozen in May 1995. NEPA requires the alternatives be compared on an equitable basis. The Draft EIS presents conceptual alternatives that were developed using common bases that allow equitable comparison. Please refer to the response to Comment number 0072.05.

Comment Number 0027.08

Roecker, John H.

Comment Cost Estimates

In this day of tight budgets the cost estimate for an alternative is a very critical item. It is impossible to understand the basis for any of the cost estimates with the information contained within the EIS itself. It is necessary to look up several reference documents. This is not the easiest task if you do not live in the Tri-Cities. It would be helpful if the backup information for the life cycle cost estimates could be included in an appendix. There are several of the existing appendices that could be greatly reduced to make room for this information. As an example, the over 50 pages devoted to socioeconomic impact could be reduced to approximately 10 pages. The endless tables representing computer modeling printout could be put in a reference document.

Response As stated in Volume One, Section 1.0, the EIS fulfills the requirement for an analysis of potential environmental impacts in the decision-making process. NEPA and The Washington State Environmental Policy Act (SEPA) provide decision makers with an analysis of environmental impacts (both positive and negative) of proposed actions for consideration during decision making. This EIS presents the impacts of the proposed action and its reasonable alternatives for review and comment by the public and interested parties. Because of the magnitude of the cost required to implement any of the alternatives, it was determined that cost estimates would be included in the EIS. The development and presentation of alternative cost estimates is not the primary purpose or major focus of an EIS. The development of bounding alternatives for the EIS would indicate the need to develop additional cost data for the decision-making process.

The technical data used to develop the alternatives presented in the EIS are contained in the TWRS EIS Administrative Record and DOE Reading Rooms and Information Repositories. The Administrative Record contains additional cost estimate detail. As indicated in the front of Volume One, EIS technical reports, background data, materials incorporated by reference, and other related documents are available at Seattle, Spokane, and Richland, Washington; Portland, Oregon; and Washington, D.C.

The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0027.09

Roecker, John H.

Comment My understanding of the capital cost estimates for the down sized facilities in the combination and Phased Implementation alternatives is that the sixth-tenths power rule was used. That is an absolute error. The sixth-tenth power rule does not work for these types of facilities. These facilities have a significant portion of their capital cost attributable to basic facility systems which are essentially independent of facility size. The sixth-tenth power rule works for facilities in which processing equipment makes up most of the capital cost. That is not the case with these waste processing facilities. That is something that must be fixed in the Final EIS. Conceptual cost estimates for the size facilities included in the EIS have been made. Why not use the available existing data which has backup rather than include erroneous data?

Response The cost estimating methodology has been reviewed for the Final EIS and revised cost estimates were completed for the Phased Implementation and combination alternatives. These revised costs are shown in Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to the response to Comment numbers 0055.06, 0057.06, and 0035.06.

Comment Number 0030.01

Krieg, Ronald K.

Comment I am also disappointed in the limited scope that the inclusion of subsurface barrier technology in this Draft EIS was only as a potentially viable component to remediation alternatives, and am dissatisfied in Appendix B's level of analysis and conclusions of subsurface barrier technology. My other areas of concern involve the focus being on future impacts and conditions of alternatives alone with no regard to current or past practices. If the DOE is to develop a systematic approach to actually solving some problems in a truly cost effective manner with the least environmental impact, all aspects and pertinent details of all alternatives should be included in this EIS.

Response Subsurface barrier technology is discussed in Volume Two, Appendix B. Subsurface barriers are a potentially viable technology available to the decision makers. The EIS incorporates by reference (Treat et al. 1995) a detailed engineering feasibility study on subsurface barriers. Subsurface barriers were added as a potential mitigation measure in Volume One, Section 5.20 in the Final EIS. Please refer to the response to Comment number 0001.01.

All of the alternatives' future potential impacts are based upon an analysis of the potential impact of the alternatives themselves, without consideration of past or current practices, as appropriate. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0030.04

Krieg, Ronald K.

Comment The Hanford Federal Facility Agreement and Consent Order set a goal for the SSTs that no more than 1 percent of the tank inventory would remain as a residual following waste retrieval activities (3-31, Vol. 1). Many times it is stated that this retrieval criteria of 99 percent may not be achieved (3-101, Vol. 1). Residuals left in tanks would not meet the water protection requirements if additional closure action is not taken (6-30, Vol. 1), with these residuals having low solubility because substantial quantities of liquid was used in the attempt to dissolve or suspend wastes during retrieval (3-31, Vol. 1). Furthermore, performance of key alternative processes have been assumed in absence of substantive data. Cost estimates may have a high degree of uncertainty because some of the processes are unproven (3-100, Vol. 1).

The Tri-Party Agreement calls for total waste removal from Hanford's single- and double-shell tanks for processing and storage offsite, unless technically unfeasible. Throughout the EIS the word "uncertainties" is used regarding costs, COC inventories and volumes, technology performance, actual risks, and SST leakage quantities. It would be a shame to see uncertainty translate to unfeasibility. The time has come to eliminate uncertainty through a systematic, cost and risk effective remedial approach with the least long-term impacts to our future populace's health and environment.

Response As required by the CEQ, the TWRS Draft EIS identifies and analyzes the range of reasonable alternatives for the proposed action, which also includes a No Action alternative. All data that support the cost and impact analysis of each alternative are presented in an objective format for comparison by the decision makers and by the public during the comment period. However, the EIS is limited to the TWRS and evaluation of reasonable tank waste remedies. Under the Tri-Party Agreement, DOE and Ecology are bound to complete specific milestones related to tank waste remediation, and given the uncertainties listed in the comment, the Agencies have selected the Phased Implementation as the preferred alternative.

Identification and presentation of the many existing uncertainties was the method chosen by DOE and Ecology to complete the evaluations and publish the EIS. To consider and resolve all uncertainties before publication of the EIS would result in inordinate delay and failure to comply with the Tri-Party Agreement. Please refer to the response to Comment numbers 0005.03, 0072.05, and 0072.80 for discussions regarding regulatory requirements for bounding alternative analyses.

Comment Number 0030.05

Krieg, Ronald K.

Comment A recent report prepared by the National Research Council regarding containment-in-place technologies acknowledges subsurface barriers as an imperative use during remediation efforts and as a feasible interim solution to hazardous substance migration at Hanford and other Department of Energy sites. The committee's comparison of costs found retrieving and processing wastes costs $15 billion more (17.5 vs. $2.4 billion) than the alternative of in situ stabilization and isolation. I do not believe the Feasibility Study of Tank Leakage Mitigation Using Subsurface Barriers (WHC-SD-WM-ES-300) fully analyzed subsurface barrier technology and recommend what the National Research Council has; that containment-in-place technology be re-evaluated on its technical, fiscal, environmental, and public health merits as a possible short- or long-term alternative for radioactive waste management and inclusion as such in this EIS.

Another problematic issue is in Appendix B's level of analysis and conclusions of subsurface barrier technology, which failed to include information from the Feasibility Study of Tank Leakage Mitigation Using Subsurface Barriers regarding subsurface barriers' cost effectiveness when supporting clean closure activities. Although closure decision are not a part of this EIS, they are stated to be interrelated with the decisions made concerning remediation of tank wastes.

The conclusion I am referring to is stated: "The most cost effective individual action is adding a close-coupled subsurface barrier to support clean-closure. This result is lowering both risk and HI and the overall cost of the alternative. This apparent anomaly arises from the substantial reduction in contaminated soil and recovered contaminants requiring treatment when a subsurface barrier is used. The resulting cost savings more than offset the cost of installing the barrier (WHC-SD-WM-ES-300 Rev. 0, pg. 8-3). Information such as this must not be overlooked, forgotten, or excluded from this EIS.

A reduction in the financial risk involved with contaminant migration and the technical uncertainties of the ex situ technologies is possible and available now. The potential cost savings to TWRS could be in the $5-7 billion range if a 10-year delay in remediation costs could be attained through effective deployment of subsurface barrier technology. This principle would carry over to many other situations throughout the DOE complex. Mitigated through the use of effective subsurface barriers under the tanks a delay in start up could save money in two ways: 1) identical real budgets have lesser present value as they are postponed farther into the future, and 2) technology productivity improvements occur as time passes, further reducing real costs. This approach would allow the DOE to improve the design, construction, and operations of initial and full scale remedial operations to the SSTs.

Barriers for confinement-in-place of buried waste have been effectively used in many environmental remediation activities. Subsurface barriers provide a cost effective option for resolving the 200 Areas' management and remediation problems either as a short or long-term approach. With their continued development, cost efficient subsurface barrier technology providing the highest containment performance standards must be retained and given serious consideration on its technical fiscal, environmental, and public health merits for inclusion in this Draft EIS.

Response The subject report by the National Research Council, titled The Potential Role of Containment-in-Place an Integrated Approach to the Hanford Reservation Site Environmental Remediation, recommended that containment-in-place technology be considered and evaluated on its technical, fiscal, environmental, and public health merits as a possible short- or long-term alternative for radioactive waste management. Such analysis should be conducted on a site-specific basis.

For analysis in the EIS, alternatives that bound the full range of reasonable alternatives were developed. In order to bound the impacts associated with in situ disposal of the tank waste or tank leakage during waste retrieval activities, subsurface barriers were not assumed to be used. This does not preclude the use of subsurface barriers during remediation activities but provides an upper bound on the expected environmental impacts. Subsurface barriers would be beneficial for retrieval of wastes from known or suspected leaking tanks. This technology would be evaluated for tank-specific application. Subsurface barriers were added as a potential mitigation measure in Volume One, Section 5.20 in the Final EIS. Please refer to the response to Comment numbers 0001.01 and 0030.01.

Comment Number 0046.03

DiGirolamo, Linda Raye

Comment We ought to convert the WHOLE NUCLEAR INDUSTRY by forming a commission name NEW AGE ENERGY - touched upon by Mr. Browning - This NAE would begin research and development at Hanford while the DOE cleans up its awful mess...beginning immediately!

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0054.01

Belsey, Richard

Comment Grout did not work because we had so many processes going on. At Savannah River, they are today using grout because they were able with relatively simple separations to clean out 99.99 percent of the high activity fraction. But Hanford kept on, the Hanford's performance assessment kept on bouncing back over, over, strung out over time saying give us more information, your I-129 releases from the grout are still rising at 10,000 years. You at least have to model it out to know where it is going to turn the corner. I raise this question because we have re-opened all of those issues almost like re-opening a wound and looking at an infection again and saying why are we doing this and I would council that in fact you all list other stabilization forms (grout and ceramics) in this Draft EIS. How did we come to glass. There has been both a rich scientific literature about stabilizing radionuclides in glass going back 20 or 30 years and whereas with other substances there is spotty science and particularly with ceramics and grout there are highly variable reactivity. You go down to Savannah River it is almost like a witches brew. They stir it up and they have to use this particular kind of stone or else the whole thing does not gel and same thing with ceramic. So from my perspective, science wise we have to be careful about changing the stabilized waste form and we also now have about a 20-year, nearly a 20-year experience, not our own, but with other people using glass particularly for the high-level wastes. So I think that we should clearly not make any change in the waste form because of the inherent delay that will come about and the one thing we can not afford to do is to delay. The delays have cost nearly a billion dollars now and every year we delay costs that much more with by and large no real value so we got to get on with it. So state clearly that you are not going to consider anything except glass and glass from whoever gets to do the job of cleaning this up. I will leave that for now. Thank you very much.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. NEPA requires that a full range of alternatives be examined in the EIS. This range of alternatives must include a No Action alternative, and may include other reasonable alternatives to allow analysis of a full range of alternatives. Some alternatives do not produce a glass waste form. Consequently, the EIS cannot omit glass from analysis as the waste form for a given alternative. It should be emphasized that for the ex situ alternatives, glass was the primary waste form to be produced. Similarly, the EIS also discusses alternate immobilization technologies to allow their analysis. These technologies were not included in the alternatives developed for impact analysis, but may serve as potential components of a remediation alternative. The discussion of alternate technologies, including grout, will be found in Volume Two, Section B.9.0. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the response to Comment numbers 0005.40, 0005.18, 0072.179, and 0009.08 for a discussion of issues related to grout.

Comment Number 0058.01

Swanson, John L.

Comment I have heard tonight different people give their biases. They blame somebody else for subjective judgement while they are drawing their own. In recent years have used a saying many times that I will repeat here. It applies to these costs analyses and comparisons of alternatives and that is the assumptions drive the conclusions.

Response When assumptions were made in the EIS, every effort was taken to ensure that these assumptions were applied equitably among the alternatives to ensure comparability. Please refer to the response to Comment number 0005.03.

Comment Number 0059.02

James Jordan Associates

Comment A brief white paper entitled, A Comparison of BNL's Small Modular HLW Treatment System with a Large Central Melter System is attached in support of JJA's request to include the BNL concept in the EIS analysis. Finally, an economic analysis of the estimated costs of producing high-level radioactive glass using the Small Module Inductively Loaded Energy concept invented by BNL is attached to this request. JJA has formally requested that the BNL concept be developed for possible use at Hanford and other DOE sites.

Response Alternatives were developed that bound the full range of reasonable alternatives and reflect the results of the public scoping process for the EIS and discussed in Volume One, Section 1.2. Representative alternatives that incorporate the range of cost, human and ecological health risk, and technologies have been developed for analysis in the EIS. The alternatives in the EIS have been developed to bound the applicable alternative technologies, including the one proposed by the commentor. Because the EIS contains bounding alternatives that will be presented to the decision makers, no change has been made to the EIS. Please refer to the response to Comment numbers 0072.05 and 0072.79.

Comment Number 0062.02

Longmeyer, Richard

Comment My second comment is with regard to the privatization. I have some concerns with regard to safety issues, as well as issues such as water quality issues. Both groundwater, and the Columbia River. The question is will the private contractors treat groundwater and the Columbia River with the same care that the government has been mandated to treat it, under the Tri-Party Agreement? Will they hold to the same safety guidelines, or perhaps better guidelines, that would be something that I would be interested to know.

Response Privatization is not within the scope of the EIS, as discussed in Volume One, Section 3.3 on page 3-13 of the Draft EIS, because it is a contracting mechanism. Under this concept, DOE would competitively bid a portion of the remediation work instead of having the Site Management and Operations contractor perform the work. Equivalent requirements for retrieval, treatment, and disposal of the waste, as well as quality and performance verification, would apply regardless of how DOE contracts to perform the remediation. Please refer to the response to Comment numbers 0009.19, 0060.02, and 0076.03.

Comment Number 0072.15

CTUIR

Comment It is difficult to follow the constituents through the various processes and into the environment. A mass balance showing distribution of the constituents for the tanks into various waste forms, effluents, and the environment would be helpful.

Response The detailed technical data developed to assess the environmental impacts of the alternatives addressed in the EIS are contained in referenced technical documents and calculations. The technical data are available for public review as a part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. A mass balance for each of the waste treatment alternatives was completed in order to estimate the off-gas and liquid effluents. These off-gas and effluents streams then were used as sources in the risk assessment analysis. The human and ecological health effects from these off-gas and effluent streams are addressed in Volume One, Section 5.11. The TWRS EIS is a lengthy document and the inclusion of the detailed conceptual engineering information into the EIS would greatly lengthen the document. DOE and Ecology must balance the need to present relevant supporting data against the need to have a manageable and understandable document. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.196

CTUIR

Comment P B-166: Sect. B.7.1: It is noted that the evaluation for potential sites does not indicate that the affected Tribes were not notified or consulted with. If they were, please produce references, if they were not, please contact technical representatives of the affected Tribes.

Response The Draft EIS identifies in Volume Two, Section B.7 that the final site selection for the facilities associated with the ex situ alternatives has not been made. The potential site locations indicated in the EIS were taken from Hanford Site studies that examined potential site locations for the treatment facilities required for tank waste remediation and are included as examples for calculation of environmental impacts. The identification of these sites, within the 200 Area Waste Operations areas, is consistent with the Hanford Site Development Plan and the recommendations of the Hanford Tank Waste Task Force. As indicated in Volume One, Section 5.20, before to any ground disturbance activities, consultations would be conducted with the DOE Richland Operations Office Historic Preservation Officer, the Hanford Cultural Resource Laboratory, Washington State Historic Preservation Officer, and concerned Native American Tribal groups and governments. Consultation with Tribal Nations groups and governments would be performed early in the planning process to determine areas or topics of importance to these groups such as religious areas and potential resources of medicinal plants. Please refer to the response to Comment number 0072.149 for a discussion of the Tribal Nation consultation process for the TWRS EIS. Please refer to the response to Comment numbers 0019.03, 0072.235, 0072.50, and 0101.06 for related borrow site and closure information.

Comment Number 0072.236

CTUIR

Comment P E-202: Sect. E.10.2: Although not clearly stated, this appears to be the preferred alternative. Please confirm. Additionally, it appears that the only alternative for MUSTs involves filling them with grout (sand, gravel and cement). As we have stated on several prior occasions, the selection of an alternative that results in irretrievable waste forms may be unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. There has been no attempt in the accident analyses or at the location referenced in the comment to identify any alternative as the preferred alternative. The preferred alternative is identified in the Summary, Section S.7 and Volume One, Section 3.4. For the ex situ alternatives, the MUST waste would be retrieved and only the residual left in the tanks would be grouted. Grouting of the MUST was included in the analysis to facilitate a balanced comparison of the alternatives. Closure of the MUSTS, like closure of the tank farms, will be the subject of future NEPA analysis. For each of the alternatives presented in Volume One, Section 3.4 and Volume Two, Appendix B, remedial actions for MUST waste are described. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0083.01

Pollet, Gerald

Comment Hanford's Dangerous Nuclear Waste Tanks

They can explode! They do leak! Leaked waste will poison the Columbia River! So why does the U.S. Department of Energy want to consider leaving 75 percent of the waste in the tanks forever? Is this your idea of clean-up?

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The EIS includes an analysis of potential accidents, including explosions, in Volume One, Section 5.12 and Volume Four, Appendix E. Past tank leaks are discussed in Volume One, Section 5.4.2. A discussion of the potential cumulative impacts of past tank leaks and the TWRS alternatives is provided in Volume One, Section 5.13 and Volume Four, Appendix F. The regulations (40 CFR 1500 to 1508) that implement NEPA requirements that an EIS address the full range of reasonable alternatives. For the TWRS EIS, the full range of reasonable alternatives was determined to range from leaving all of the waste in the tanks to retrieving as much of the waste as practicable (assumed to be 99 percent) and alternatives that fall between these two extremes. The DOE and Ecology preferred alternative is to retrieve 99 percent of the waste to the extent technically practicable. Please refer to the response to Comment numbers 0072.05 and 0009.01.

Comment Number 0085.03

Klein, Robin

Comment In the mean time we're calling for funding to develop real solutions. Not just for Hanford tank wastes, but to address soundly the global problem of disposing of dangerous radioactive materials worldwide. At the same time we're being asked to comment on TWRS. I'm going on a slight tangent here on purpose. We're also being asked to comment on the PEIS for disposition of weapons usable fissile materials nation wide. There we are faced with the ominous alternative, possibility of processing the worlds stores and reactors, with the likelihood that this could occur at Hanford. I hope that in parallel, with comments on what to do with the tank wastes, we don't lose sight of the pressure mounting to fire up reactors once again along the Columbia River. This is a non-solution to a problem, for which there is no good solution. Maybe if just a fraction of the dollars that were spent on developing those horrific weapons were spent on coming up with a permanent real solution, funding those great minds at the labs in Los Alamos Sandia, we'd probably stand a chance, and I believe we would. After all, that stuff's going to be around a while one way or another. But don't revive a failing nuclear industry at the price of health and safety of our futures.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Congressional funding issues are not included in the scope of this EIS. However, Volume One, Section 5.13 (Cumulative Impacts) addresses actions at other DOE sites and programmatic actions that could impact the Hanford Site, actions adjacent to the Hanford Site, and planned or reasonably foreseeable DOE actions at the Hanford Site.

L.3.0 DESCRIPTION AND COMPARISON OF ALTERNATIVES

L.3.1 INTRODUCTION

L.3.2 SITE AND WASTE DESCRIPTION

L.3.2.1 Tank Waste

Comment Number 0005.10

Swanson, John L.

Comment On another matter related to tank-by-tank inventory, on page A-2 it is said that "...tank farms were grouped together based on tank contents (inventory)..." Again, what data were used to perform such groupings? The inventory data presented in the EIS, and represented to be used therein, do not allow such groupings to be made. We thus have no way of knowing (or estimating) how valid these groupings are. I detect no special bias here, as I do in the consideration of the combined ex situ/in situ alternatives cases, but the story presented in the EIS should be complete and consistent.

Response DOE and Ecology acknowledge the concern expressed in the comment. The text has been modified to show that the tanks were grouped according to configuration, not according to content. This text modification appears in Volume Two, Appendix A, Section A.2.1.1.

Comment Number 0005.22

Swanson, John L.

Comment On page A-3, it appears to be stated as a fact that the K Basins sludges will be added to the tanks. This is news to me, and I do not believe that it is reflected in other portions of the EIS.

Response One proposed option for disposition of K Basin sludge identified by the 1996 K Basins EIS ROD is to remove and transfer the sludge to the DSTs. If implemented, the final disposition of this waste would be in accordance with the alternative implemented for tank waste management and disposal under the TWRS EIS. The Draft EIS included, in Appendix A, the K Basin sludge inventory as a potential source of new waste to be added to DSTs. K Basin sludges are discussed in Volume One, Section 3.4.1 and Volume Two, Appendix A, Section A.2.4.

Comment Number 0005.37

Swanson, John L.

Comment On page 3-11 it is said that "--new leaks are developing in these tanks at a rate of more than one a year." Are data available to support this statement, or is it an assumption that is stated as fact?

Response At the time the Safe Interim Storage (SIS) EIS was published, 67 SSTs were assumed to have leaked over the past 50 years. This number was used to support the statement that leaks would develop at a rate of more than one a year in the future. The saltwell pumping program, which involves removing liquids from the tanks, is expected to slow the rate of corrosion and substantially reduce future leaks (see Volume One, Section 3.4). Data are not available to accurately predict the number of new leaking tanks that will develop. The data identified above provide the best estimate available at the current time. Based on the saltwell pumping program to stabilize the SSTs and for the purposes of analysis in the TWRS EIS, no new leaks are assumed to occur during the 100-year administrative control period. The text of the EIS in Volume One, Section 3.2 has been modified to state that, "... new leaks are developing at a rate of one new tank known or assumed to have leaked per year."

Please refer to the response to Comment numbers 0072.70 (leak detection methods), and 0072.85 (predicted and anticipated future leaks).

Comment Number 0012.14

ODOE

Comment Tank Waste Characterization

The tank wastes are complex and poorly understood. The complex operating history of Hanford tanks has created a situation where the contents and character of the waste in every tank varies significantly from every other tank.

USDOE is working to characterize tank wastes. This should allow USDOE to narrow the uncertainties and mitigate severe hazards such as flammable gas generation. But, the data will not be detailed or accurate enough to ensure the risk assessments can accurately predict the fate of these wastes if they are left in the tanks.

Response The tank wastes are not well characterized on an individual tank basis, but an estimate of overall tank contents can be made. As noted in the EIS in Volume One, Section 3.2 and Volume Two, Appendix A, DOE has implemented a program to characterize tank waste on a tank-by-tank basis, which will be instrumental for resolving tank safety issues and final design activities for waste treatment. This program will aid in narrowing uncertainties regarding the waste in the tanks. However, DOE and Ecology believe that the existing historical data, laboratory data, and characterization reports provide an approximate estimate of tank contents from which the analysis of the tanks alternative can be completed to support the analysis and comparison of potential environmental and human health impact under National Environmental Protection Act (NEPA). The EIS acknowledges the uncertainties involved with the level of knowledge of the tank waste inventory and uses a conservative approach to assessing impacts based on the available data. This approach, known as bounding, provides an inventory of tank wastes that supports a risk assessment that DOE and Ecology believe fairly and objectively informs the decision makers and the public of the potential impacts associated with each alternative and support a comparative analysis of the alternatives. Tank-by-tank characterization will be needed to implement detailed design and operation of the TWRS action. If characterization data become available that are not bounded by the EIS analysis, DOE would complete an appropriate NEPA analysis to support analysis of environmental impacts and, if appropriate, alternatives that address the new data. See Volume Two, Appendix A for a discussion of tank inventory and Volume Five, Appendix K for a discussion of uncertainties.

Comment Number 0072.07

CTUIR

Comment In particular, two aspects are deficient within the TWRS-EIS. First, thorough characterization of the natura and composition of Hanford's chemically and physically ckmplex tank wastes is in its infancy. It is clear that not enough information exists about these wastes within this EIS to adequately support retrieval and treatment needs, let alone facility design(s). If overall planning goals are not well understood in advance, the CTUIR SSRP asks, how will it be possible to design retrieval, treatment, and disposition systems that will meet protective waste management endstate and Tri-Party Agreement goals? This EIS should fit hand in hand with the Hanford sites overall guiding, framework document.

Response Though the characterization program for the tank waste is not complete, the EIS functions primarily as an environmental planning document, not as an engineering design document, and as such, will not include the complete details of programs like tank inventory and characterization or retrieval. As required by the Tri-Party Agreement, the tank waste characterization program will be completed September 1999. Assuming the tank waste characterization sample collection, analysis, and data interpretation must be finalized well in advance of the program, in addition to the reservoir of existing information, sufficient data would be available to support the detailed design of the transfer and retrieval systems, as well as of the treatment facilities. Where appropriate, the EIS incorporates such information by referencing the publicly available information on relevant topics. The locations of DOE Reading Rooms and information repositories containing publicly available information are given in the Summary, Section S.8. For example, the EIS contains references WHC 1995b, WHC 1995o, WHC 1994f, and WHC 1994g pertaining to tank contents and WHC 1994h pertaining to the characterization program. Tank retrieval and blending strategy is the subject of reference WHC 1995p. DOE and Ecology agree that it is necessary to ensure that tank waste remediation decisions are based on this EIS and are consistent with overall goals or designed endstates for the Hanford Site. To this end, the EIS describes the relationships among the alternatives and broader goals and policies, both nationwide and for the Hanford Site. For example, the relationship between the alternatives and tank closure is discussed in Volume One, Sections 3.3, 5.1-5.10, and 6.0. Further, Volume One, Section 6.0 describes the policy and regulatory background, including the Tri-Party Agreement, in relationship to the proposed action. Please refer to the response to Comment number 0012.14.

Comment Number 0072.14

CTUIR

Comment Considering the controversy surrounding the characterization of tank waste, the documentation of the contents of individual tanks and development of the "supertank" inventory should be better.

The entire tank waste characterization strategy needs to be examined and improved.

Response More complete knowledge of the tank contents would be preferable. At present, there is a program of tank characterization which, when completed, will provide information on the contents of each tank. Because that program of characterization is not completed, estimates of tank components were used in the EIS. The documentation of the inventory estimates that were used in the EIS is discussed in Volume Two, Section A.3.0 and in Volume Four, Appendix E (Section E.1.1.3.1). The use of the super tank inventory is specifically discussed in Appendix A (Section A.3.3). The super tank inventory is intended to present the most conservative impacts from an accident so that the effects of accidents will not be underestimated. The super tank concentration of a chemical or radionuclide is the highest reported value that has been measured or calculated for that substance. This means that for assessing the impacts of an accident, a uniform inventory will be used for every accident scenario. For assessment of impacts, the use of this inventory data provides an equitable comparison of impacts. For the Final EIS, Appendix K (Volume Five) has been added to provide expanded information regarding uncertainties including inventory and accident. Please refer to the response to Comment numbers 0012.14 and 0072.07.

Comment Number 0072.67

CTUIR

Comment P 3-2: Sect. 3.2.1.2: Tank farm description: It is indicated here that 67 SSTs have leaked 2.3 million -3.4 million liters of liquids, it would be useful if there were a description on how this was calculated.

Response The estimate for the volume of waste that has leaked from the 67 known or assumed leaking SSTs was taken from the cited reference (Hanlon 1995). The referenced document, titled Tank Farm Surveillance and Waste Status Summary Report is one of a series of periodic reports that contains tank volume data as well as estimates and data for leak volumes from each of the known or assumed leaking SSTs. The methods used to estimate the volume of waste to have leaked varied by tank. The estimating method and the other parameters that impacted the assessment are contained in the footnotes to Table H-1 in the Waste Tank Summary Report for the month ending February 29, 1996 (Hanlon 1996).

Comment Number 0072.68

CTUIR

Comment P 3-4: PP 1: A vadose zone baseline characterization program could not possibly have determined the structure of the region underneath the tank farms given the amount of liquids presumed to have leaked and the large number of unknowns associated with the vadose zone points to an enormous amount of error in the ground water assumptions changing the future predictions on the rate of contaminate transport through the vadose zone will necessarily change the risk.

Response There are uncertainties and unknowns associated with the vadose zone modeling of rate and transport of contaminants from the tanks. Many of the uncertainties were addressed in Volume Four, Sections F.4.3.5 and F.3.4. The impact assessment modeling in Appendix F only addresses impacts from releases associated with TWRS remediation, not past leaks. Additional modeling was performed with evaluations provided in Volume Five, Appendix K that address potential transport mechanisms that may have been active during past leaks. Together, these evaluations and assessments provide the basis for developing appropriate mitigating measures. The response to Comment number 0012.15 contains an extensive discussion of vadose zone contamination issues, particularly uncertainty and subsurface geology.

Comment Number 0072.69

CTUIR

Comment P 3-7: PP 3: S 5: what is the precipitation process for the metal-salt compounds indicated here.

Response The sentence cited in the comment refers to the sludges in the tanks. Sludge is contained in a layer of water-insoluble chemicals that precipitated and settled to the bottom of the tank when the waste liquid from the processing plants was made basic by the addition of sodium hydroxide. Because of their reaction with sodium hydroxide, the sludge compounds are composed of primarily of metal hydroxides. Because the sludge composition may vary and other compounds may precipitate, the precipitate also is termed hydrous metal oxides.

Comment Number 0072.70

CTUIR

Comment P 3-11: PP 3: Bullet 1: How was the rate of leakage determined? Please explain how the control wells or the leak sensors are strategically placed.

Response The statement cited in this comment, taken from the SIS EIS, is as follows: "Removing saltwell liquid from older SSTs to reduce the likelihood of liquid waste escaping from corroded tanks into the environment. Many of these tanks have leaked, and new leaks are developing in these tanks at a rate of more than one per year" (DOE 1995i). This statement was intended to reflect the age, condition, and historical perspective of the SSTs. This statement also reflected the thinking at the time that since 67 SSTs were assumed or confirmed to leak, the leakage rate would continue at more than one per year in the future.

Several methods are used to find leaks. Starting in the early 1960's, vertical monitoring wells, called drywells, were drilled around the SSTs. These wells are called drywells because they do not reach the water table. Approximately 760 drywells, located around the SSTs, are used to measure increases in radiation in the ground caused by tank leakage. Multiple drywells are located around the perimeter of the tanks in order to monitor around the tanks. A second way to detect leaks is to use a lateral drywell. This is a drywell drilled horizontally underneath a tank where the radiation in the soil can be measured by a detection probe. A third way to detect leaks is to lower radiation probes into liquid observation wells inside the tank and measure the radiation as a way to identify the level of liquid. By comparing the current liquid level with the last recorded level, a large leak can be detected. Detecting leaks in SSTs is an imprecise activity. As all tanks continue to age, the number of leaking tanks will likely increase. Please refer to the response to Comment number 0005.37.

Comment Number 0072.71

CTUIR

Comment P 3-11: PP 5: Bullet 3: In the event of loss of institutional control, and the loss of the mixer pump in 101-SY, could the microcrystalline mat reform much stronger and thicker, resulting in greater entrapment of hydrogen and other flammable gases?

Response The loss of institutional control, as an assumed event, would result in the termination of continuing operations at the tank farms. The loss of institutional control would mean that the day-to-day activities concerned with management of the tank wastes would no longer continue. This would mean that the mitigative measures currently being applied to the tank wastes would no longer be performed including the use of the mixer pump in tank 101-SY. The tank would revert to its condition before the mixer pump was installed. Whether the sludge layer would reform much stronger and thicker is unknown; however, this possibility cannot be ruled out. A discussion of potential remediation and post-remediation accidents is contained in Volume One, Section 5.12 and Volume Three, Appendix E. Please also refer to the response to Comment numbers 0040.02 and 0040.03 for more information related to administrative controls and the response to Comment number 0072.80 for discussions of the reason and basis for assuming a 100-year administrative control period.

Hydrogen and other flammable gas deflagration accidents were analyzed in the EIS. For post-remediation accidents, an analysis of the flammable gas deflagration accident, among others, determined that a seismic event would result in bounding case accident conditions and therefore the post-remediation accident presented in Volume One, Section 5.12 is the seismic event.

Comment Number 0072.72

CTUIR

Comment P 3-13: PP 1: This is the first notation on complexing of tank waste, please include a discussion on exactly what is meant by complexing waste.

Response The subject discussion regarding the SIS EIS ROD is provided in the EIS to inform the reader of planned activities to address urgent safety or regulatory compliance issues. The discussion of complexed and noncomplexed waste with respect to tank 102-SY was presented in the SIS EIS (DOE 1995i). A definition of complexed and noncomplexed waste is also provided in the glossary of the TWRS EIS. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please also see the response to Comment number 0072.170 for more information about complexed waste.

Comment Number 0072.73

CTUIR

Comment P 3-13: PP 2: S 3: What part if any has the DOE done to insure that the affected tribes are involved and kept up to date with the transfer of responsibility, accountability, and liability?

Response The phased approach to implementation of the alternatives is discussed in Volume One, Section 3.3. Contracting strategy is not an issue addressed in the EIS. However, DOE recognizes the importance of maintaining an interactive relationship with the affected Tribes. Informal discussions as well as meaningful consultation and cooperation result in better understanding of important cleanup issues.

In the developing months of the privatization effort (Spring/Summer 1995), invitations were issued to the affected Tribes to present the initially envisioned concept. Letters and follow-up communiqués were issued to J.R. Wilkinson, Hanford Program, Confederated Tribes of the Umatilla Indian Reservation (CTUIR); Donna Powaukee, Environmental Restoration and Waste Management (ERWM) Manager, Nez Perce Tribe; and Russell Jim, Confederated Tribes and Bands of the Yakima Indian Nation. Of the invitations, only the Nez Perce requested and participated in a discussion of the project with a DOE representative and staff. Follow up correspondence addressing questions and concerns was issued August 1995.

Following issuance of the TWRS Request for Proposals (RFP) (February 1996), a request was made for a copy by Joseph H. Richards, Environmental Compliance Auditor, CTUIR on February 23. The following day, the document was forwarded to him.

Progress reports and status updates are routinely provided to the Hanford Advisory Board, which has Tribal representation. This is not to suggest that interactions with the Board substitutes, or may be conducted in lieu of, both formal and informal interactions with the Tribes. DOE encourages such interactions and welcomes opportunities to discuss important cleanup activities with the Tribes. An in-depth discussion of the Tribal consultation process for the TWRS EIS is presented in the response to Comment number 0072.252.

Comment Number 0072.74

CTUIR

Comment P 3-13: PP 2: S 7: The CTUIR agrees that the plan for privatization is subject to the final record of decision of the TWRS EIS.

Response The TWRS EIS ROD will document the decision for how to remediate the tank waste. DOE intent in preparing the schedules for the TWRS EIS and the award of Phase 1a contracts was to have the EIS ROD completed prior to the contract award. To ensure that the award of contract could proceed in the event of a schedule disruption to the EIS ROD, DOE clarified in the final RFP that action under the contract would be contingent on the outcome of the TWRS EIS ROD, a decision which would be considering other alternatives and, if chosen, might necessitate renegotiating or voiding the contract award.

DOE NEPA Implementing Procedures (10 CFR 1021) require DOE to "complete its NEPA review for each DOE proposal before making a decision on the proposal (e.g., normally in advance of, and for use in reaching, a decision to proceed with detailed design)" (10 CFR 1021.210 [b]). The November 1995 draft RFP indicates that Phase 1a is intended as a "development period to establish the technical, operations, regulatory, and financial elements required in privatized facilities." It is only in Phase 1b that the selected contractors will provide detailed, complete design, and be authorized to proceed with construction and operations. These circumstances and requirements comply with NEPA procedures that provide for submittal of environmental data and analysis by offerors and incorporation of an environmental synopsis of that data and analysis in any NEPA document prepared (10 CFR 1021.216 [h]), as long as the actions taken prior to beginning detailed design do not "have an adverse environmental impact" or "limit the choice of reasonable alternatives." Based on the planned Phase 1 approach of splitting the action into two subphases, DOE would be able to proceed with Phase 1a (conceptual design) prior to completion of the TWRS EIS ROD and be within the intent of NEPA. However, the TWRS EIS ROD would be required prior to the anticipated April 1998 award of Phase 1b contracts.

Comment Number 0072.80

CTUIR

Comment P 3-21/22: while it is acknowledged that NEPA requires that an EIS includes a no-action alternative, it should also be acknowledged that leaving leaking tanks violates several laws, regulations, and statutes. Also, no-action would not necessarily be a "continue the current waste 'management' program." It would more likely be a walk-away situation where institutional controls fail.

Response The No Action alternative would result in failure to comply with Federal and State laws and regulations. This information is presented in Volume One, Section 6.2 and in the Summary, Section S.7. EIS Sections S.7, 3.4, and 6.2 describe the Federal and State compliance issues applicable to the No Action alternative. DOE guidance on NEPA requires that EIS alternatives be addressed regardless of "conflict with lawfully established requirements" (DOE 1993d). DOE is required to identify the laws and regulations that apply to each alternative and indicate whether the alternative, if selected, would comply with applicable laws and regulations (40 CFR 1502.2d). Please refer to the response to Comment numbers 0093.02 and 0072.52.

Guidance on the implementation of NEPA Council on Environmental Quality (CEQ) Memorandum to Agencies: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations states the following.

Section 1502.14(d) requires the alternatives analysis in the EIS to "include the alternative of no action." There are two distinct interpretations of "no action" that must be considered, depending on the nature of the proposal being evaluated.

The first situation might involve an action such as updating a land management plan where ongoing programs initiated under existing legislation and regulations will continue, even as new plans are developed. In these cases "no action" is "no change" from current management direction or level of management intensity. To construct an alternative that is based on no management at all would be useless academic exercise. Therefore, the "no action" alternative may be thought of in terms of continuing with the present course of action until that action is changed.

In the case of the TWRS program, there is an ongoing program to safely manage the tank waste that would continue under any reasonable scenario for the 100-year administrative control period. For this EIS, no action is assumed to be no effort other than the safe management practices currently conducted. The "walk-away" alternative was not evaluated, because it would present an imminent danger to human health and the environment and would be a useless academic exercise.

Comment Number 0072.81

CTUIR

Comment P 3-24: last paragraph: exactly what does "enough waste would be remediated"? Does this mean that the characterization of the tanks, tank farms, intra-tank, tank mixtures, solubility mixtures would be done on a pilot scale in ten years on an order of magnitude to justify 1.6 billion dollars of set-aside moneys. Is this amount of money justified in terms of removal of tank waste, lowering of risk, characterization, and achieving Tri-Party Agreement milestones.

Response The referenced language means that a sufficient quantity of waste would be remediated during Phase 1 to prove that remediation would be effective for the entire remediation program. The sentence was modified in Volume One, Section 3.3 as follows for clarification. "A sufficient quantity of a variety of tank waste types would be processed to demonstrate the effectiveness of the process and to provide the necessary data to design a full-scale facility." Please refer to the response to Comment number 0005.38.

Comment Number 0072.168

CTUIR

Comment P A-1: Sect. A.2.1: It is appropriate to list the estimated radionuclide and non-radionuclide inventory for each tank or tank farm for comparison.

Response Please refer to the response to Comment numbers 0012.14 and 0072.07. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.169

CTUIR

Comment P B-8: What is actually in the miscellaneous underground storage tanks? The characteristics of an expected waste indicates a need for a comprehensive characterization, even if the total combined inventory of MUSTs volumes is less than one half of one percent of the total tank inventory.

Response Please refer to the response to Comment numbers 0012.14 and 0072.07 for issues related to tank waste characterization. Please also refer to Comment number 0072.99 for MUST content information. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.170

CTUIR

Comment P B-10: What are the characteristics of concentrated complexant waste?

Response Concentrated complexant waste is the concentrated aqueous raffinate from strontium-90 liquid-liquid extraction operations performed in the 1960's and 1970's. This waste is a component of the wastes in the AN and SY tank farms, although some is in the DSTs because of saltwell pumping. It is characterized by a high organic content including the complexants ethylenediaminetetraacetic acid (EDTA), citric acid, and hydroxyethylenediaminetriacetic acid (HEDTA).

Comment Number 0072.171

CTUIR

Comment P B-12: PP3: Please explain what is meant by 'have or may have' greater than 50,000 gal of drainable liquid.

Response The section describes the installation of liquid observation wells in the tanks. The criteria for installation is the presence, or suggested presence, of at least 50,000 gallons of drainable liquid. The criteria retains the provisional phrase 'have or may have' because the exact quantity of liquid remaining in the saltcake will not be known until the liquid has been removed and its volume is measured.

Comment Number 0072.172

CTUIR

Comment P B-12: PP4: How many and how often are radiation measurements taken in the drywells?

Response Radiation measurements taken in the drywells are included in the discussion of ongoing tank monitoring and maintenance activities and are one of the methods used to monitor for tank leaks in Volume One, Section 3.2 and Volume Two, Appendix B. Two drywells at two SSTs (tanks 241-C-105 and 241-C-106) are currently monitored monthly by gamma radiation sensors. The remaining tanks are monitored by the TWRS program periodically based on the need to detect potential new leaks and/or to document the extent and nature of past leaks.

Comment Number 0072.173

CTUIR

Comment P B-16: PP5: Please re-do this paragraph. It is confusing and could be better written. For example, the description of the majority of radioactive elements in the sludges needs to be expanded and an indication needs to be made whether the sludges are at the bottom of the tanks or elsewhere.

Response The referenced paragraph provides a generic description or overview of the waste in numerous tanks rather than in individual tanks. The three types of waste (i.e., liquid, sludges, and saltcake) are present in the individual tanks in varying combinations and proportions. For example, sludges may be located at the bottom of the tank, caked along the side of the tank, or both. Although there is a considerable amount of tank waste inventory available from process records and past sampling activities, this information is not considered adequate to characterize the waste in individual tanks. However, DOE is actively involved in an ongoing waste characterization program that is using waste sampling and analysis, in situ measurements, monitoring, surveillance, and waste behavior modeling to provide more detailed and accurate characterization data for the content of individual tanks. Current agreements among DOE, Ecology, and EPA require that all characterization reports be issued by September 1999. Volume Two, Sections A.2 and A.3 present additional information on the tank inventory data including the estimated radionuclide inventory for SSTs and DSTs, ongoing tank characterization programs, and tank inventory data accuracy and its effect on the EIS. Please refer to the response to Comment numbers 0012.14 and 0072.07. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.174

CTUIR

Comment P B-18: PP3: The statement, "upgrade the regulatory compliance status" implies that the DOE may not be in compliance even after they complete the SIS EIS activities.

Response In the context of the TWRS EIS alternatives, the referenced statement regarding the SIS EIS refers only to the compliance status of the cross-site transfer portion of TWRS. Installing the cross-site transfer pipeline would comply with applicable regulations whereas the existing cross-site transfer pipeline does not. It is DOE policy to conduct its operations in an environmentally safe and sound manner in compliance with applicable environmental statutes, regulations, standards, and the Tri-Party Agreement. Routine operations at the tank farms include monitoring and maintaining the regulatory status, and operations and maintenance of facilities and equipment. However, upgrading the regulatory compliance status as part of the process of placing the tank farms in a controlled, stable condition involves multiple and continuing activities, particularly as facilities age. The EIS addresses upgrades specific to the waste transfer system (Volume Two, Section B.3). The cross-site transfer system and upgrades under the TWRS EIS are actions identified in the Tri-Party Agreement Resource Conservation and Recovery Act (RCRA) compliance provisions. Volume One, Sections 1.1 and 3.2 provide additional information regarding how the SIS EIS and TWRS are interrelated. Volume One, Section 6.0 describes the statutory and regulatory requirements potentially applicable to TWRS.

Comment Number 0072.175

CTUIR

Comment P B-20: PP1: If the goal of privatization has a component that transfers a share of accountability and liability to industry, have the affected Tribes been properly notified and consulted regarding this? If so, when and with whom were the notifications and consultations addressed to?

Response Please refer to the response to Comment number 0072.73.

Comment Number 0072.176

CTUIR

Comment P B-20: PP2: Once again the statement "upgrade the regulatory compliance status" indicates that even after the current planned upgrades the tank farms may not be in compliance. The planned upgrades listed including instrumentation, ventilation, and electricity is supposed to place the tank farms in a controlled stable condition. Please bring forth a discussion on how these three upgrades will accomplish this.

Response DOE and Ecology acknowledge that even after the current planned upgrades, the tank farms may not be in full compliance. However the upgrades are required by the Tri-Party Agreement which is the RCRA enforcement agreement among DOE, Ecology, and EPA. The upgrades when completed along with other projects such as the saltwell pumping program will result in the attainment of controlled onsite conditions for the SSTs. Upgrades to the instrumentation, ventilation, and electrical systems are not included in the scope of this EIS; however, these activities are the subject of other NEPA documents. Please refer to the response to Comment number 0072.174. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0077.01

ODOE

Comment More than a million gallons of high-level wastes have already leaked from these tanks, threatening the aquifer and the groundwater. Plutonium and americium from one tank leak at Hanford have migrated over 100 feet through the soil and may have reached the groundwater. A third of the tanks have been placed on a "watch" list because of the danger of explosions.

Response DOE and Ecology concur the magnitude and complexity of the tank waste issues that constitute the purposes and need for the TWRS action. DOE must implement decisions to manage and dispose of tank waste to reduce existing and potential future risk to the public, Site workers, and the environment. The EIS includes an analysis of alternatives to manage and dispose of tank waste. The analysis of impacts includes potential impacts to groundwater in Volume One, Section 5.2 and Volume Four, Appendix F; remediation and post remediation health impacts in Volume One, Section 5.11 and Volume Three, Appendix D; and remediation and post-remediation accidents, including the risk of explosions, in Volume One, Section 5.11 and Volume Four, Appendix E. The cumulative impacts of past leaks and TWRS actions are presented in Volume One, Section 5.13. Please refer to the response to Comment numbers 0072.61 (estimates of tank volume thought not to have leaked), 0072.63 (leak volume thought to be cooling water) and 0072.67 (leak volume estimating methods) for more information about tank leaks. Current methods used to detect leaks are discussed in the response to Comment number 0072.70.

Comment Number 0089.10

Nez Perce Tribe ERWM

Comment Page A-13, Table A.2.1.2

The Table delineates the soluble and insoluble portions of chemical species. This information is useful, but it would be helpful to see a listing of the chemical compounds rather than just anions and cations listed separately. A better understanding of tank chemical processes is possible with a listing of chemical compounds.

Response DOE and Ecology concur that more complete knowledge of the tank contents, including the exact nature of the chemical compounds would be advantageous. At present, there is a program of tank characterization which, when completed, will provide greater depth of knowledge as to the contents of each tank. Because that program of characterization is not yet completed, estimates of tank components were used in the EIS. Information on the chemical compounds within the tanks is limited. The inventory estimate provided for use in the EIS (WHC 1995d) gives the chemical species in their ionic form. For purposes of assessing impacts from the release of the tank contents, the use of the ionic forms was sufficient. Please refer to the response to Comment numbers 0012.14 and 0072.07. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

L.3.2.2 Cesium and Strontium Capsules

No comments were submitted for this topic.

L.3.3 DEVELOPMENT OF ALTERNATIVES

L.3.3.1 Tank Waste

Comment Number 0005.17

Swanson, John L.

Comment The fact that tank closure is not included in the analysis seems to me to be a serious deficiency. The statement on S-15 that "Closure is not within the scope of this EIS because there is insufficient information available concerning the amount of contamination to be remediated." seems to me to be a cop-out. You go on to base the analysis that you do on an assumed 1 percent left in the tanks; data given on page S-7 indicate that 0.5 percent of the waste activity has been released or leaked to the ground. Isn't an estimate of 1.5 percent of the contamination to be remediated during closure sufficient information on which to base an analysis? (It is certainly as close an estimate as many of those used in the analyses that were done in this draft).

Response Closure is not within the scope of this EIS because information, such as the nature and extent of vadose zone and groundwater contamination to identify and analyze reasonable closure alternatives is insufficient to support an evaluation of closure alternatives. The Notice of Intent to prepare the TWRS EIS stated, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future" (59 FR 4052). However, some of the decisions to be made concerning how to dispose of tank waste may impact future decisions on closure, so the EIS provides information on how tank waste remediation and closure are interrelated. A single and consistent method of closure was assumed for all alternatives to allow for a meaningful comparison of the alternatives. The closure method used for purposes of analysis was closure as a landfill, which includes filling the tanks and placing an earthen surface barrier over the tanks after remediation is complete. For a discussion of how closure was addressed within the EIS, see Volume One, Section 3.3.

Specific and detailed information on the distribution of contaminants from tank leaks and past practice activities is not available in sufficient detail to provide a meaningful comparison of impacts. When sufficient information is available to evaluate the closure options, DOE will submit a final closure plan to Ecology for review and approval, and an appropriate NEPA analysis will be completed. An extensive discussion of closure and issues related to closure is presented in Comment number 0072.08.

Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0005.18

Swanson, John L.

Comment The assumptions of a) 1 percent of the contaminants (including the water soluble ones) left in the tanks and b) no attempt to immobilize this residual, lead to a lack of discrimination risk is dominated (by a factor of 100) by the risk of the non-immobilized 1 percent assumed to be left in the tanks. This is a classic case of "assumption driving the conclusion." For the purposes of this EIS, wouldn't it be better to assume a closure approach that would allow differences in the considered alternatives to apparent? It would be strange to me if the same "public" that drove out grout as a LLW form because of perceived contaminant release problems would be willing to accept a situation where the overall release is 100 times greater than that from their preferred waste form because something was not done to immobilize the waste left in the tanks (or to rinse out more than 99 percent of the water-soluble contaminants).

Response As stated in Volume One, Section 3.4, the calculations in the EIS are based on the assumption that the waste residual would be composed of the average tank contents, which is a very conservative assumption because the liquids used to retrieve the waste would remove a high percentage of water-soluble contaminants. The water-soluble contaminants are those that contribute to long-term risks because they can be transported over the long term into the groundwater. In response to the issue raised in this comment and others, calculations have been performed and presented in the Final EIS based on a less conservative content of the residuals where most of the water-soluble contaminants are removed. This provides both a bounding and nominal calculation of risks and provides the public and decision makers with greater information concerning long-term risks. This new information is contained in Section 3.4, 5.2 and Appendix F of the Final EIS. For more information regarding closure assumptions and how closure was addressed in the EIS, please refer to the response to Comment numbers 0005.17 and 0072.08 and Volume One, Section 3.3.

Comment Number 0005.26

Swanson, John L.

Comment Page A-7 contains a statement that conservative values of distribution coefficients"--would ensure that travel times of contaminants were at the upper bound--." Shouldn't that be LOWER bound?

Response The distribution coefficient is defined in such a manner that the constituents with the lowest distribution coefficients are those that travel with a greater velocity. The higher the distribution coefficient, the greater the resistance to movement. Therefore, the text is correct as written.

Comment Number 0005.38

Swanson, John L.

Comment At the bottom of page 3-24 and top of page 3-25, it is said that the Phased Implementation approach Phase 1 would remediate enough waste to prove that the many waste types in the tanks could be remediated effectively. This sounds good, but for it to be true you must have a different Phase 1 in mind that the Privatization Phase 1, which will prove essentially nothing about the pretreatment of SST sludges. (On page 3-92 I find "The waste processed during Phase 1 COULD (emphasis added) also include selected SST waste." This is a much different slant than the statement on page 3-24,-25).

Response The referenced text in Volume One, Section 3.3 has been revised to be less encompassing. It is DOE's intent to process enough different feedstocks (e.g., waste types and compositions) during Phase 1 to demonstrate the treatment processes before implementing Phase 2. Different feedstocks processed during Phase 1 would be expected to demonstrate maximum facility thruput, treatment of high cesium level waste, and treatment of organically complexed TRU and Strontium-90 waste. It is believed that by treating the different waste feedstocks identified during Phase 1, the majority of the waste types present in the tanks, including the SST sludges, would be adequately demonstrated to proceed with Phase 2. As explained in Volume One, Section 3.3, the contracting strategy known as privatization is not within the scope of the EIS. Please refer to the response to Comment number 0072.81.

Comment Number 0022.02

Sims, Lynn

Comment In terms of all human history we are treading on unchartered ground. Here we are confronted with a terrible cold war legacy which threatens our lives and environment. We are engaged in a monumentally serious and expensive undertaking which projects itself far into the future. Our current technology is not totally adequate, but we are morally obligated to do the very best we can NOW and not pass this dilemma to future generations.

We do know we are in this situation because of poor management and inadequate long-term planning during the production years. We do not wish to repeat these mistakes and impose disastrous results upon future generations by shortcomings in clean up decision making now.

Response The magnitude and potential impact of the tank waste are among the most extensive of the Cold War legacies. Moreover, the type and volume of waste and the scale of the technologies required for retrieval, treatment, and disposal are unprecedented. The waste poses substantial potential risks to human health and the environment. The costs for implementing any of the alternatives are substantial, and all alternatives would involve tasks that would continue for many years into the future.

It is for these reasons, among others, the Federal agencies are required to complete an EIS before decisions are made and before actions are taken. This allows decision makers and the public to be aware of the potential environmental consequences of the proposed action and ways to mitigate those impacts and for the public to be involved in decisions that affect the quality of the human environment.

Comment Number 0072.05

CTUIR

Comment The idea of NEPA is to identify and assess the full range of available options and technologies to address an issue -- in this case, the safe, effective, and protective treatment and disposition of dangerous Hanford high-level radioactive and hazardous mixed tank wastes. The current TWRS-EIS focuses only on retrieval of wastes and the explicit thermal treatment option of vitrification. Moreover, although 'closure' is not within the scope of the TWRS-EIS, a number of identified alternatives and considerable discussion throughout the EIS either pre-determine or limit ultimate closure options. The CTUIR SSRP, as a result of their interactions with other federal agencies, have noted that other potentially applicable technologies for tank waste treatment exist. A more broad range of applicable and feasible alternative treatment/disposal technologies needs to be systematically assessed with our consultation.

Additionally, NEPA requires a thorough scoping and assessment of key issues, a systematic set of screening or decision criteria, and a comprehensive consideration of a range of technological (or other) approaches to reach the desired endstate. The current TWRS-EIS examines only a limited set of treatment/disposal options and therefore cannot possibly compare the full spectrum of risks, costs, and benefits of alternative treatment/disposal options.

The Tank Waste Task Force (TWTF) identified that a "portfolio" of options for tank waste treatment and disposition should actively be explored, analyzed, and maintained for contingency planning purposes. The sheer complexity, diversity, and volume of Hanford tank wastes should intuitively mandate such an option-as-necessary-and-available approach.

Response A wide range of potentially applicable technologies exists for treating tank waste. One challenge was to eliminate from consideration technologies that were not viable and develop a range of reasonable alternatives for detailed analysis and presentation in the TWRS EIS. This discussion describes how the alternatives were developed.

There is a distinction between technologies and alternatives. Technologies are specific processes (e.g., cesium ion exchange) that relate to a component (e.g., retrieval or treatment) of an alternative. Alternatives include a set of technologies, or building blocks, that have been engineered to work together, forming complete systems for accomplishing the purpose and need for action. Alternatives are made up of a number of technologies linked together.

The evaluation of potential technologies for inclusion in the TWRS EIS began with a review of available technologies from a variety of sources including the Tank Waste Technical Options Report (Boomer et al. 1993), the Tri-Party Agreement (Ecology et al. 1994), Hanford Defense Waste EIS (DOE 1987), and the engineering data packages prepared by the Site Management and Operations contractor (WHC 1995a, c, e, f, g, h, i, j, and h).

The first step in developing alternatives was to screen out technologies that were not viable. The full range of available technologies for each component of the proposed action was evaluated, and technologies that were not viable were eliminated from further consideration. The technologies eliminated by this screening process are described in Volume One, Section 3.8 and Volume Two, Appendix C.

After rejecting technologies that were not viable, a large number of potential technologies remained for inclusion in the EIS. It would not be practicable to develop alternatives that include all of the potential combinations of technologies. In accordance with NEPA, representative alternatives were developed for detailed analysis to bound the full range of reasonable alternatives (DOE 1993d). Upper, lower, and intermediate bounding alternatives were developed in terms of cost, risk, and technologies for the two primary decisions that affect environmental impacts: the amount of waste to be retrieved from the tanks and the degree of separations of retrieved waste into HLW and LAW. The full range of applicable technologies and alternatives therefore is included in the EIS.

Similar to the approach used by the Tank Waste Task Force, representative alternatives were developed for detailed analysis in the EIS. There are many other viable technologies for individual components of the alternatives that could not be included. These technologies are included in Volume Two, Appendix B and constitute the "portfolio" of options that could be substituted for one of the technologies that is included in an alternative without a substantial change in the impacts of that alternative. An evaluation was performed for each of the technologies identified in Appendix B. Where there would be changes in impacts, the changes are discussed in Appendix B. The level of analysis was dependent on the magnitude of the change on impacts.

The alternatives developed for presentation in the EIS were chosen to be representative of many of the possible variations of the alternative. The design information for all alternatives is at an early planning stage, and the details of the alternative that ultimately is selected and implemented may change as the design process matures. Therefore, the alternatives are intended to represent an overall plan for remediation at a level of detail sufficient for impact analysis and alternative comparisons.

DOE and Ecology are not aware of any other viable technology EIS for tank waste treatment. Please refer to the response to Comment numbers 0005.17 and 0072.08 for a discussion of the reasons closure was not addressed in the EIS.

Comment Number 0072.08

CTUIR

Comment The second major deficient factor is closure, both of waste treatment/disposal facilities and the tank farms themselves. The resolution of the tank waste issues are complex, time-transgressive, and fundamentally impact life-cycle costs. Closure issues, while not within the scope of this EIS, are essential to comprehensive planning for both waste retrieval and treatment from the tank farms. Additionally, closure will significantly impact long-term waste management and land consumption requirements on Hanford's Central Plateau -- a directly connected action which must be specifically assessed and coordinated with the CTUIR SSRP. A specific and incremental plan must be developed to accomplish safe and effective long-term waste management, and this necessarily requires a known endstate goal.

Response The final disposition of the tanks and associated equipment and the remediation of contaminated soil and groundwater associated with leaks from the tanks is a process called closure. Closure is not within the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. The amount and type of waste that ultimately remains in the tanks after remediation may also affect closure decisions. The Notice of Intent to prepare the TWRS EIS stated that: "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS to support tank closure, in the future (59 FR 4052)." However, some of the decisions made concerning how to treat and dispose of tank waste may impact future decisions on closure, so the tank waste alternatives provide information on how tank waste remediation and closure are interrelated. Closure options and assumptions are discussed in Volume One, Section 3.3.1 of the EIS.

Under the Tri-Party Agreement, the tanks are classified as hazardous waste management units that eventually would be closed under the State Dangerous Waste Regulations (WAC 173-303) and the requirements of the Tri-Party Agreement. Three options exist for closure of the tanks. The first option is clean closure, which would involve the removal of all contaminants from the tanks and associated equipment, soil, and groundwater until natural background levels or health-based standards are achieved. The second option is modified closure, which would involve a variety of closure methods and would require periodic (at least once after 5 years) assessments to determine if the modified closure requirements were met. If modified closure requirements were not being met, additional remediation would be performed. Modified closure is a method specific to the Hanford Site Permit under the State Dangerous Waste Regulations (WAC 173-303). The third option is closure as a landfill, which would involve leaving some waste in place with corrective action taken for contaminated soil and groundwater performed under postclosure requirements. This type of closure usually involves the construction of a low permeability cover over the contaminated media to reduce water infiltration and prevent inadvertent human intrusion. When sufficient information is available to evaluate the closure options, DOE will submit a final closure plan to Ecology for review and approval and an appropriate NEPA analysis will be completed.

Although sufficient information is not available to make final decisions on closure, some of the alternatives affect future closure decisions, so information is provided to allow the public and decision makers to understand how the alternatives would be interrelated with future closure of the tank farm system. For example, some of the alternatives addressed in the EIS involve removing most of the waste from the tanks (the ex situ alternatives) and would not substantially affect options for future closure decisions. Conversely, some of the alternatives do not involve removing the waste from the tanks (the in situ alternatives) but rather, would treat and dispose of the waste in the tanks. These alternatives include placing a low permeability cover over the tank farms to reduce water infiltration and prevent inadvertent human intrusion (e.g., Hanford Barrier). This would be considered closure as a landfill. Clean closure would be precluded by implementing one of the in situ alternatives. However, this would not address remediation of the soil and groundwater previously contaminated, so it would not represent complete closure of the tank farms. Therefore, the in situ alternatives would preclude clean closure of the tanks. The ex situ alternatives would not preclude any closure alternative. The decisions on closure will be made in the future when sufficient information is available.

For purposes of comparing the alternatives, a single and consistent method of closure was assumed for all of the alternatives. Closure as a landfill was chosen as the representative closure method for purposes of analysis and is included in all of the alternatives (except the No Action and Long-Term Management alternatives). This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. It is included to allow a meaningful comparison of the in situ and ex situ alternatives and to provide information to the public and the decision makers of the total cost and impacts of final restoration of the Site.

Because decisions on closure cannot be made at this time but are interrelated with decisions to be made on remediation of the tank waste, the EIS presents an analysis of impacts with and without closure in Section 5.0. In each applicable subsection of Section 5.0, the impacts of the activities associated with remediating the waste are presented first. This is followed by the presentation of the combined impacts of remediating the tank waste and closing the tank farms by closure as a landfill. This provides the public and the decision makers with information on the impacts of the issues that are ripe for decision making (remediation of the tank waste) and information on the total project impacts (remediation and closure) as well as how they may be interrelated with the decisions on remediation of the tank waste.

A comprehensive land-use plan (CLUP) is being developed for the Hanford Site, and another NEPA analysis will be prepared on the tank farm closure. The CTUIR will be consulted during the preparation of both documents.

Comment Number 0072.50

CTUIR

Comment It is not clear whether any of the alternatives will allow clean closure, and none of the alternatives include removal of tanks (or support structures).

Response Please refer to Comment number 0072.08 for a discussion of the relationship between the TWRS EIS and future closure decisions. Selection of the No Action, Long-Term Management, In Situ Fill and Cap, In Situ Vitrification (ISV), or Ex Situ/In Situ Combination alternatives would preclude clean closure. The extensive retrieval alternatives would not preclude any closure option. The discussion of closure in Volume One, Section 3.3 was modified to identify which alternatives would preclude clean closure.

Comment Number 0072.51

CTUIR

Comment There is an ongoing problem with failure to define retrieval and closure goals before retrieval is begun. At present, the action plan is to attempt retrieval, and then determine how well we did and therefore whether the tank farms will be closed as a landfill or clean closed.

Response DOE has plans to perform retrieval tests. The project is called The Hanford Tank Initiative and is discussed in Volume One, Section 3.2 of the Final EIS. The information gained from this program will provide data on the effectiveness of a variety of retrieval techniques. The waste retrieval goal is discussed in Volume One, Section 3.4 of the EIS. Please refer to the response to Comment number 0072.08 for a discussion of the relationship between NEPA requirements, the TWRS EIS alternatives, and closure. If an ex situ alternative is selected, the success of retrieval would be a factor in determining the type of closure performed.

Comment Number 0072.75

CTUIR

Comment P 3-18: PP 6: Because closure is not in the scope of this EIS, the CTUIR feels that this EIS is incomplete and actions to correct this should be taken, for example, by designing how a closure plan should be incorporated into this EIS.

Response Please refer to the response Comment number 0005.18 for a discussion of the reasons why tank farm closure alternatives cannot be analyzed at this time. The response to Comment number 0072.08 discusses the relationship between this EIS and future closure options. This response contains a discussion of the relationship between NEPA requirements, the tank waste remedial alternatives

evaluated, and related closure issues. DOE, in the Notice of Intent to propose this TWRS EIS, has committed to complete the appropriate NEPA analysis when data become available to support the analysis. The Tri-Party Agreement contains milestones relative to the preparation and approval of a closure plan for the SSTs.

Comment Number 0072.76

CTUIR

Comment P 3-20: PP 1: The CTUIR SSRP technical staff states that anything less than clean closure would result in excess risk to tribal members.

Response DOE and Ecology acknowledge the preference expressed in the comment and will consider this and other concerns when selecting the final action for TWRS waste. Closure will be addressed in a future NEPA analysis when sufficient data are available to provide a meaningful comparison of closure alternatives. Please refer to the response to Comment numbers 0072.08 and 0072.50.

Comment Number 0072.77

CTUIR

Comment P 3-20: PP 2: For the purposes of comparing the alternatives and as not to preclude ruling out any closure alternatives, the clean closure is, should, and will be replaced in all the following alternatives sections. Additionally it is impossible to do a meaningful comparison between in situ and ex situ alternatives.

Response Tank farm closure was presented in the EIS as a hypothetical closure scenario to demonstrate the relationship between remediation and closure to the public and the decision makers and so in situ and ex situ alternatives could be equitably compared. Using closure as a landfill as the hypothetical closure scenario does not mean that it has been or will be selected for implementation. Tank farm closure will be addressed in a future NEPA analysis when sufficient data are available to provide a meaningful comparison of closure alternatives. Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives are not appropriate for inclusion in the EIS.

Comment Number 0072.78

CTUIR

Comment P 3-20: PP 3: S 4 : Environmental restoration, waste management, and remediation together which define clean-up have been and are ripe for tank farm decision making. You can not separate a removal process from a closure process and plan for privatization without truly considering the future. This process has to be fair, open, meaningful and involve the complete integration of the affected tribes in order to insure true tank farm closure.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives are not appropriate for inclusion in the EIS. Volume One, Section 5.13 of the EIS presents an analysis of the cumulative effects of tank farm remediation and other projects at the Hanford Site. Section 5.13 has been updated to include emerging information concerning the environmental remediation program.

Comment Number 0072.79

CTUIR

Comment P 3-21: PP 4: S 2: Why is it not practical to compare the potential acceptable technologies with the alternatives considering the time and effort used to produce this document? It would seem at the very least to be a reasonable thing to do. If you could not include all of the potential combinations of technologies, how can a reader be sure you have included a full range of applicable technologies?

Response In accordance with the regulations (40 CFR 1500 to 1508) that implement NEPA, the full range of reasonable alternatives were developed and analyzed in the EIS. All other viable technologies and their impacts were also addressed in Volume Two, Appendix B. The purpose of the TWRS EIS was to evaluate reasonable methods or processes (i.e., alternatives) of removing, treating, and disposing of tank waste at the Hanford Site. Including all of the potential combinations of technologies in full alternatives would result in dozens of alternatives to be addressed in the EIS. This would be unmanageable and confusing to the public and the decision makers. Specific removal, treatment, and disposal technologies will be evaluated during the detailed design phase following approval of the Final EIS. Selected technologies will be tested against specific effectiveness and efficiency criteria during the Phase I demonstration (preferred alternative). Please also refer to the response to Comment number 0072.05 and Volume One, Section 3.3 for a detailed explanation of the process used to determine the range of technologies to include in the evaluation.

The Draft EIS addressed the full range of reasonable alternatives. The alternative identified in the comment (i.e., evaluate all potential technologies) is bounded by the alternatives addressed in the Draft EIS, and therefore, DOE and Ecology believe that including the analysis of all the potential combinations of technologies would not provide valuable additional information to the public or decision makers.

Comment Number 0072.177

CTUIR

Comment P B-29: PP2: The in situ alternative may be required by NEPA, but it violates the Tri-Party Agreement. Please insert language regarding this with all in situ alternatives for clarification purposes.

Response The in situ alternatives would not meet the requirements of the Tri-Party Agreement. The Summary, Section S.7 and Volume One, Section 6.2 discuss whether the alternatives meet all applicable laws, regulations, and agreements (including the Tri-Party Agreement). As required by CEQ, the TWRS Draft EIS identifies and analyzes the range of reasonable alternatives for the proposed action. Potential violation of existing laws, regulations, or agreements (any of which may be revised) is not considered basis for eliminating an otherwise reasonable alternative from consideration. Please refer to the response to Comment numbers 0072.80 and 0072.52.

Comment Number 0089.07

Nez Perce Tribe ERWM

Comment Page 3-32, Paragraph 1

The EIS assumed that 99 percent recovery of the tank wastes would be achieved. The remaining 1 percent of tank waste volume left in the tanks will leave a sizable volume of contamination in the tanks to continue to contaminate the vadose zone and groundwater. Future tank closure and soil remediation will not be possible without removal of all tank wastes.

Response The residual waste would likely contain a very low concentration of soluble contaminants because the large volume of liquids used to retrieve the waste would leach the soluble contaminants from the residual waste. The Final EIS presents human health risks based on two scenarios: 1) that the residual waste would contain the average tank contents; and 2) that the residual waste would have been leached to reduce the concentration of soluble contaminants that could be leached into the groundwater. Closure of the tank farms is not within the scope of the EIS. Please refer to the response to Comment number 0072.08 for a discussion of the reasons why closure of the tank farms will be addressed in a future NEPA analysis and 0005.18 for a discussion of the waste retrieval assumption.

Comment Number 0094.01

Moore, Jennifer

Comment I just want to say the thing I find the most disturbing about this EIS, well one of the things I find the most disturbing about this EIS, is the fact that they list not one, not two, but quite a few alternatives which violate the Tri-Party Agreement and other laws and standards. We are dealing with a ... laws which were put so that the public would be protected and that this clean up would keep going at a standard that eventually can ensure that people can live around this area and use the drinking water and basically not live in fear of dying of fatal cancer from being exposed to nuclear waste. The fact the Department of Energy is listing these as viable alternatives, viable options indicates that they do not seem to take the public safety into account very much and somewhat see themselves as above the law which they themselves entered into.

Response The NEPA regulations (40 CFR Parts 1500 to 1508 and 10 CFR 1021) require DOE to evaluate reasonable alternatives even if they do not comply with laws and regulations, so it was necessary to include such alternatives in the EIS. The response to Comment number 0072.80 contains an extensive explanation of NEPA requirements and the criteria used in this EIS to analyze the tank waste alternatives. Please refer to the response to Comment number 0072.05 and Volume One, Section 3.3 for a discussion of how DOE and Ecology identified the alternatives to be analyzed in the EIS. DOE and Ecology's preferred alternative would meet all applicable laws and regulations. Please also refer to the response to Comment numbers 0072.52 and 0072.177.

Comment Number 0097.01

Perry, Henry

Comment Considering that the DOE is representing us, the public, and is playing with more than fire in this situation with the possibility of placing the environment of the entire Pacific Northwest at risk, can there be any question that the EIS, that it prepares, should be prepared on the basis of the worst-case scenario and certainly in accordance with the Tri-Party Agreement previously agreed to.

Response The EIS presents a bounding analysis of the reasonable alternatives. Conservative assumptions and calculation methods are used to provide the public and decision makers with an assessment of the reasonable upper limit of the potential impacts of each alternative if implemented. These assumptions and calculation methods are fully presented in the appendices. The preferred alternative is in full accordance with the Tri-Party Agreement, and in the EIS, the Summary and Volume One, Section 6.2 identify regulatory compliance issues for each alternative. The regulations (40 CFR 1500 to 1508) which implement NEPA and other NEPA implementation guidance discourage the use of "worst case" analyses because these scenarios become unrealistic and blur the differences in impacts between alternatives. The EIS was modified to include an expanded consideration of uncertainties associated with the assumptions and analysis of environmental and human health impacts. The information is presented in Volume Five, Appendix K.

Comment Number 0098.02

Pollet, Gerald

Comment Secondly, in regards to the cost issues, the EIS should clearly compare the cost of the Phased Implementation Tri-Party Agreement path against the risks and costs of the prior Tri-Party Agreement path that were in place for a short period of time before 1994. Under the prior Tri-Party Agreement path, we would retrieve and process approximately twice as much waste by the year 2010 as we will under so-called Phased Implementation. As part of that clear analysis and depiction, the State and the U.S. Department of Energy owe the public and decision makers a clear presentation of the risk each year from delay. In other words, every year you leave more waste in a tank, you have a set of risks. That is why we are hear tonight. You can not deny it. That is ... we all agree that is why we are here. So the question is, does the public deserve to see what is the risk every year from delay. What is the risk from going forward with a path that the General Accounting Office has said may fail. That the State has said is likely to fail. Because of the Department of Energy's contracting decisions which are outside scope of this EIS, but the risks of failure are in the scope of this EIS and need to be disclosed because decision makers for the next decade sitting

3,000 miles away or in the State capital are going to look at this EIS and say, Ah, the risk of another change in the Tri-Party Agreement and another delay in vitrification of 2, 3, 4, 5, 10 years is not so great and we can not let them say that the risks are not so great.

Response The costs of the prior Tri-Party Agreement path are shown in the EIS as the Ex Situ Intermediate Separations alternative costs and the costs of the revised Tri-Party Agreement path are shown as the Phased Implementation alternative costs (without any adjustments for privatization). This information is presented in Volume One, Section 3.4 and Volume Two, Appendix B.

The Phased Implementation alternative would result in less waste being treated during the first 10 years of the project but also would result in all of the waste being treated 4 years earlier than previously required. These two factors would offset each other in terms of releases to the vadose zone before treatment. In any case, the leaks prior to completion are expected to be greatly reduced by the salt-well pumping program, which is currently underway. The Phased Implementation alternative also would decrease the potential for construction of a facility that does not function effectively and thereby reduce the potential for long program delays.

Comment Number 0101.06

Yakama Indian Nation

Comment Invalid Constraints on Scope of EIS Reflecting Lack of Systems Engineering Integration -- The lack of consideration of the impacts associated with the closure of the tank farms following removal of the bulk of the wastes and remediation of the hazardous vadose zone around the tanks is unreasonable, since an integrated systems approach to develop low impact alternatives for tank waste retrieval and tank farm decontamination and decommissioning is warranted to save financial resources and reduce worker exposure. For example, actions required to remediate vadose zones at the tank farms as part of the closure actions may greatly simplify tank waste retrieval actions, reducing costs and expediting retrieval. Cumulative impacts can only be attained when related/integrated actions are evaluated.

Response DOE and Ecology believe that there is sufficient information available to analyze alternatives for remediation of the tank waste even though a number of uncertainties exist for various aspects of the action. These uncertainties are identified in the EIS. DOE is implementing a systems engineering approach to remediation of the tank waste. The integration of tank waste remediation with tank farm closure has been difficult because there is insufficient information available on contamination in the vadose zone and past practice releases. The Notice of Intent to prepare this EIS stated that, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS to support closure, in the future" (59 FR 4052).

There is a relationship between closure and tank waste remediation because certain alternatives for tank waste remediation would preclude clean closure of the tank farms. This relationship was discussed in the Draft EIS in Volume One, Section 3.3 on pages 3-18 to 3-20. In addition, a representative closure option, closure as a landfill, was included in all of the remediation alternatives to demonstrate the relationship of closure to remediation and to allow an equitable comparison of the alternatives. This does not mean that closure as a landfill will be selected as the closure alternative, but it provides an assessment of the total potential impacts for the environment. Consistent with NEPA regulations (40 CFR 1500 to 1508), the EIS has been prepared with the most current available information.

The emerging information concerning contamination in the vadose zone was mentioned in the Draft EIS in Volume One, Section 3.4, and the Final EIS has been modified to address the data, as appropriate, in Volume One, Section 4.2 and Volume Five, Appendix K. A systems engineering approach also will be taken to the development of data and engineering when DOE performs a NEPA analysis for closure.

L.3.3.2 Cesium and Strontium Capsules

No comments were submitted for this topic.

L.3.4 TANK WASTE ALTERNATIVES

L.3.4.1 Preferences for Tank Waste Alternatives

L.3.4.1.1 Specific Preferences

Comment Number 0008.06

Evett, Donald E.

Comment I consider the No Action and Long-Term Management alternatives to be unsuitable for consideration. I believe the impact study reveals significant rationale making this alternative too high of a risk, especially for many years into the future.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please also refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives, and the response to Comment number 0072.80 for issues related to the CEQ, NEPA and the 100-year administrative control period.

Comment Number 0009.07

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) has acceptable risks to workers and offsite public. The other alternatives do not have a significant reduction in fatalities. (About 75 in 10,000 years.) It should be kept in mind that even though statistics indicate a certain level of health effects will be experienced, Hanford will continue to reduce them. The current safety record of Hanford is much better than the national average. We must assume that the good record will continue, and in fact, we must ensure it.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. As noted, the Hanford Site does have a safety record that exceeds the national average, and DOE is committed to continuing improvement of its safety performances. Please refer to Volume One, Section 5.12 and Volume Four, Appendix E, which discuss accident risk during and after remediation. Please also refer to the response to Comment number 0009.06.

Comment Number 0009.08

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) is one of the lowest cost to perform. In addition, it minimizes repository costs. We do not know what the repository costs will be, but it is unlikely that they will be lower than the current estimates.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. A discussion of factors influencing the evaluation of alternatives is provided in the Summary (Section S.6), a comparison among the alternatives is provided in the Summary (Section S.7), and a summary of the environmental impacts is presented in Volume One, Section 5.14.

A reevaluation of repository costs, which accounted for the use of larger canisters in the geologic repository, led to a reduction in repository costs for some alternatives. These revised costs have been presented in the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B. The response to Comment numbers 0081.02, 0004.01, and 0008.01 extensively discuss the issues related to repository costs.

Comment Number 0009.09

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will have the facilities constructed by 2007. This is faster than most of the alternatives. Speed is very important because it seems that Hanford, as time goes on loses its concentration and wants to do something else. The number of canceled projects is very large, and very expensive.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of project completion is but one of many factors that influence the evaluation of alternatives. Other factors analyzed include short- and long-term risk to human health and the environment, technical uncertainty, cost, and regulatory compliance. Please refer to the response to Comment numbers 0009.08 and 0009.10.

Comment Number 0009.11

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) does not meet all of the regulations; however, they can be negotiated to be modified to assure that the public is adequately protected. The Tri-Party Agreement is a good place to document the negotiations.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The ability of the alternatives analyzed in the EIS to comply with Federal and State regulations is presented in the Summary (Section S.7) and discussed in detail in Volume One, Section 5.7.

Comment Number 0009.16

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the cost (for the Preferred Alternative) is not the lowest that provides adequate protection of the public.

Response DOE and Ecology acknowledge the objection to selection of the Phased Implementation alternative as the preferred alternative, and this comment and other public comments will be taken into consideration when making a final decision on remediating TWRS waste. Please refer to the response to Comment number 0009.15. As discussed in the Summary (Section S.6), there are a number of factors that influence the evaluation of the alternatives. Cost was one factor analyzed for each alternative. The results of the impacts analysis are presented in the EIS in an objective, nonvalue-laden (e.g., less or more cost is preferable) manner for careful consideration by the public and decision makers. Cost comparison of the alternatives was never conducted in the absence of all other factors, which included risk to human health and the environment, long-term land use restrictions, and regulatory compliance. Furthermore, for the final EIS cost impacts associated with HLW storage at the proposed geologic repository have been presented separate from costs associated with the waste management, retrieval, treatment, and disposal or disposal onsite. For example in comparing the Ex Situ/In Situ Combination 1 alternative to the Phased Implementation alternative, the cost of long-term land use restrictions and risk to human health and the environment, as well as cost, monetary or other, of not complying with current regulatory requirements were analyzed equally. Please refer to the response to Comment number 0081.02 for discussions of cost issues related to the alternatives.

Miscellaneous Preferences

Comment Number 0001.01

Bell, Robert C.

Comment There currently exists containment technology that could completely seal off the leaking nuclear contaminants from migrating through the earth and contaminating the groundwater. However, it appears that no monies have been budgeted for the containment of the leaking nuclear waste. By containing the leaking storage tanks the public along with all life would be protected from the most toxic and deadly nuclear waste. I urge you to actively support the request to the United States Congress for funds to pay for the containment of the leaking tanks at Hanford.

Response Subsurface barriers are addressed in the EIS as a containment technology that could be applied to control tank leakage. The function of the subsurface barriers would be to prevent leakage of tank waste from migrating beyond the barrier into the vadose zone, which would help minimize the volume of contaminated soil. The possible use of subsurface barriers was derived from concerns about using hydraulic sluicing for retrieval, and because some of the SSTs either are confirmed or assumed leakers. Also, a study titled Feasibility Study of Tank Leakage Mitigation Using Subsurface Barrier (Treat et al. 1995) was completed in support of a Tri-Party Agreement milestone and was one of the references used during preparation of this EIS. The feasibility study assessed the application of existing

subsurface barrier technologies and the potential of existing technologies to meet functional requirements for SST waste storage and retrieval activities. Information on subsurface barriers is included in Volume Two, Section B.9.

In addition, the current TWRS program involves a wide variety of ongoing activities that include monitoring the integrity of tanks and characterizing the vadose zone around the tank farms to detect leaks. DOE also conducts numerous activities to provide continued safe storage of the tank waste, such as the saltwell pumping program, which involves removing retrievable liquids from SSTs to minimize potential future leaks. These ongoing programs are described in Volume One, Section 3.2.

This EIS addresses the full range of reasonable alternatives. This includes 10 tank waste alternatives ranging from no action to extensive retrieval. Risk to human health and the environment was among the factors considered by DOE and Ecology in identifying the preferred alternative, Phased Implementation (a discussion of factors that influence the evaluation of alternatives is presented in the Summary, Section S.6). Volume One, Section 5.13 (Cumulative Impacts) addresses actions at other DOE sites, programmatic actions, and actions at the Hanford Site that could impact the TWRS actions, including the Hanford Remedial Action Program. The proposed TWRS activities would be carried out against the baseline of overall Hanford Site operations. Volume One, Section 5.11 and Volume Three, Appendix D detail the anticipated risk for each alternative.

DOE and Ecology acknowledge the recommendation expressed in the comment regarding funding. However, Congressional funding issues are not included in the scope of this EIS.

Comment Number 0040.01

Rogers, Gordon J.

Comment The In Situ Fill and Cap alternative is clearly the best choice. The cost is low enough to have some real chance of being funded by Congress. It reaches a reasonable stage of completion in the shortest time. The short-term impacts are trivial. The long-term impacts appear likely to be small and acceptable providing that onsite use of groundwater is prohibited; and further than onsite farming and irrigation is prohibited.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Short- and long-term environmental impacts, uncertainties, and regulatory compliance are among the factors influencing the evaluation of alternatives. A discussion of these and other factors influencing the evaluation of alternatives is provided in the Summary, Section S.6, a comparison among the alternatives is presented in the Summary, Section S.7, and a summary of environmental impacts is provided in Volume One, Section 5.14.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, although Congressional funding issues associated with implementation of the alternatives were not included in the scope of the EIS. Please refer to the discussion contained in the response to cost concerns related to a comparison of the alternatives contained in Comment number 0081.02.

Comment Number 0072.11

CTUIR

Comment Of the alternatives presented, the CTUIR SSRP technical staff prefers Ex Situ with Extensive Separations because the cost is comparable, the volume of waste is comparable, the technical uncertainty is no higher than the other ex situ alternatives, and the activity of the LAW would be substantially lower than with less extensive separations. The phased approach will not be practical since substantially more land is required for two sets of vitrification facilities rather than the one set required for the non-phased options.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Multiple factors, including land-use commitments, influence the evaluation of alternatives. Among the factors are short- and long-term environmental impacts, regulatory compliance and uncertainties. These factors are addressed in the EIS in the Summary, Section S.6. In the Summary, Section S.7 contains a comparison of the alternatives based on various evaluation factors and Volume One, Section 5.14 provides a summary comparison of all of the environmental impacts addressed in the various sections of Volume One, Section 5.0 and the supporting appendices. The response to Comment number 0081.02 contains a discussion of the comparison impact of separating repository costs from retrieval and treatment costs of the ex situ alternatives.

Land use commitment impacts were analyzed in detail in Volume One, Section 5.7. Based on that analysis, Volume One, Section 5.19 identifies potential land use restrictions as a potential environmental justice concern for affected Tribal Nations. Volume One, Section 5.20 identifies potential mitigation measures that could be implemented to address the land use impacts identified in Section 5.19. For the Final EIS, these sections of the Draft EIS were revised to reflect technical information unavailable at the time the Draft EIS was published.

Comment Number 0085.02

Klein, Robin

Comment While it is true that a clearly proven, good solution does not exist, it is also true that the liquid wastes must not remain in these tanks. The leaking tanks are the greatest source of waste contaminations to the soils. Contaminated waste originating from the tanks are moving toward groundwater. Groundwater contaminated with Hanford pollutants already in the soils is now in communication with the Columbia River. Cleaning up waste once in the soils will take heroic efforts. Once they get into the river, the long lived contaminants are practically irretrievable. The single most affective measure we can take to protect the river in the long run is to stop the driving force that enables rapid migration of the wastes offsite, get the waste out of the leaking tanks soon. So it is important to have an aggressive plan in place.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology are committed to protecting the Columbia River. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0088.03

Porter, Lynn

Comment There's an article in the Oregonian Sunday March 17th, that raised a whole lot of questions. This was a large article beginning on the front page quoting a panel of scientists from the National Research Council, whoever that is, I probably should know, but I don't. And they're saying just leave the stuff in the tanks. They quote some DOE engineers saying yes we can do it. And one of the points that puzzled me was they're saying in this article, the National Research Council says that before you can sluice out these tanks you have to seal the ground underneath them. I didn't find anything about that in the summary of the Draft EIS, except for the ISV option. So I don't know where this comes from, but their point seems to be that if you're going to have to seal the ground anyway, you might as well leave the stuff in the tanks. That's something I would have like to of heard discussed.

I think the problem is that this kind of thing keeps coming up. And so of course we wonder where's it coming from. There seems to be a lot of energy behind this idea we'll just leave the stuff in the tanks and put it cap on it and walk away. I'm glad to hear that isn't the feeling at the top. But since it keeps coming up in such volume, we wonder what's going on, like is this a trial balloon. If it is, I'd like to shoot it down. I just think leaving the stuff in the tanks is a completely unacceptable alternative. And I wish someone would take this idea out and bury it and drive a stake through it's heart.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The National Research Council, in the cited article, advocated an alternative that evaluated the impact of not removing waste from selected tanks. This alternative, which corresponds to the Ex Situ/In Situ Combination 1 and Ex Situ/In Situ Combination 2 alternatives evaluated in the EIS, is not the preferred approach endorsed by DOE and Ecology. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and Comment number 0001.01, which discusses subsurface barriers as this issue relates to leak containment.

Specific Preference for Ex Situ/In Situ Combination Alternative

Comment Number 0009.05

Broderick, John J.

Comment The above reasoning has lead me to recommend you select the following remediation alternative: Ex Situ/In Situ Combination. I believe the Preferred Alternative is doomed to be not completed because it is trying to avoid leaving waste in place, will take too long to construct, and will cost too much. In addition, there is a possibility that the whole issue will again be revisited at the beginning of the second phase. This will be another opportunity to change the remediation approach.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0009.06 for a description of revisions to the alternatives in the Final EIS, 0009.08 for a description of the factors considered when evaluating alternatives, and 0009.09 for a description of the time required to implement alternatives.

Comment Number 0009.06

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) selects the actions based on long term health effects, rather than a "one size fits all" approach.

Response The ex situ/in situ combination alternatives are based on reduction of human health risk and different tanks having much different contents, therefore representing differing potential long-term impacts to human health. For the Final EIS, two ex situ/in situ combination alternatives are analyzed in detail. Volume One, Section 3.4 and Volume Two, Appendix B provide a description of the two alternatives and the potential impacts associated with each alternative are analyzed in Volume One, Section 5.0 and associated appendices.

Comment Number 0009.10

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will deal with more waste faster than other, more extensive alternatives. Thus there will be less effort expended in just managing the waste.

Response DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of completion of the project was one of many factors that influence the evaluation of alternatives (please refer to the response to Comment number 0009.08). Duration of construction and remediation is directly proportional to the nature and volume of tank waste, as well as the complexity of the tank farms as a whole (i.e., vadose zone contamination, groundwater migration, and closure). The preferred alternative, using a phased approach, would allow evaluation and optimization of the technologies used to treat the waste form and nature to be retrieved, which would enable the Agencies to apply "best fit" for the waste type. A summary of the environmental impacts of all alternatives analyzed in the EIS is presented in Volume One, Section 5.14 and a comparison of the alternatives is presented in the Summary (Section S.7).

Comment Number 0009.12

Broderick, John J.

Comment This alternative (Ex Situ/In Situ Combination) will provide means so the waste will not migrate from its disposal location. Still, there will be waste present, so there must be a continuing program to restrict farming, groundwater use, and intrusion. This program will be much less expensive and less complicated than removing all waste from Hanford.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. For purposes of analysis in the EIS, institutional controls for this and other alternatives would end 100 years following the end of remediation. Thus, the long-term impacts assume unrestricted use of the Site for farming and potential use of groundwater as well as intrusion into the waste disposal onsite. Therefore, while the cost, technical complexity, and short-term impacts of the combination alternatives are less than that of the ex situ alternative; long-term impacts tend to be higher. For a comparison of the alternatives, please refer to the Summary, Section in 5.7.

Comment Number 0009.15

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the extra effort (for the Preferred Alternative) does not significantly reduce the fatalities expected, even though all the waste is removed.

Response DOE and Ecology acknowledge the preference expressed in the comment, but have identified the Phased Implementation alternative as the preferred alternative for the reasons described in the Summary (Section S.7). As discussed in Section S.6, there are a number of factors that influence the evaluation of the alternatives including short-term and long-term impacts, uncertainties, and compliance with laws and regulations. Please also refer to the response to Comment number 0098.06 for more information about risk calculation. Reduction in fatalities is one method of comparing alternatives; however, other issues such as regulatory compliance, long-term reduction in potential risks to human health and the environment, and implementability in light of technical uncertainty must also be considered.

Comment Number 0009.17

Broderick, John J.

Comment The Preferred Alternative is not acceptable because there will be significant repository costs (for the Preferred Alternative). The costs are uncertain now because we do not have a repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The repository cost for each alternative was calculated to provide the public and decision makers with information associated with the total potential costs of the various alternatives. Based on new information made available since the publication of the Draft EIS, repository costs have been substantially revised for the Final EIS (Volume One, Section 3.4 and Volume Two, Appendix B). A discussion of the methodology used to calculate repository costs, the cost associated with each alternative, cost formulas, and canister size issues, is contained in the response to Comment numbers 0081.02, 0004.01, and 0008.01.

Comment Number 0009.18

Broderick, John J.

Comment The preferred alternative is not acceptable because the construction of facilities will not be completed until 2012 (for the preferred alternative). This is way too long, our experience is that long duration projects often do not reach the operational phase.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Phase 1 of this alternative (construction and operations) would be completed in 2007. Phase 2 construction would be completed in approximately 2011. DOE and Ecology acknowledge the risks associated with projects that take a long time to complete. However, speed of completion of the project is but one of many factors that influence the evaluation of alternatives. Please refer to response to Comment numbers 0009.09, 0009.10, and 0098.02, which discusses issues related to construction starts and duration and the impact of the phased approach on the volume of waste treated.

Comment Number 0009.19

Broderick, John J.

Comment The Preferred Alternative is not acceptable because the phased approach is not needed. We can build the facilities with existing technology. As our knowledge and experience increase over the next 45 years, we can modify the facilities. We will need to do that anyway to keep up with technology and safety requirements.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The preferred alternative, Phased Implementation, represents near-term use of currently available technologies to the extent possible. Phase 1, also known as the demonstration period, will assess the capability and effectiveness of existing technologies to retrieve and treat the waste and provide DOE with information on retrieval efficiencies, blending practices, separation efficiencies, vitrification techniques, and costs prior to constructing and operating full-scale facilities. This will result in more efficiently designed and operated facilities for Phase 2. The implementation schedule for the preferred alternative is consistent with Tri-Party Agreement milestones, as well as concurrent with other programmatic and systems activities currently conducted at the Site. Because the phased approach is designed to implement "learn as you go" improvements, system optimization and cost savings are expected. This approach and resulting benefits may be less likely with a fixed, less flexible technology or implementation of full-scale facilities without a demonstration phase. For a discussion of the phased approach to alternative implementation, see Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to the response to Comment number 0098.02 for a discussion of schedule and treatment volume estimates associated with the preferred alternative.

Comment Number 0029.01

Bartholomew, Dale C.

Comment I believe that the Ex Situ/In Situ Combination alternative offers the best balance between risk and benefit of the proposed alternatives and should be selected as the preferred alternative for the following reasons:

It offers the highest <u>real</u> value. It provides a level of safety to the public <u>commensurate</u> with other sub-surface contamination immediately adjacent to some of the tanks, adjacent to the 242-S evaporator, and sites such as cribs throughout the 200 Areas as well as other contaminated areas adjacent to the 200 Areas such as BC Crib. If my understanding is correct, no further action is planned on these other sites. Therefore, totally uncontrolled access by the public would be unacceptable, and I recommend that a waiver be obtained for relief for tank wastes from the regulations. This may be politically incorrect, but makes the most sense in the context of a balanced total system.

Retrieval of wastes from all SSTs, DSTs, and MUSTs is a huge waste of money if the soil contamination sites outside the tanks are not also ameliorated.

I also believe retrieval of wastes from all tanks creates a higher-than-projected exposure of working personnel to both occupational and radiological accidents and injuries. I have no data to support this. However, my experience suggests that the input data for the calculations may not be realistic.

The Summary Table indicates that the Ex Situ/In Situ Combination alternative and the preferred alternative are both rated "moderate" with respect to Technical Uncertainty. I believe the degree of technical uncertainty associated with the Ex Situ/In Situ Combination is less than the preferred alternative because only one-half of the waste volumes would be vitrified and sent to the repository with the Ex Situ/In Situ Combination alternative, (50 percent of the tanks would be filled and capped). It should have received a lower Technical Uncertainty rating because of scaled-down throughput requirements.

I suspect when wastes from all of the tanks are retrieved, there will be several SSTs thought to be non-leakers that will be found to be leakers. That will only add to existing soil contamination during sluicing.

I noticed where the U-238, Tc-99, C-14, and I-129 isotopes were to be retrieved. I fully support this action. I may have read the document too quickly, but I did not notice any reference to TRU wastes. Obviously, these must also be removed and vitrified.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The following responses are in the same order as the comments.

Short-term and long-term impacts to human health and the environment, managing the uncertainties associated with the waste characteristics and treatment technologies, cost, and compliance with laws, regulations, and policies are among the factors considered when evaluating the alternatives (please refer to the response to Comment number 0009.08). No decision has been made regarding remediation of subsurface contamination adjacent to the tanks or in the other areas referred to in the comment. Contamination from past tank leaks is beyond the scope of this EIS (see Volume One, Section 3.3 and the response to Comment number 0072.08). Other contamination of soils in the 200 Areas is the subject of the Hanford Remedial Action EIS and subsequent Comprehensive Environmental Response, Comprehensive Environmental Response Compensation and Liability Act (CERCLA) decisions. The TWRS EIS presents the cumulative impacts of the tank waste alternatives and the 200 Areas contamination in Volume One, Section 5.3).

The retrieval of wastes from the SSTs, DSTs, and MUSTs and their subsequent remediation is considered in this EIS. Tank waste retrieval and treatment is the first step in remediation of the tank farms. The remediation of soil contaminated sites outside the tanks will be considered in other environmental documentation, such as the Hanford Remedial Action EIS. The EIS analyzes a range of alternatives from no waste retrieval to extensive waste retrieval. Each of the alternatives presents differing trade-offs among short-term and long-term environmental impacts, technical uncertainty, and regulating compliance. Additionally, alternatives that involve no retrieval or partial retrieval, such as the ex situ/in situ combination alternatives would influence the closure actions that could be implemented, as discussed in Volume One, Section 3.3. Implementation of these alternatives would limit or potentially increase the cost and complexity of the future closure actions such as remediation of contaminated soils. Extensive retrieval alternatives would provide the least complications and cost impacts on future closure actions.

The risks to the workers during construction and operation of the retrieval and transfer facilities for the ex situ alternatives have been analyzed for all the alternatives. The results of this analysis are given in Volume Four, Appendix E and in Volume One, Section 5.12. In general, risks to the workers are less when less retrieval and transfer are conducted. Regardless of the alternative selected, DOE would complete a detailed safety analysis of the alternative to determine additional safety measures for implementation. Please refer to the response to Comment number 0098.06 for risk calculation information.

The technical uncertainty of an alternative is a compilation of numerous factors, such as similarity to other like operations, the history of demonstrated performance of the technology, the ability to construct and operate the alternative given the conditions at the Site, and others. However, if two technologies are operating at roughly the same scale and production rate, the technical uncertainty is not a direct function of the throughput requirement. The ability to design, construct, and operate the Phased Implementation alternative and the ex situ/in situ combination alternatives are approximately the same. Both alternatives have approximately the same degree of process development, consequently, the two processes will be rated about equal in their technical uncertainty.

To account for leakage from the SSTs during retrieval, the EIS assumes an average of 4,000 gallons of leakage from each tank (see Volume One, Section 5.2 and Volume Four, Appendix F). It is not expected that all SSTs will leak this amount. Some SSTs will not leak during retrieval, and as the comment suggests, some SSTs will develop unexpected leaks. It has been assumed in the EIS that the total leakage divided by the number of tanks will be bounded by the 4,000-gallon figure. For tanks that are known leakers or that develop leaks during retrieval, the EIS presents technology options to sluicing, such as robotic arm-based retrieval, that would involve substantially lower volumes of liquids (see Volume One, Section 3.4 and Volume Two, Appendix B).

The purpose is to retrieve the radionuclides that are the chief contributors to long-term risk (i.e., uranium-238, technetium-99, carbon-14, and iodine-129). Neptunium-237, a TRU isotope, is also a contributor to long-term risk, and this alternative shows a calculated retrieval of approximately 93 percent for this isotope. There is a large calculated proportion of other TRU elements that would be retrieved, but do not move quickly enough in the vadose zone and groundwater to contribute to risk within 10,000 years.

Specific Preference for the Phased Implementation Alternative

Comment Number 0012.01

ODOE

Comment Governor Kitzhaber and Oregon strongly support the preferred alternative in the environmental impact statement (EIS). This alternative calls for a retrieval of all of the tank wastes technically possible (estimated at 99 percent of the wastes) and vitrifying the wastes. While the vitrified wastes will still be radioactive, they will be safer to store and not susceptible to leakage pending ultimate disposal.

Although we support the preferred alternative, it will not resolve all the issues related to the high-level wastes at Hanford. We believe there will continue to be the need for ongoing monitoring, characterization, and pumping and treating of groundwater contamination caused by waste which has leaked and migrated from the tanks.

Response DOE and Ecology acknowledge the preference of the State of Oregon for the preferred alternative, and will take this preference and other public comments into consideration when selecting the final action for TWRS waste. The issues identified were among the factors considered by DOE and Ecology in identifying the preferred alternative.

The Hanford Site will require ongoing monitoring and characterization relative to past tank leaks and the migration resulting from those leaks into the surrounding environment. The characterization and monitoring programs are discussed in the response to Comment numbers 0072.61, 0072.63, 0072.67, and 0072.70. Each of the alternatives includes continuation of existing programs to characterize vadose zone and groundwater contamination and long-term monitoring programs that extend beyond the completion of the tank waste action (Volume One, Section 3.4 and Volume Two, Appendix B). As more information becomes available regarding the environmental consequences of past leaks and the nature of residual waste remaining in the tanks following retrieval, DOE will be able to address actions associated with tank farm closure, including the potential for pumping and treating groundwater contamination beneath the 200 Areas (see Volume One, Section 3.3 for a discussion of closure). It is because of the lack of adequate data regarding these issues that the closure of the tank farms is not included in the scope of this EIS. Please refer to the response to Comment number 0072.08.

Comment Number 0012.03

ODOE

Comment Leaving wastes in the tanks poses huge risks. The tanks are corroding and failing. As they fail, the radioactive waste is released to the soil and ultimately to the groundwater and to the Columbia River. Vitrifying the tank waste makes it far more stable and greatly reduces the threat to the public and the environment. While the cost of the preferred alternative is substantial, it is the only alternative which satisfactorily deals with the dangers presented by these wastes as quickly as practical. The phased approach allows USDOE to get on with cleanup while allowing for possible development of better approaches which remove all tank wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The issues identified were among the factors considered by DOE and Ecology in identifying the preferred alternative, Phased Implementation. Please refer to the response to Comment number 0009.19 for reasons the Phased Implementation was identified as the preferred alternative.

Comment Number 0012.07

ODOE

Comment The preferred alternative relies on proven technology and a phased approach. This allows a "learn as you go approach" which should identify problems earlier and at a smaller economic and environmental cost.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The issues identified were among the factors that influence the evaluation of alternatives. Please refer to the Summary, Section S.6 and S.7 and the response to Comment numbers 0009.08 and 0009.19.

Comment Number 0012.09

ODOE

Comment The current risk modeling and analysis are too simplistic to allow detailed decisions which call for leaving part of the wastes in place and still protect human health and the environment. We believe the risk assessment in this EIS is sufficient to support the proposed alternative and to conclude that the risks are too large to allow any of the tank waste to remain in the tanks at the end of cleanup.

Response The risk modeling and assessment performed for this EIS used the best available data, state-of-the-art models, and industry standard approaches and techniques and is both comprehensive and detailed. The data generated by the modeling and assessment provided for a balanced and equitable comparison among the alternatives and as such, provided results that were useful in comparing the potential short-term and long-term human health and environmental impacts. To the extent that the risk assessment provided sufficient data to evaluate the preferred alternative, it also provided equally valid data to support the evaluation of all alternatives, including alternatives involving leaving some or all of the waste in place. For the Final EIS, an appendix (Volume Five, Appendix K) was added to the EIS to provide a basis for understanding uncertainties associated with the risk assessment, as well as other areas of uncertainties.

Comment Number 0022.03

Sims, Lynn

Comment We know millions of gallons of waste have already leaked from the tanks and migrated towards groundwater. This relentless assault upon the environment will not cease without intervention. We are not certain of the environmental and human health damage which has and will result from leaking tanks, but forecasts are ominous. The only responsible alternative is the preferred alternative which removes as much waste as possible and isolates them from the environment by vitrification.

Response DOE and Ecology acknowledge the preference expressed in this comment and will take into consideration this preference and other public comments when selecting the final action for TWRS waste. DOE has implemented a program to remove as much of the liquids as practicable from the SSTs to reduce the likelihood of future leaks. A discussion of this program is provided in Volume One, Section 3.4 and Volume Two, Appendix B. An analysis of potential cumulative impacts, including past leaks is presented in Volume One, Section 5.13 and new information regarding the extent of migration of past leaks to the vadose zone and groundwater has been included in Volume Five, Appendix K. The ongoing characterization and monitoring program is discussed in the response to Comment numbers 0072.61, 0072.63, 0072.67, and 0072.70.

Comment Number 0032.04

Heacock, Harold

Comment We support the Department's preferred alternative of phased implementation of an ex situ intermediate separations process, which provides for the greatest protection of the environment, including protection of the groundwater consistent with a reasonable projected cost, the disposal of the vitrified high-level waste at a national waste repository, and an acceptable degree of risk.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Pleaser refer to the response to Comment number 0009.19 for a discussion of the reasons Phased Implementation is the preferred alternative.

Comment Number 0035.08

Martin, Todd

Comment I would like to address what I think is good in the EIS. We support the pretreatment selection in the preferred alternative.

Intermediate separations is appropriate. HEAL would vigorously oppose any movement towards extensive separations pretreatment process.

The stakeholder community in the Northwest has made it very clear that intermediate separations is responsive to our values. It is available relatively, and it will reduce the waste volume by a satisfactory amount.

Secondly I support the assumption that 99 percent of the waste will be retrieved. The risks in the EIS show very clearly that the only responsible alternative is to retrieve all of the waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0005.38 for a discussion of issues related to pretreatment. The response to Comment number 0012.19 contains a detailed discussion of the extent to which the public has made a positive impact on this document.

Comment Number 0036.10

HEAL

Comment HEAL supports the full retrieval of Hanford's tank wastes. The preferred alternative's retrieval scenario is responsive to the stakeholder values. It has always been assumed that Hanford's tank wastes post a great risk to future generations. This EIS confirms the assumption. The EIS shows that future risk is directly correlated to the amount of waste left behind. The impact of leaving only a small portion of contamination behind is evidenced by the difference in long-term risk for the preferred alternative where 1 percent of the waste is left and the Ex Situ/In Situ alternative where 10 percent of the waste is left behind. By leaving 9 percent more waste behind, the risk for residential farmer at

5,000 years would increase by a factor of 10. These high risks clearly show that the only responsible solution is to retrieve all of the waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Impact to the public welfare, including residential farmers, was a factor analyzed for all alternatives. Please refer to the response to Comment number 0009.05. The environmental impacts of all the alternatives analyzed in the EIS are summarized in Volume One, Section 5.14. Potential long-term health effects are summarized for each alternative in the Summary, Section S.7.

Comment Number 0038.03

Reeves, Merilyn

Comment Now, the board supports the full retrieval from Hanford tank waste. The preferred alternative retrieval scenario is responsive to the board's value.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0009.19 for a discussion of the reasons the Phased Implementation alternative is the preferred alternative.

Comment Number 0038.05

Reeves, Merilyn

Comment The Board supports the preferred alternative's pretreatment process. And again, we go back to the Tank Waste Task Force, which stated the high cost and uncertainty of high tech pretreatment and R and D threatens funding for higher performance low level waste form vitrification and cleanup.

Use the more practical, timely, available technology while leaving room for future innovations. Keep a folio of technology options and make strategic investments over time to support the limited number of promising options. Give up further research on unlikely options. Again a statement from 1993.

The intermediate separations case is responsive to this value although the difficult challenge of technetium removal in the Phased Implementation alternative is a concern to the Board.

And the Board would strongly oppose any movement towards extensive separations pretreatment technology.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.05 for a description of how the alternatives analyzed in the EIS were identified and methods for analyzing technology options in the EIS.

Implementing Phase 1 of the preferred alternative would allow evaluation of existing technologies while moving forward on retrieval and treatment goals. As the demonstration phase progresses, the efficiencies and effectiveness of the retrieval and treatment technologies, including technetium separation, can be evaluated and optimized. Technetium removal could be implemented during Phase 1 using established separations technology or emerging technologies that show promise in keeping with recommendations of the board. One way of removing technetium-99 from alkaline waste solutions is to selectively sorb the isotope, as TcO_4, using a strong-base organic ion-exchanger (WHC 1995a).

Comment Number 0042.01

EPA

Comment The EIS addresses the treatment, storage, and disposal of Hanford Tank Waste to meet the requirements of the Hanford Federal Facility Agreement and Consent Order and the Resource Conservation and Recovery Act as amended by the Hazardous and Solid Waste Amendments of 1984. As a signatory to the Agreement and Consent Order, EPA has endorsed the approach identified in the Draft EIS as the preferred alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0005.07.

Comment Number 0043.02

Hanford Communities

Comment In its selection of an alternative for the cleanup of tank wastes, we believe that the Department of Energy must comply with State and Federal laws and must also comply with its commitments under the Tri-Party Agreement. We believe that the Department should proceed with an ex situ process of extensive waste retrieval with phased implementation. This process appears to have the strongest backing of people in this area and provides the best long-term environmental solution.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology intend to comply with all Federal, State, and local regulations and ordinances applicable to tank waste remediation. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0076.01

Blazek, Mary Lou

Comment I had passed out a comment, or a formal comment that I would like to have read into the record. I won't do that now, it would be lengthy. I just like want to say on the record that Governor Kitzhaber and the Oregon Department of Energy strongly support the proposed alternative in this Environmental Impact Statement. The retrieval for all the tank waste that are technically possible, up to 99 percent we think is critical that occur. The need for this undertaking is compelling in our minds. The potential impact to the Columbia River cannot be impacted in this way.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology remain committed to protecting the Columbia River and the analysis of potential impacts of TWRS alternatives includes impacts to the River as presented in Volume One, Section 5.2 and Volume Four, Appendix F. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0076.02

Blazek, Mary Lou

Comment The other alternatives under consideration leave most, or all of the waste in the tanks, with the exception of the in situ vitrification, which is an immature and unproven technology. Other alternatives do little to remove the hazards posed by the waste. The major criteria that must be applied to any decision is the protection of public health and safety and the environment. This criteria eliminates all of the alternatives, which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, although it's an immature and unproven technology. Because the in situ vitrification technology is uncertain, we oppose all of the alternatives, which leaves the waste in Hanford tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and 0005.18, which discusses tank waste residuals.

Comment Number 0077.03

ODOE

Comment Sacrificing Hanford in this way does not adequately reduce the harm and risks to the environment or to future generations. For these alternatives, the risk analyses in the EIS show massive plumes of radioactive material slowly moving across the Hanford site and into the Columbia River for hundreds to thousands of years.

Cost should not be the sole or even predominant criteria used to select among the alternatives. The first criteria that must be applied is protection of public health and safety and the environment. This criteria eliminates all of the alternatives which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, although it is an immature and unproven technology for tank waste. Because in situ vitrification technology is uncertain, the potential for failure is unacceptably high. We strongly oppose all of the alternatives which leave the waste in Hanford's tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Removing, treating, and disposing of the tank waste would be the first step in providing protection to the vadose zone, groundwater, and the Columbia River. Please refer to the response to Comment numbers 0076.02, 0040.01 and 0005.18 for more information. The response to Comment number 0009.16 contains a discussion of the analysis of cost alternatives.

Specific Preference for Vitrification

Comment Number 0047.01

Ahouse, Loretta

Comment The wastes that are in the tank farms at Hanford must be dealt with at all costs. My preference is to see that all of the tank waste be removed and vitrified, regardless of whether or not the vitrified logs are ever moved to Yucca Mountain, Nevada.

It is an undisputed fact that the tanks at Hanford have leaked, although there appears to be a question of how far and how fast. Despite this, we do know that the tanks leak and may pose a potential danger to the groundwater under the Hanford site, and ultimately the Columbia River. For this reason, all of the waste that is technically feasible to remove, must be removed and immobilized in a safe manner. This should not be an issue of costs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. As more information becomes available from the ongoing vadose zone and groundwater monitoring and characterization program, DOE will be able to address issues related to tank farm closure. The EIS has been modified to include information on vadose zone contamination in Volume One, Sections 4.2 and 5.13 and in Volume Five, Appendix K. Vadose zone contamination is also discussed in the response to Comment number 0012.15.

Comment Number 0047.02

Ahouse, Loretta

Comment I do not agree with any plans which would leave a portion of the waste behind in the underground tanks.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

The preferred alternative assumes 99 percent retrieval of the tank waste. In a separate NEPA review, DOE intends to consider alternatives to tank farm closure. The EIS analysis addresses a range of alternatives that includes leaving all or a portion of HLW onsite, as well as alternatives that retrieve from the tanks as much waste as practicable (assumed to be 99 percent). Decisions associated with the

extent of retrieval will be supported by the TWRS EIS; however, the decisions on closure are not within the scope of the TWRS EIS. Please refer to the response to Comment numbers 0005.18 (assumption used in analysis of alternatives), 0072.08 (a discussion of closure), and 0072.05 (NEPA requirements for analysis of alternatives).

Comment Number 0079.02

Knight, Page

Comment One of the proposal alternatives is to take wastes from only from the double-shell tanks which are not yet leaking, vitrify them, and fill the single-shell tanks with sand and in effect walk away. This would possibly push the liquid waste deeper into the ground, hastening the contamination flow to the groundwater, and thus to the Columbia River. Presently, at the T tank farm, plutonium has become bound up in chemicals of the tank waste, and is moving rapidly toward groundwater. This is an inkling of what is to come in the next 100 years if the waste is left in the tanks. This is thus, an unacceptable alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The TWRS EIS addresses the management, retrieval, treatment, and disposal of the tank waste and does not address closure of tank farm residuals, equipment, or soil contamination. For the purposes of this EIS, closure as a landfill was assumed, but this closure assumption contained in the EIS will not be used to identify a closure alternative in the TWRS ROD. Closure will be addressed in future NEPA documents. Please refer to response to Comment number 0072.05 for additional closure information.

DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River. The EIS analyzes the impacts to groundwater associated with each of the alternatives in Volume One, Section 5.2 and Appendix F. The Final EIS has been modified to include a discussion of emerging data on vadose zone contamination beneath the tank farms. This discussion is provided in Volume Five, Appendix K. Please refer to the response to Comment number 0076.02.

L.3.4.1.2 General Preferences

Miscellaneous Preferences Related to Remediation

Comment Number 0009.03

Broderick, John J.

Comment Over the past decade, Hanford has demonstrated that it can not complete a project that takes a long time to construct. Grout, the new tank farm and HWVP come to mind in this regard, but there are many others. The many canceled projects have spent hundreds of millions of dollars with nothing to show for the effort. Each time there seems to be a good reason to cancel - but the percentage of canceled projects is very high. For this reason, the remediation of the tank waste must be done in facilities that can be constructed in a short period of time.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Volume One, Section 3.4 and Volume Two, Appendix B contain the implementation and completion schedule for each alternative. The Preferred Alternative identified in the EIS is consistent with the proposed remedy contained in the Tri-Party Agreement and the remediation schedule milestones in the Tri-Party Agreement. In addition, the existing schedule has been accelerated by approximately two years as a result of concurrent TWRS activities. Please refer to the response to Comment numbers 0009.10 and 0009.18 for a discussion of issues related to implementation of the preferred alternative, including projected construction completion dates. Please also refer to the response to Comment numbers 0055.06 and 0009.16 for a discussion of issues related to the consideration of cost in the alternatives analysis and the applicability of the HWVP to the preferred alternative.

Comment Number 0009.04

Broderick, John J.

Comment The National debt is increasing every year. There are strong pressures to reduce the deficit, and the debt itself. We have already seen the DOE budget drop substantially; and there are pressures to cut it even more. For this reason, the remediation of the tank waste must be done at the lowest possible price.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. DOE and Ecology believe that there is a potential to reduce the cost for tank waste remediation by allowing the market place to establish, through the competitive bidding process, the cost for waste treatment. Please refer to the response to Comment number 0036.15 for more information. The environmental impact of all factors analyzed during the evaluation of each alternative included in the EIS is presented in Volume One, Table 5.14.1.

Comment Number 0014.03

Bullington, Darryl C.

Comment Further proposals of hazardous chemical processes based upon unproven technology using insupportable assumptions such as a ninety-nine percent retrievability of sludge to generate so much high-level waste that it can not be safely contained in existing repositories continues to erode any credibility that may yet exist between the DOE and the public. Such reports not only wasted resources, they assure continued inaction and indecision.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. For each of the alternatives, technical uncertainties were addressed in Volume One, Section 3.4 and Volume Two, Appendix B. For the Final EIS, Volume Five, Appendix K was added to the EIS to consolidate discussion of uncertainties associated with the analysis of environmental and human health impacts. The EIS also analyzes alternatives involving retrieval of less than 99 percent of the tank waste. These alternatives include the in situ alternatives which would involve minimal waste retrieval and the ex situ/in situ combination alternatives which would involve partial waste retrieval. For more information regarding the 99 percent retrieval assumption, please refer to the response to Comment numbers 0005.18 and 0089.07. Please also refer to response to Comment numbers 0069.04 and 0037.03 for issues related to regulatory compliance requirements associated with disposal of tank waste and geologic repository availability.

Comment Number 0021.01

Shilling, Fred E.

Comment Our concerns regarding the storage of nuclear wastes at Hanford: some of the stuff is leaking and it was not supposed to; some of it presents the threat of explosion, and it was not supposed to; some sort of omnibus cleanup was supposed to be under way by now but it is not; all the while the costs keep escalating while axe grinders argue for use of the plutonium for fuel for their profit and our disposal problem. And there is still no safe disposal.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The TWRS EIS was initiated because DOE needs to manage and dispose of tank waste to "reduce existing and future risk to the public, Site workers, and the environment" (Draft TWRS EIS, Section 2.0). The EIS addresses the DOE proposed action to manage and dispose of tank waste, as well as a range of reasonable alternatives. The use of plutonium for fuel is beyond the scope of this EIS. For each alternative, the EIS analyzes potential impacts to the human and natural environment including potential impacts from future releases to groundwater in Volume One, Section 5.2, releases to the air in Section 5.3, impacts to ecological and biological resources in Section 5.4, impacts to human health in Section 5.11, and impacts from explosions and other accidents in Section 5.12. Each of the alternatives, except No Action and Long-Term Management identify how tank waste would be disposed of. For HLW retrieval from the tanks, disposal would be offsite in the proposed geologic repository. For discussion of waste disposal under each alternative see Volume One, Section 3.4, and Appendix B.

Comment Number 0026.01

Blazek, Mary Lou

Comment I see three long-term strategic hazards that must be considered:

1. prevention of dispersal into the environment
2. prevention of direct human exposure (i.e., Site workers, etc.)
3. prevention of misappropriation by terrorist/criminal groups.

These concerns are not limited to high-grade plutonium.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment number 0021.01 for a discussion of EIS analysis regarding disposal of water into the environment. Prevention of direct human exposure is addressed for each alternative in Volume One, Section 3.4, and Appendix B. All alternatives would provide for appropriate security to minimize the risk of misappropriation.

Comment Number 0026.02

Blazek, Mary Lou

Comment I believe there are reasons to select a variety of processes in management. Some elements will be best served by vitrification, and others by simple long-term storage. I see no reason why at least a portion of the waste should not be stored at ground level, where it can be adequately monitored for leakage or casket deterioration and repackaged as indicated.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The bounding approach to the evaluation of reasonable alternatives provides the option for the decision makers to select a variety of processes in the ROD. The EIS range of alternatives included retrieval from zero to 99 percent of the waste, as well as a discussion of those technologies currently available for retrieval, separations, and immobilization. In addition, the EIS addresses four alternatives (i.e., ISV, In Situ Fill and Cap, and Ex Situ/In Situ Combinations 1 and 2) that include storage and/or disposal of all or part of the waste near surface onsite.

Risks to human health associated with transportation of HLW to the proposed geologic repository were analyzed and compared for each alternative in the accident scenarios discussed in Volume One, Section 5.12, and Volume Four, Appendix E. This analysis in conjunction with the analysis of risks associated with onsite disposal versus offsite disposal of HLW, supports the comparison of alternatives. Long-term risk to human health and the environment specific to onsite and offsite storage and risks in general were discussed in Volume One, Section 5.11 and Volume Three, Appendix D. All ex situ alternatives, except for the Ex Situ No Separations alternative, specify that the LAW be stored onsite in a near surface vault and that the remaining HLW be stored onsite pending disposal at the proposed geologic repository. The Ex Situ No Separations alternative would result in offsite disposal of the tank waste. Please refer to the response to Comment numbers 0026.01 and 0072.05.

Comment Number 0026.03

Blazek, Mary Lou

Comment In general I do not favor transfer to other sites. I believe the actual transfer would often times be hazardous, I see no advantage to deep burial over surface interment, and it is generally viewed as a means of "getting it out of my backyard" with all the political overtones and delays involved.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0026.01 for discussion of the analysis of impacts in the EIS, and 0026.02 for a discussion of a comparison of alternatives relative to onsite verses offsite disposal.

Comment Number 0026.04

Blazek, Mary Lou

Comment I see a need for use of a variety of separation/purification techniques, a variety of storage techniques, and a sense of urgency to start the process. We have spent far too long on looking for a single perfect solution and site. Technology will change over the next 50-100 years, and we can neither wait for that to happen nor insist on locking ourselves into a single process.

Response Please refer to the response to Comment numbers 0026.01, and 0026.02 for a discussion of the range options available for the decision makers based on the EIS analysis and the response to Comment number 0072.05 for discussion of NEPA requirements for analysis of a range of alternatives. The response to Comment number 0076.03 addresses modification to technologies over time, and the response to Comment number 0009.01 discusses technology optimization and the urgency associated with tank waste remediation.

Comment Number 0032.02

Heacock, Harold

Comment The continued management and minimum waste retrieval alternatives are not acceptable solutions to a major environmental problem since they do not include the retrieval of waste from the single-shell tanks.

We believe that any tank waste remediation program must include removal and processing the waste to an acceptable solid in order to eliminate the environmental threats resulting from any retention of the waste in tanks of questionable integrity and lifetime.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

The EIS analysis presents data to support a comparison of the potential environmental impacts form retention of waste in the tanks (No Action and Long-Term Management alternatives) verses various waste management and disposal strategies represented by the other alternatives analyzed in the EIS. Please refer to the response to Comment numbers 0026.01 and 0026.02 for more information.

Comment Number 0034.02

Belsey, Richard

Comment So there are real compelling reasons to do the one thing that will most increase the safety and health issues for workers, people, and the environment. And that is this material needs to be stabilized so it does not and cannot move.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to response to Comment numbers 0026.01, 0026.02, and 0072.05 for a discussion of the range of alternatives addressed in the EIS, including alternatives involving immobilization of all or portions of the waste.

Comment Number 0034.03

Belsey, Richard

Comment Waste management side there are compelling reasons too. Interestingly they are dollars. The cost of sitting or baby-sitting these tanks is the most frustrating thing that I can think of.

It costs -- has costs anywhere from 200 to 300 million dollars a year. Finally, the people in the Tank Waste Remediation System are beginning to bring this mortgage down by a variety of techniques, but it is still the largest single overhead -- and I put it in as overhead because it does not produce any cleanup.

It does not produce any movement. Those resources are needed to do actual cleanup work. And the meter is running. As we sit here, the meter runs every single day.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Reduction in mortgage costs associated with continued management of tank waste was accounted for in the cost estimates for each alternative analyzed in the EIS. The No Action alternative cost estimate represents the 100-year mortgage for tank waste management. Please refer to the response to Comment number 0009.16, which discusses the methods by which cost was incorporated into the alternative analyses.

Comment Number 0034.04

Belsey, Richard

Comment And these were because people knew or had learned about the problems in the tanks, and they wanted to do something about it. This was an intense five or six-month period. And the Tank Waste Task Force came out and said we have to change what we were doing. We need to put both the high-low-level activity fractions into glass, different kinds of glass.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The approach to tank waste identified in the Comment is represented in the EIS in the various ex situ alternatives presented in Volume One, Section 3.4. The ex situ alternatives provide for varying Volumes of low-activity verses HLW to be vitrified based on the level of separations (i.e., from separations to extensive separations).

Comment Number 0034.06

Belsey, Richard

Comment And I say all of this because -- as background to the fact that the committee and the board now has supported the alternative path as the one that is most likely to meet the needs of the Tri-Party Agreement, not the milestones.

The milestones are just indicators of how you are working on health and safety issues, moving toward the ultimate first step, the biggest step, which is taking it from being in a soluble form which can migrate into the ground, into the groundwater, into the Columbia River, and stabilizing that so it will keep in place for thousands of years.

Response DOE and Ecology acknowledge the concern expressed in the comment. DOE and Ecology are fully committed to the intent, as well as the milestone requirements in the 1994 Tri-Party Agreement and amendments to the Tri-Party Agreement.

Comment Number 0074.01

Sims, Lynn

Comment I think one of the issues here is that this project that we're talking about is probably the largest civil works project, the most expensive, and the most dangerous project ever attempted by mankind in history. And we're all very concerned about it and want to do the best we can to make it work. And that's, everybody is emotionally involved with this, and there might not be any good solutions, except to try to keep it out of the water, out of the Columbia River.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and the response to Comment number 0026.02 for a discussion of impacts analyzed in the EIS, including impacts to groundwater and the Columbia River.

Preferences Related to Tank Waste Removal

Comment Number 0012.02

ODOE

Comment Oregonians oppose all tank waste options which leave significant amounts of waste in Hanford tanks. The cumulative impacts from all of the past activities at Hanford on public health and safety, the environment and the Columbia River make it inappropriate to consider leaving any of the tank wastes in place. The Northwest has shouldered more than a fair share of the cold war burden and its legacy. Hanford's cleanup mission must proceed.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Cumulative impacts from the TWRS alternatives and other proposed or reasonably foreseeable related actions are presented in Volume One, Section 5.13.

Comment Number 0012.04

ODOE

Comment The other alternatives under consideration leave most or all of the wastes in the tanks. With the exception of in situ vitrification, which is an undeveloped and unproven technology, other alternatives do little to remove the hazards posed by the wastes. To reduce the risks to people, these alternatives would require permanent closure of Hanford lands to other uses. Sacrificing Hanford in this way does not adequately reduce the harm and risks to the environment or to future generations. For these alternatives, the risk analyses in the EIS show massive plumes of radioactive material slowly moving across the Hanford site and into the Columbia River for hundreds to thousands of years.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Technical uncertainty of undeveloped or unproven technology, and the long-term risk associated with the various alternatives were factors analyzed by DOE and Ecology for each alternative. This information is presented in Volume One, Section 5.4. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. As stated in Volume One, Section 3.3, decision on closure of the tank farms will be made in the future. Additional analysis will be performed at that time concerning any additional measures that need to be taken to protect the groundwater and its future potential users. The TWRS EIS addresses the management, retrieval, treatment, storage, and disposal of the tank waste and does not address final remediation of the tank farm residuals, equipment, or soil contamination. For more information on closure, please refer to the response to Comment number 0072.08.

Comment Number 0012.05

ODOE

Comment Cost should not be the sole or even predominant criteria used to select among the alternatives. The first criteria that must be applied is protection of public health and safety and the environment. This criteria eliminates all of the alternatives which leave all or part of the waste in the tanks, except in situ vitrification. The EIS claims a lower risk for in situ vitrification, but because in situ vitrification technology is uncertain, the potential for failure is unacceptably high. We strongly oppose all of the alternatives which leave the waste in Hanford's tanks.

Also, the cost analyses do not include the lost value of the lands or the costs from harm to future generations or the environment. Ultimately, the costs of these alternatives would prove to be much greater than removing and cleaning up the wastes, as called for by the preferred alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume One, Section 5.12 contains discussions of accident risk for each alternative. The EIS discusses long-term loss of land use and immediate and potential future risks to human health impacts. Neither is analyzed in terms of cost because a dollar value to human life and the land cannot be assumed.

Cost and risk to human health and the environment were several factors analyzed by DOE and Ecology for each alternative. Assessing the economic impact due to lost land value or harm to future generations other than health impacts or the environment were beyond the scope of this EIS and were not considered. Each impact was analyzed using a consistent methodology. The results were objectively presented in the EIS for the public and the decision makers. DOE and Ecology are committed to the Tri-Party Agreement requirement that no residual volume greater than 1 percent remain in the given tank, unless this requirement is not technically achievable.

Comment Number 0037.01

Eldredge, Maureen

Comment The risks in this EIS show clearly that the only responsible option is retrieving all the waste. This needs to start happening now.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0021.01.

Comment Number 0073.01

Yazzolino, Brad

Comment I simply wanted to put this in perspective, in the sense that I'm in the art world. The art world is basically lasts for thousands of years in the same sense that the radioactivity does. And I've been immersed in the geology of the

Hanford area for the last year or so, and some other aspects about the river. And basically you need to remove the radioactive material from its proximity to the river because in fact that river valley has been there for about 21 million years. And it's going to persist in that area, and it's going to eventually wash your radioactivity to the sea, and spread it all over the river valley if you leave it there. It needs to be removed.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The long-term impacts associated with tank waste alternatives, including impacts for alternatives that would leave all or part of the waste in place in the tanks and others that would retrieve the greatest extent of waste practicable, were among the factors analyzed in the EIS. This analysis included human health and groundwater impacts that were calculated to 10,000 years in the future, as well as impacts associated with climate changes that potentially would result in the situation described in the comment. The response to Comment numbers 0012.01 and 0012.15 discusses the impact of past tank leaks and current efforts to determine the extent to which these leaks have impacted the area beneath the tanks.

Comment Number 0090.04

Postcard

Comment Please listen to us say no:

to leaving High-Level Nuclear Waste in our ground.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0026.02 for a discussion of the extent to which each of the alternatives would result in onsite disposal of HLW.

Comment Number 0091.02

Dyson, Jessica

Comment It is time to stop being in denial and start making public safety your utmost concern. In doing so, you must follow the Tri-Party Agreement and vitrify all the waste in the tank and it is not acceptable to leave any waste in the tank because that could pose a danger to the public in the future.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The DOE and Ecology preferred alternative, Phased Implementation, would comply with the requirement of the Tri-Party Agreement. As indicated in Volume One, Section 2.0, the underlying need for action is to "reduce existing and potential future risk to the public, Site workers, and the environment." DOE also must take action to "ensure compliance with Federal and Washington State laws regulating the management and disposal" of the tank waste and the cesium and strontium capsules. These underlying needs for the proposed action are also the basis for the continued management of the tank waste by the TWRS program, as described in Volume One, Section 3.2. Please refer to the response to Comment number 0026.02 for a discussion of the extent to which each alternative would retrieve waste from the tanks.

Preferences Related to Privatization

Comment Number 0014.04

Bullington, Darryl C.

Comment If Congress is really serious about containing existing hazardous wastes along with adequate monitoring and emergency planning it should set aside funds in separate easily identified accounts which are not subject to whatever political whim that comes along to be used exclusively to:

1. Identify the size of all waste streams from all anticipated future sources and then establish a final repository sufficiently large to accommodate the demand for storage as required.
2. Monitor the integrity of all existing tanks and establish plans and funds to reduce the danger of further leakage including emergency plans should further leakage occur.
3. Reduce the options for safely confining stored wastes to several that can be achieved in the time frame established using existing technology and involving a minimum of time consuming and costly research and development. Chosen methods should have a high probability of accomplishing all milestones with the least risk to the public and the workers involved. Funds should also be set aside for insurance purposes should accidents occur. Safety of the public and the environment should take precedence over providing jobs or solving other social needs. These few alternatives, assuming that all the 50,000 curies of plutonium can be excluded from the biosphere, should then be contrasted with the do-nothing alternative. The report should show the costs and consequences of each alternative including a discussion of accidents that may occur along the entire pathway until confinement.

Response The purpose of this EIS is to present and analyze the range of reasonable alternatives that are available to remediate the tank waste at Hanford. Please refer to the response to Comment number 0072.05. DOE Richland Operations Office prepares a budget each year, which includes requests for funds used for cleanup; however, only Congress has the authority to appropriate funds. Congressional funding issues were not included in the scope of this EIS.

There are several ongoing activities involved with collecting and analyzing data on tank contents. Tank inventory data are presented in Volume Two, Appendix A (Tables A.2.1.1, A.2.1.2, and A.2.1.3), and waste projections for future tank waste additions are shown in Table A.2.4.1. Please refer to the response to Comment numbers 0012.14 and 0072.07 for a discussion of the tank waste inventory and characterization methods planned or currently under way.

Establishing a final repository is not included in the scope of this EIS; however, for the purposes of analyzing the alternatives presented in this EIS, a potential geologic repository candidate site at Yucca Mountain, Nevada was assumed to be the final disposal site. A discussion of the requirement for HLW disposal in a geologic repository is provided in Volume One, Section 6.2.

The TWRS program also includes monitoring the integrity of tanks and characterizing the vadose zone around the tank farms to detect leaks. DOE also conducts numerous activities to provide continued safe storage of the tank waste, and emergency plans have been developed and are in place. Descriptions of ongoing programs and tank safety issues are presented in Volume One, Section 3.2 and Volume Two, Appendix B, respectively. All monitoring and safety programs (Section 3.4) would continue through remediation. DOE is required to mitigate all accidents involving releases to the environment and Volume One, Section 5.20 identifies potential mitigation measures that could be implemented to alleviate the environmental impacts of the alternatives.

A range of reasonable alternatives was analyzed for the TWRS EIS, including the No Action alternative and alternatives involving extensive retrieval. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The purpose of the EIS is to present the results of impact analyses in the most objective manner possible. These results will also be used by the decision makers to select an alternative and prepare the ROD. Volume One, Section 3.7 and Volume Two, Appendix B contain summary discussions of the alternatives comparisons. The Summary, Section S.7 contains an alternatives comparison, based on impact type and Volume One, Section 5.14 summarizes the environmental impacts of each alternative.

Comment Number 0017.01

Fisk, Charles P.

Comment Given Westinghouse's, Battelle's, etc. dismal performances, I certainly would not recommend privatization! Government created the mess and government should accept cost of remediation, not some for-profit corporation.

Response DOE and Ecology acknowledge the recommendation expressed in the comment. Although the contracting strategy known as privatization is not addressed in the EIS, the discussion of the Phased Implementation alternative does address the technical strategy of an incremental approach to tank waste remediation. Please refer to Volume One, Sections 3.3 and 3.4 of the EIS for more information on alternatives implementation and the Phased Implementation alternative.

Comment Number 0017.02

Fisk, Charles P.

Comment The "preferred alternative" is full of holes, as HEAL has persuasively analyzed far better than I can.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives and the response to Comment number 0009.19 for reasons Phased Implementation is the identified preferred alternative.

Comment Number 0017.03

Fisk, Charles P.

Comment The <u>entire</u> amount of waste needs to be vitrified, not just 25 percent of it, regardless of the cost. If, as Republicans propose, we could afford a continuation of "Star Wars", we can be assuredly cancel that wasteful idea and put the money into a completed and thorough clean up of the mess.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Cost was one factor analyzed by DOE and Ecology for each of the alternatives. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. For a discussion of the extent to which each alternative would result in waste retrieval and/or treatment please refer to the response to Comment number 0026.02. DOE and Ecology note that the preferred alternative would result in remediation of all waste practicably or no less than 99 percent.

Comment Number 0017.04

Fisk, Charles P.

Comment We have the technology for vitrification; now get with it and DO IT! The Columbia River deserves maximum protection as soon as possible.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology are committed to protecting the Columbia River. The response to Comment number 0012.01 addresses groundwater contamination and vadose zone characterization and monitoring. Please also refer to the response to Comment number 0072.05 for discussion of the approach to analyzing alternatives and technologies in the EIS.

Comment Number 0060.01

Davenport, Leslie C.

Comment I support the preferred Phased Implementation alternative, but with some changes; primarily that only one separations/LAW/HLW processing facility be built by a private contractor during Phase 1. The primary reason for this choice is that it can meet the Tri-Party Agreement and yet result in the minimization of overall costs and ultimately facilities needing decontamination and disposal. Whether additional separations should remove technetium, cesium, strontium, and TRU elements should be left to engineering judgement, dependent primarily on meeting required LAW product specifications for disposal onsite in near-surface retrievable disposal vaults. The other primary consideration would be to ensure that interim and final disposition methods for TRU elements always are critically safe.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. DOE and Ecology remain committed to compliance with the Tri-Party Agreement under which the general requirements for the preferred alternative were renegotiated in 1994. Specific separations technologies will be evaluated during the detailed design phase that will follow the final remedy selection and the ROD. Separation technologies, along with removal and immobilization technologies, will be tested during the demonstration phase (Phase 1).

Comment Number 0078.07

ODOE

Comment USDOE must move forward with cleanup as quickly as possible. USDOE must commit to remove all the waste from the tanks and convert it to a durable and stable waste form. The privatization alternative is the only alternative of the four acceptable alternatives that can be done soon. All of the others will involve extensive delays.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05, 0076.03, and 0009.19.

Miscellaneous Preferences Related to the Alternatives

Comment Number 0032.03

Heacock, Harold

Comment We also do not believe the technical feasibility of several of the in situ treatment processes has been demonstrated adequately to seriously consider them as viable alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. ISV is a relatively new process that has not been tried at this scale previously, but was considered a potentially viable alternative. Implementability issues for each of the alternatives are discussed in Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to response to Comment numbers 0072.10 and 0072.80 for information on NEPA requirement to consider reasonable alternatives in the EIS.

Comment Number 0035.02

Martin, Todd

Comment It continues to debate issues that have long been laid to rest, such as what is the waste form that we will use at Hanford. The preferred alternative does not mandate the glasses used. It does not mandate vitrification. It should. We have made that decision. Let's go forward.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Vitrification and glass-types were analyzed for the HLW disposal; however, DOE and Ecology have identified the treatment process for the LAW as immobilization rather than vitrification for the Phased Implementation alternative. As identified in Volume One, Section 3.4 and Volume Two, Section B.3 of the EIS, LAW would be processed using a technology that would meet LAW specifications. These specifications would be performance based, using vitrification as a benchmark, and would have specific requirements for size, chemical composition limits, isotopic content, and physical parameters. Even though the Tri-Party Agreement suggests that certain decisions have been made, NEPA requires an objective analysis of all reasonable alternatives. Please refer to the response to Comment numbers 0060.02, 0005.07, and 0034.05.

This approach to LAW treatment is consistent with the Tank Waste Task Force (HWTF 1993) recommendation to use the most practicable, timely, available technology, while leaving room for future innovation. All HLW removed from the tanks and that remains after separations will be vitrified under the preferred alternative. Please refer to the response to Comment number 0009.19 for a discussion of the reasons Phased Implementation is identified as the preferred alternative.

Comment Number 0036.09

HEAL

Comment HEAL supports the preferred alternative's pretreatment process.

The TWRS Task Force values on pretreatment are explicit and strongly held. According to the TWRS Task Force Final Report:

The high cost and uncertainty of high-tech pretreatment and R&D threatens funding for higher performance low-level waste forms, vitrification, and cleanup. Use the most practicable, timely, available technology, while leaving room for future innovation. Keep a folio of technological options and make strategic investments over time to support a limited number of promising options. Give up further research on unlikely options (TWTF p. 11)

The intermediate separations case is response to this value (although the difficult challenge of technetium removal in the Phased Implementation alternative is a concern). HEAL strongly opposes any movement toward an extensive separations pretreatment technology.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0098.02.

Comment Number 0046.04

DiGirolamo, Linda Raye

Comment Yes, encase in glass and bury this "CRUD" and more importantly... Stop all future plutonium fuel rod production at once. New Age Energy must be embarked upon at once to save man and the earth.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0059.01

James Jordan Associates

Comment JJA recommends that the Environmental Impact Statement include in its analysis an alternative concept invented by Drs. Morris Reich, James Powell, and Robert Barletta of Brookhaven National Laboratory for the safe immobilization and isolation from-the-environment radioactive waste. This novel concept has the potential of being the safest, least costly, and most expeditious method for the disposal of the various radioactive wastes currently stored in the underground storage tanks at Hanford, including, if desired, the vitrification of the cesium and strontium capsules located at the Hanford Site.

This system which uses modular canisters with integral vitrification capability does not require an upgrade to the tank farm waste transfer system. This system will not require the construction of extensive buried transfer lines that is included in all of the alternatives except the No Action alternative. Indeed, the elimination of the complex tank farm waste transfer system significantly reduces the potential for short-term impacts of human health and the environment. Using modular canisters with integral vitrification provides for a dramatic reduction in the risk of long-term impacts on the public health and the environment in that the system does not have a large central vitrification facility to deactivate and dispose of at the end of the vitrification campaign. Compared to a conventional vitrifier, the in-can vitrifier does not require the pouring of molten radioactive glass.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Draft EIS addressed the full range of reasonable alternatives. The alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS. DOE and Ecology therefore believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment numbers 0072.05, 0072.79, and 0097.01.

Comment Number 0060.02

Davenport, Leslie C.

Comment Both continued management alternatives are unacceptable for the long term.

The Minimal Waste Retrieval (In Situ) alternatives do not meet waste disposal laws, regulations, and policies and I feel are unacceptable in the long term. The In Situ Fill and Cap would not immobilize the wastes, only fill the tanks with gravel (creating more contaminated waste) and keep it all onsite in a form that would eventually leach to the groundwater. The In Situ Vitrification alternative is interesting and perhaps could be used on some of the small Multiple Underground Storage Tanks (MUSTs) that contain lower amounts of radioactivity, but the degree of technical uncertainty is too high to consider application to an entire tank farm of up to 20 tanks at once. Verifying that all tanks are completely vitrified down to 60 ft below the ground surface is nearly impossible, and there is no way to immobilize radionuclide plumes below the leaking SSTs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not comply with laws and regulations. The TWRS EIS addresses 10 alternatives for tank waste, ranging from No Action to extensive retrieval, and four alternatives for the cesium and strontium capsules. Please refer to the response to Comment numbers 0072.80 and 0072.10 for a discussion of the NEPA requirement to include a No Action alternative in the EIS analyses.

Comment Number 0060.03

Davenport, Leslie C.

Comment The partial waste retrieval alternatives do not meet waste disposal laws, regulations, and policies because they would retrieve only 90 percent or less of the radionuclides. I feel they will be deemed unacceptable in the future, thereby necessitating additional future operations to finish the job.

Response DOE and Ecology acknowledge the concerns presented in the comment. DOE and Ecology remain committed to compliance with the Tri-Party Agreement, which requires removal of all technically achievable waste or no less than 99 percent of the waste from each tank. Please refer to the response to Comment number 0060.02 and for discussions of the NEPA requirement to address a range of alternatives including alternatives that do not comply with regulations. Refer to the response to Comment numbers 0072.80 and 0072.10.

Comment Number 0060.04

Davenport, Leslie C.

Comment The extensive waste retrieval (ex situ) alternatives appear to be the only acceptable methods to deal with the approximately 200 MCi of radionuclides. However, the Ex Situ No Separations alternative appears to be too expensive because all tank wastes would be vitrified and/or calcined, resulting in too many high-level waste packages to ship to and store in a waste repository. The Ex Situ Intermediate and Extensive Separations alternatives are difficult to choose between, because the efficiency of the sludge washing, ion exchange, and multiple complex chemical separations processes are not fully known for the various types of tank wastes. Hence, those two alternatives should be compared in a pilot plant using a Phased Implementation (possibly along with the In Situ Vitrification alternative applied selectively, particularly for MUSTs, and SSTs that have not leaked).

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Technical evaluation, categorization of tank waste, and application of appropriate technology would be conducted during Phase 1 (demonstration phase) of Phased Implementation and during the detailed design phase of any alternative analyzed in the EIS. Volume One, Section 3.4 includes descriptions of the processes, cost, and Implementability for each tank waste alternative. Volume One, Section 5.14 provides a summary of the environmental impacts for each tank waste alternative. The EIS provides

the basis for comparison among the alternatives identified. DOE and Ecology believe sufficient differentiation exists between the alternatives to support a decision on the alternative to be implemented; therefore, a demonstration phase comparison of the two alternatives would postpone remediation.

Comment Number 0072.10

CTUIR

Comment The Tri-Party Agreement mandates full retrieval as the goal; only if this is not practicable on a tank-by-tank basis can lower retrieval goals be negotiated. Therefore, the in situ alternatives are not allowed and did not have to be evaluated.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

As required by the CEQ, the TWRS Draft EIS identifies and analyzes a range of reasonable alternatives for the proposed action, including those that are "not within the jurisdiction" of the agency (40 CFR 1502.14). DOE guidance on NEPA requires that EIS alternatives be addressed even if there is "conflict with lawfully established requirements" (DOE 1993d). However, the Agency is required to identify the laws and regulations that apply to each alternative and indicate if the alternative, if selected for implementation, would comply with applicable laws and regulations. This information must be provided to the public and the decision makers. Therefore, the failure to comply with the Tri-Party Agreement is not sufficient basis for excluding an alternative from detailed analysis in the EIS (40 CFR 1502.2d). A discussion of the methods used to develop the alternatives in compliance with NEPA requirements is presented in the response to Comment number 0072.05. Please refer to the response to Comment numbers 0072.80 and 0072.52.

Comment Number 0072.16

CTUIR

Comment In situ alternatives were not necessary since they are not allowed under the Tri-Party Agreement.

Response Please refer to the response to Comment numbers 0072.10 , 0072.52, and 0072.80.

Comment Number 0076.03

Blazek, Mary Lou

Comment The preferred alternative relies on using proven technology, and using a phased approach. We think a learn as you go approach makes sense, given the history of Hanford. And that should identify problems earlier, and at smaller economic and environmental cost.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Preferred Alternative would allow DOE to proceed with tank waste remediation. System modifications would be evaluated as waste inventory, removal method, separations, and disposal data are collected and analyzed during the Phase 1 demonstration. This continuous improvement is the cornerstone of the "learn and improve while doing" approach cited in the comment. Please refer to the response to Comment numbers 0060.04, 0060.02, and 0009.19 for more information on the preferred alternative.

Comment Number 0077.02

ODOE

Comment Leaving wastes in the tanks poses huge risks. The tanks are corroding and failing. As they fail, the radioactive waste is released to the soil and ultimately to the groundwater and to the Columbia River. Vitrifying the tank waste makes it far more stable and greatly reduces the threat to the public and the environment. While the cost of the preferred alternative is substantial, it is the only alternative which satisfactorily deals with the dangers presented by these wastes as quickly as practical. The phased approach allows USDOE to get on with cleanup while allowing for possible development of better approaches which remove all tank wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0076.03 and 0060.04. The response to Comment number 0091.01 addresses protection of the Columbia River in relation to the preferred alternative.

Comment Number 0078.02

ODOE

Comment Unacceptable Alternatives

The EIS evaluates the alternatives USDOE believes are available for the tank waste. Four alternatives are unacceptable because they could allow exposures to the environment and the public at levels higher than allowed. These include:

1. Two alternatives manage the waste as is; in failing tanks,
2. Two alternatives leave all or most of the tank waste in the tanks covered with sand and a complex barrier to keep rain water out,
3. One alternative proposed vitrifying all of the waste in the tanks in place.

A sixth alternative was added as the EIS went to print. This alternative is included in the cover letter for the EIS and is not analyzed in depth in the EIS. It would leave most of the waste in the SSTs, fill the tanks with sand and cover them with a barrier.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. NEPA requires an EIS address a comprehensive range of reasonable alternatives. The TWRS EIS fully addresses 10 alternatives for tank waste, which includes no action, long-term management, in situ, ex situ, and combination alternatives. NEPA also requires that these alternatives be analyzed regardless of regulatory compliance to allow an even-handed analysis of all factors, as discussed in the response to Comment number 0072.80. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0078.03

ODOE

Comment

Unacceptable Alternatives

The EIS includes four alternatives which meet legal requirements. These are:

1. Retrieve all of the waste, glassify it and sent it to a national high-level nuclear waste repository,
2. Retrieve all of the waste, use extensive chemical processes to separate the nonradioactive portions from the radioactive portions, glassify them and send the glass to a national high-level nuclear waste repository,
3. Retrieve all of the waste, use less extensive separations of the waste into high-activity and low-activity fractions, glassify, both, bury the low-activity fraction at Hanford and send the high-activity fraction to a national high-level waste repository (Government owned and contractor operated),
4. Do the same as three, but do it in phases using private companies to build and operate the plants. (This is the preferred alternatives in the EIS).

If privatization fails, the Tri-Party Agreement requires USDOE to revert to government owned and operated vitrification plants.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment number 0072.80 for a discussion of the NEPA requirements to analyze a full range of alternatives in an EIS regardless of regulatory compliance.

Comment Number 0079.01

Knight, Paige

Comment Hanford Watch supports the phased implementation plan, not because it's so great, but because it gets the waste out of the tanks. It is our conviction that waste must be removed from the tanks and put in a stable form. If this new preferred alternative reaches a point of failure, you must be prepared to turn back immediately to the path outlined in the Tri-Party Agreement, and follow the advice given by the Tank Waste Task Force, in the summer and fall of 1993. That advice can be summed up in the words get on with cleanup. The public has stated time and time again that the DOE must get on with it. Hear us. Do not change paths again.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0076.03. Please also refer to the response to Comment numbers 0009.19 and 0060.02 for more information on the reasons Phased Implementation was identified as the preferred alternative.

Comment Number 0079.03

Knight, Paige

Comment The alternative of long-term management also is unacceptable because according to the TWRS EIS that document will end in, that management will end in 100 years. This possibility the amount of time previous to the waste plumes becoming a severe health risk to the public and the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment number 0040.02 and 0101.01 for a discussion of the 100-year administrative control period.

Comment Number 0079.04

Knight, Paige

Comment The in situ alternative is also unreasonable, because again no protection of the groundwater is offered, and security and external control will end in 100 years. And that's when the contamination, theoretically, is going to become a real problem for the health and environment, health of people and environment. Further, the use of riprap basalt is suggested. And we fear that this material will be taken from sites at Hanford, that are sacred to the Indian tribes.

In short, any plan to leave this deadly brew of wastes in the tanks is totally unacceptable, and will meet with the resounding opposition from the citizens of the region. Water is sacred, and must be protected at all costs.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment numbers 0091.01 and 0012.01 for discussions of groundwater issues related to current and planned monitoring programs and protection of the Columbia River.

Volume One, Section 5.7 describes the land-use impacts of the various alternatives, including impacts to potential borrow sites. Volume One, Section 5.5 describes the cultural resources impacts, including prehistoric and historic sites, and issues of potential concern to Native Americans. DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River and impacts to groundwater and the Columbia River are addressed in Volume One, Section 5.2 and Volume Four, Appendix F. Please see the response to Comment number 0019.03 for a discussion of borrow site issues. Please refer to the response to Comment number 0040.02 and 0101.01 for a discussion of the 100-year administrative control period. Response to Comment numbers 0091.01 and 0012.01 discuss groundwater issues related to current and planned monitoring programs and protection of the Columbia River.

Comment Number 0085.01

Klein, Robin

Comment Except to say that the no action alternatives, including long-term management are unacceptable options. They are not within the range of reasonable alternatives as the Draft EIS states. But are imprudent, hazardous, and in violation of the Tri-Party Agreement.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0072.52, 0072.05, 0078.02 and 0072.80.

Comment Number 0087.04

Tewksbury, Ross

Comment And I think that they should do the extensive waste retrieval and vitrify all, or nearly all of it, and whether it's stored on the site, or off the site is not really the major thing. The major thing is to get it in a form where it's not able to leak out into the groundwater and soil and the river, and everything else, and to do that as fast and as safely as possible. And I think that you should not really be concentrating on this waste separation idea that you were going over tonight, except what's absolutely necessary for the technical, chemical, and safety purposes. Because all of it has to be taken care of for hundreds, if not thousands of years. Thank you.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0072.05 and 0078.02. The phased approach to the alternative implementation is discussed in the response to Comment numbers 0060.04 and 0076.03. Groundwater protection issues are discussed in the response to Comment numbers 0091.01 and 0012.01.

Comment Number 0088.01

Porter, Lynn

Comment I guess I support the preferred alternative because it sounds better than the others.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0014.04, 0072.05, 0078.02, 0009.19, and 0060.02 for a discussion of the reasons Phase Implementation has been identified as the preferred alternative.

Comment Number 0089.01

Nez Perce Tribe ERWM

Comment The Nez Perce Tribe ERWM favors protection of the Columbia River and its ecosystem through removal and disposal of tank wastes from 200 Area tanks as supported by the EIS. ERWM believes groundwater and the Columbia River are at risk from potential radionuclide or toxic chemical releases from the tanks. We endorse the alternative calling for removal of tanks wastes through one of the Ex Situ Separations alternatives or Phased Implementation.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0014.04, 0072.05, and 0078.02.

DOE and Ecology remain committed to protecting the groundwater beneath the Hanford Site and the Columbia River and its ecosystem. An analysis of impacts to groundwater and the Columbia River are provided in Volume One, Section 5.2 and Volume Four, Appendix F. Discussions related to groundwater and protection of the Columbia River are contained in the response to Comment numbers 0091.01 and 0012.01.

Comment Number 0093.02

Devoy, Tiffany

Comment I also would like to say that I do think the Tri-Party Agreement should be followed in this case and actually in most cases and it seems odd that there is always someone trying to get out of it. It was signed and I think it should be followed. I think that they need to vitrify as much waste as possible and to leave as little waste behind as possible and I do not think that is an unrealistic expectation. There are 177 tanks and I do not even remember what was quoted to me as to how many gallons each those tanks were but it is pretty amazing and to think of all that waste concentrated and to just leave it there, I know that is not your preferred alternative, but I think some of your alternatives are not that much better. So vitrify it as much as possible, leave as little behind as possible, and follow the Tri-Party Agreement. That is about it.

Response DOE and Ecology acknowledge the preference for extensive waste retrieval, treatment, and disposal within the context of the Tri-Party Agreement expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating TWRS waste. The inclusion of alternatives in the EIS that do not comply with the Tri-Party Agreement complies with the NEPA, which is the Federal law requiring the preparation of this EIS. Please refer to the response to Comment numbers 0072.10 and 0072.80 for a discussion on requirements for inclusion of alternatives in an EIS analysis.

L.3.4.2 Elements Common to Tank Waste Alternatives

Comment Number 0098.03

Pollet, Gerald

Comment The public deserves to know how much money is going to be taken out of the authorization for Hanford clean up for the so-called privatization reserve. This process is a sham so long as an undisclosed amount of your Hanford clean up dollars are being removed in the future. Let us face it, basically the President and Congress have said you are going to have less money for Hanford clean up, we know what the President's projection is, it is seriously less than it used to be, and out of that a future chunk is going to privatization in a liability reserve but you and I can not see what it is. At the same time, the Department of Energy has target budgets now through the year 1998 which fail to fully fund essential safety and Tri-Party Agreement activities such as characterizing the wastes in these tanks. As the General Accounting Office has said, If you fail to properly characterize, you can not expect the contractors to be able to vitrify and, in fact, anyone can see down the road that the contractors are liable to say, You did not characterize properly, therefore, you owe us the full cost we put out for building the plant and our anticipated profit, we will take that 1.4 whatever billion dollar reserve it is, put it in our corporate pockets, the government will be out that money, you will have a plant that will not work because wastes were not characterized. Currently, the Department of Energy is planning in its budgets to be at least 3 years behind the Tri-Party Agreement requirement for characterizing the wastes. This can not be allowed to go forward.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The privatization contracting strategy and the budgetary process for funding the alternative selected are outside the scope of this EIS. DOE Richland Operations office prepares a budget each year, which includes funds required for cleanup; however, only Congress has the authority to appropriate funds. Please refer to the response to Comment numbers 0012.14 and 0072.14 for discussions of issues related to the tank waste inventory and ongoing efforts to characterize the tank waste.

Comment Number 0101.01

Yakama Indian Nation

Comment Unrealistic Assumptions Regarding Institutional Controls Restricting Future Human Actions --Design basis assumptions associated with the disposal of waste at Hanford optimistically assume protective conditions will exist in the future in connection with the estimation of impacts to the public

health and safety and the environment. Specifically, we consider the assumption of institutional controls restricting intruder actions or inadvertent intruder actions beyond about 130 years hence is invalid.

Response DOE and Ecology concur that intruder or trespasser activities could not be monitored or restricted beyond 100 years. The 100-year administrative control period is a bounding assumption used during the analysis of the alternatives. For all alternatives analyzed in the EIS, post-remediation risks assume that institutional controls would not exist beyond 100 years. Please refer to the response to Comment numbers 0040.02 and 0040.03 for more information regarding administrative controls. Because the information contained in the text was correct, no change was made to the document.

Comment Number 0101.04

Yakama Indian Nation

Comment Consideration of Low-Impact Waste Management Alternatives--Alternatives which evaluate impacts associated with the minimization of the volume of waste retaining a long-lived hazard (hazardous for 130 years or more) and large cask storage of stabilized wastes was not accomplished. We believe such options which were addressed in preliminary impact analyses, should be presented in the impact statement to allow full assessment of options. We consider that DOE (OCRWM) actions in preparation of the EIS to require consideration of small casks with no apparent technical or economic basis is unwarranted and capricious.

For example, the use of 10 cubic meter capacity (m^3) (360-cubic foot [ft^3] casks for storage and/or disposal of stabilized high-level radioactive wastes should be evaluated. Furthermore, consistent with evaluating alternatives which minimize the volume of waste for disposal, the option of using waste processes that would purify sodium salts (making up about 85% of the solids in the tanks) to a specific activity and hazard equivalent to Class A low-level radioactive waste with the calcination of the remaining high-level radioactive waste stream should also be specifically compared with processing options that produce larger volumes of long-lived hazardous wastes.

We note that the an additional benefit of removing sodium is the added stability of potential high-level radioactive waste forms without significant sodium, making this processing option desirable for disposal performance assessments.

Response The Ex Situ No Separations Vitrification and Ex Situ No Separations Calcination alternatives have been revised for the Final EIS to use a 10-m^3 (360-ft^3) canister for HLW storage and disposal. The size assumptions are presented in Volume One, Section 3.4 and Volume Two, Appendix B. These canister sizes have been used for impact analysis presented in Volume One, Section 5.0, Volume Three, Appendix D, Volume Four, Appendices E and F, and Volume Five, Appendices G and H. Please refer to the response to Comment number 0081.02 for related information.

The use of crystallization to remove sodium salts from the waste stream is included in the Ex Situ Extensive Separations alternative as a technology that could potentially reduce the LAW volume. This technology was not included as a primary treatment technology because it was not sufficiently mature to allow detailed evaluation. The focus of the EIS was to evaluate alternatives, rather than specific technologies, to allow sufficient flexibility to evaluate and implement emerging technologies in the future. Please refer to the response to Comment number 0072.05 for information on NEPA alternatives analysis requirements.

DOE and Ecology agree that removal of the sodium from the waste stream prior to immobilization potentially would reduce the volume of HLW for the Ex Situ No Separations Vitrification alternative and LAW for the ex situ alternatives that include separating the HLW and LAW for treatment. It would be expected that removal of the sodium would result in increasing the waste loading such that either waste form would meet waste form performance criteria. Please refer to the response to Comment numbers 0027.11 and 0008.01 for more information related to waste loading and the response to Comment numbers 0008.01 and 0009.08 for more information regarding consideration of canister (cask) size in the Draft and Final EIS.

Comment Number 0101.07

Yakama Indian Nation

Comment On another scale the impacts associated with the disposal of waste streams generated by the actions being considered must also be considered in a integrated manner. The issue associated with waste minimization and waste package sizing greatly affects disposal costs and other impacts, particularly those associated with the high-level radioactive waste deep repository at Yucca Mountain. Integration of the disposal facilities under the office of Civilian Waste Management (OCRWM) and the TWRS in DOE's overall environmental management actions should be evaluated and assessed from a systems engineering approach to resolve this issue.

We consider large savings (several billion dollars) are possible if valid systems integrations are accomplished compared to the base-line alternatives currently being pursued by DOE. These estimates stem from cost evaluations accomplished by the authors of the subject EIS.

Response Large canisters have been addressed in the Final EIS.

Please refer to the response to the following comments for more information:

- Comment numbers 0004.01 and 0081.02 - coordination with Office of Civilian Radioactive Waste Management (OCRWM) and revisions to repository cost calculations
- Comment number 0008.01 - canister size re-evaluation decision
- Comment number 0027.02 - systems engineering approach to the alternatives evaluation
- Comment number 0037.04 - relationship of the TWRS EIS to other Sitewide NEPA and programmatic documents.

The cost estimates in the EIS include contingency and a range of uncertainty based on the conceptual nature of the alternatives and standard industry practice for large capital projects. DOE expects that as detail design progresses, progress in technology optimization will result in cost savings. Please refer to response to Comment numbers 0052.04 and 0081.03.

L.3.4.2.1 Issues Related to Disposal Costs Calculations and Repository

Comment Number 0004.01

Boldt, A.L.

Comment References:

1. DOE, 1996, *Draft Environmental Impact Statement for the Tank Waste Remediation System*, DOE/EIS-0189D, U.S. Department of Energy, Richland, Washington and Washington State Department of Ecology, Olympia, Washington, April, 1996.
2. DOE, 1995, *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program*, DOE/RW-0479, U.S. Department of Energy, Washington D.C., September, 1995.
3. *Nuclear Waste Policy Amendments Act of 1987*, Public Law 100-203, December 22, 1987, 42 USC 10101 et seq.
4. Federal Register Notice, *Civilian Radioactive Waste Management; Calculating Nuclear Waste Disposal Fees for Department of Energy Defense Program Waste*, pp. 31508-31524, Vol. 52, No 161, August 20, 1987.
5. TRW, 1995, *Assessment of Pre-Closure System Cost and Health and Safety Impacts of Hanford HLW Vitrification Options on the Civilian Radioactive Waste Management System*, A00000000-01717-5705-00003, Rev. 0, TRW Environmental Safety Systems, Inc., Vienna, Virginia, April 27, 1995.

The geologic disposal costs presented in section B.3.0.8 of the draft TWRS EIS (ref 1) are based on a linear extrapolation of the unit container disposal costs provided by reference 2 for a specific scenario. The linear extrapolation of the unit container disposal cost from reference 2 to all the TWRS alternatives does not meet the requirements of the Nuclear Waste Policy Amendments Act (ref 3) and Federal Register Notice 52-161 (ref 4).

Federal Register Notice 52-161 identifies, in detail, the method to be used in estimating the disposal fees for the Department of Energy defense program HLW (HLW) share of total Civilian Radioactive Waste Management System (CRWMS) costs. Federal Register Notice 52-161 cost allocation is based on the concept of full cost recovery with sharing formulas applied to all fixed and variable system cost components.

The assumption of linear extrapolation of unit container disposal costs in the draft TWRS EIS greatly underestimates the disposal costs of the extensive separations alternative and greatly overestimates the disposal costs of the no separations alternative. Example disposal cost variability for alternate HLW container sizes and HLW volumes resulting from no separations, intermediate separations, and extensive separations using the methodology specified in Federal Register Notice 52-161 are provided in reference 5.

I am requesting that the draft TWRS EIS be revised to incorporate HLW disposal costs calculated with the methodology specified by Federal Register Notice 52-161.

Response As stated in Volume One, Section 3.4, the repository fees are based on the 1995 Analysis of the Total System Life Cycle Cost (1995 TSLCC) of the Civilian Radioactive Waste Management Program. The Draft EIS also acknowledges that the 1995 TSLCC was based on a single scenario and one repository. It is acknowledged that there is uncertainty in identifying a disposal fee prior to the final licensing of a national repository. Additional uncertainty results from analyzing various options considered in the EIS as the number of canisters varies from the baseline. However, DOE will comply with the provisions of the Nuclear Waste Policy Act requiring full cost recovery. The purpose of the cost analysis is to provide a basis for comparison among the alternatives (TWRS Draft EIS, Volume Two, Appendix B, page B-40).

In response to public comment, for the Final EIS, DOE and Ecology have reevaluated the estimate of disposal costs presented in the Draft EIS, using the 1987 methodology to more accurately reflect possible costs associated with disposal for the various canister options presented. This effort was coordinated through the OCRWM. Please refer to the response to Comment numbers 0081.02 and 0008.01 for additional information.

Comment Number 0005.44

Swanson, John L.

Comment I do not get the point of the sentence on page 3-37 "The use of a standard-sized canister does not consider waste loading, which ranges from 113,000 curies per canister to about 300-."

Response The use of the term "waste loading" here certainly could be confusing as it also refers to the waste loading of the glass with respect to percent sodium or waste oxides. Individual chemical entities such as sodium were considered in the "waste loading" of the glass. The quantity of radioisotopes and curie content was not limited in the glass formulations because the maximum heat load per canister was below the limit of 1,500 watts set for the repository.

The Final EIS was revised to include larger HLW canisters, which eliminates the need for the subject discussion in Volume One, Section 3.4. Please refer to the response to Comment numbers 0008.01 and 0081.02 for more information.

Comment Number 0008.01

Evett, Donald E.

Comment First, Current planning also assumes that this waste could be contained in approximately 18,000 standard-sized canisters. Also, there is insufficient capacity in the first repository to accept all Hanford Site -high-level waste under almost every alternative. Your study states that an estimated $360,000 cost per canister disposed of at the repository. The report alludes to the feasibility of using much larger canisters whereby the repository fees could be substantially reduced. In my opinion, I would think that the Department of Energy would vigorously pursue the much larger canisters.

Response Larger HLW canisters result in fewer waste packages for disposal at the geologic repository and offer substantial cost savings over the use of standard-sized HLW canisters. DOE is pursuing the use of HLW canisters that are larger than the standard-sized canister currently defined in the repository Waste Acceptance Systems Requirements Document (DOE 1994g). Since the Draft EIS was published, DOE-RW has acknowledged the technical feasibility of a larger canister for HLW and an independent technical review team convened to review the waste loading and blending assumptions used in the Draft EIS. The recommendations of the independent technical review team, along with the larger HLW canister specifications, have been incorporated into the ex situ alternatives for the Final EIS. The use of larger canisters and revised estimates for HLW volumes have been incorporated into the repository fee estimates shown in the Summary, Volume One, Section 3.0, and Volume Two, Appendix B. Section 3.4 describes the common assumptions for canister size and waste loading and additional detail is provided in Appendix B. Please refer to the response to Comment number 0081.02.

Comment Number 0008.02

Evett, Donald E.

Comment What happens if the Yucca Mountain project is defeated? What happens next and where will the canisters be disposed? If the year 2015 is the earliest date for acceptance of the high-level waste in canisters, where will the canisters be stored until this time? It is assumed that the use of canisters can commence much earlier than the year 2015.

Response DOE fully intends to comply with the Nuclear Waste Policy Act of 1982 as amended, which requires development of sites suitable for long-term disposal of spent nuclear fuel and HLW, and with DOE Order 5820.2A, which requires that HLW be processed and disposed of in a geologic repository. Therefore, disposal of HLW in a geologic repository was assumed and used as the basis for all alternatives involving HLW retrieval. The in situ and combination alternatives would result in onsite HLW disposal and the EIS analyzes the impacts associated with those actions. See Volume One, Section 6.0 for a discussion of the regulatory requirements and Volume One, Section 3.4 for assumptions associated with the geologic repository included in the EIS. Onsite storage at the Hanford Site for the HLW under the ex situ alternatives for up to 50 years is analyzed in the EIS. If longer-term storage is required due to delays in opening the geologic repository for disposal, appropriate NEPA analyses will be conducted.

Comment Number 0012.06

ODOE

Comment A large part of the cost shown for the vitrification alternatives included charges to dispose of the waste to the national high-level waste repository. These charges should not be used to decide whether to put the waste in a stable and durable form.

Several alternatives call for removal of all wastes from the tanks and vitrification. They differ in the methods used, complexity, speed and cost. The repository charges should be used as one criteria in deciding among these alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The cost estimates developed for each ex situ alternative presented in Volume One, Section 3.4 list the treatment cost, the estimated repository fee, and a total alternative cost range that combines treatment cost and estimated repository fee. The estimated repository fees, as acknowledged in the Draft EIS, have a high degree of uncertainty. Please refer to the response to Comment numbers 0004.01, 0008.02, and 0081.02 for more information concerning repository costs, canister size, and related uncertainties.

Comment Number 0027.02

Roecker, John H.

Comment Technical Data Manipulation

In Chapter 3 (page 3-33) DOE discusses the wide range of HLW canisters that could be produced and it makes reference to a WHC document for the low end of the range and a DOE document for the high end. The WHC document is an engineering document containing factual technical data and the DOE document is a set of comments on the TWRS System Requirement Document, which are not supported by technical data. This is another example of DOE Headquarters continuing to manipulate the technical data to support and satisfy their agenda rather than letting facts tell the story openly and honestly. Incidentally, the TWRS System Requirements Document has not yet been approved, to my knowledge, but yet here we are reviewing EIS alternatives which are supposed to be based on systems engineering. More on that later. I would request that in the Final EIS such manipulations of the technical data be eliminated and that all data be presented in accordance with standard systems engineering techniques and principles.

Response Because the alternatives evaluated in the EIS are conceptual at this time, engineering feasibility is limited to an Implementability review for each alternative. This is consistent with CEQ guidance that NEPA analysis occur as early in the decision making process as possible and always before irreversible and irretrievable commitments of resources have been made (40 CFR 1500). Following the publication of the Final EIS and approval of the TWRS

ROD, a systems engineering and safety analysis of the preferred alternative will continue during the detailed design phase of the demonstration facilities. DOE intends to continue using systems engineering as a method for evaluation and implementation of the TWRS mission. It is anticipated that the detailed design of the waste retrieval, transfer, treatment, and storage demonstration facilities will be conducted using the system engineering and safety requirements currently being developed for TWRS (and concurrently with the TWRS Draft EIS).

The EIS presents an unbiased evaluation of each of the alternatives using the best available information. More information on canister assumptions and revisions to the EIS in response to revised information on canister size can be found in the response to Comment number 0008.01

Comment Number 0027.05

Roecker, John H.

Comment Repository Cost

I am not a lawyer, but in my reading of the Nuclear Waste Policy Act (NWPA) of 1982 as amended in 1987 and the Federal Register Notice 52-161 I believe it is quite clear on how the repository fee for disposal of HLW should be calculated. The use of linear extrapolation of a unit container cost for a specific disposal scenario to calculate the repository fee for all alternatives is completely wrong, misleading and totally obscures the real cost of each alternative. The use of a linear extrapolation of unit container cost greatly understates the cost of disposal for the extensive separations alternative and greatly overstates the cost for the No Separations alternative. This is a blatant example of data manipulation to make a particular alternative look attractive and misleads both the public and decision makers.

Response Please refer to the response to Comment numbers 0004.01, 0008.01, and 0081.02.

Comment Number 0027.07

Roecker, John H.

Comment Use of 0.62 m^3 HLW Canister

Requiring Hanford to use the 0.62 m^3 canister is overly restrictive and ridiculous particularly in light of the fact that a larger canister will be required for spent nuclear fuel. A larger HLW canister is a significant advantage for Hanford waste disposal and should be utilized.

Response DOE and Ecology recognize the potential benefits of using a larger canister for HLW. The use of larger HLW canisters has been included in the Final EIS. The size assumptions are presented in Volume One, Section 3.4 and Volume Two, Appendix B. These canister sizes have been used for impact analysis presented in Volume One, Section 5.0 and Appendices D, E, F, G, and H. Please also refer to the response to Comment number 0008.01 for more information on canister size and related impact on repository costs.

Comment Number 0035.04

Martin, Todd

Comment A clear stakeholder value has been that Yucca Mountain should not drive decision. We have said that the best waste form should determine which waste form is used, not the site, nor size, nor cost of a speculated national repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Repository considerations associated with the size, location, and cost of the potential repository did not drive the EIS analysis of waste form. The waste forms analyzed in the EIS are discussed relative to their ability to comply with existing waste acceptance criteria at the proposed repository; however, the analysis shows that the only waste form acceptable at the proposed repository is the one presently identified in the Tri-Party Agreement. This waste form is a borosilicate glass. Further, the information regarding timing is presented to provide a base case plan for analysis of impacts as required under NEPA. Information regarding the size of the repository is presented to inform decision makers and the public of the potential impact of TWRS waste on planning for the repository and the potential need for a second repository. In all cases, the EIS assumes, for purposes of impact analysis, that the waste would be stored on an interim basis at the Hanford Site and ultimately shipped for disposal at a geologic repository. The Final EIS has been revised to provide for up to 50 years of interim storage onsite. Each ex situ alternative includes interim onsite storage large enough to hold all HLW produced. This allows the waste treatment program to move forward with out relying on the geologic repository. The interim storage method provides for shielded storage of the immobilized HLW, protective of human health and the environment.

This is consistent with the Tank Waste Task Force value that DOE "accept the fact that interim storage, at least, of the waste in an environmentally safe form will occur for some time at Hanford" (HWTF 1993). Later in the Tank Waste Task Force report when addressing waste storage, a discussion is included that advises DOE to "assume temporary storage will occur at Hanford but don't assume that all radionuclides should be here forever." Please refer to the response to Comment numbers 0008.02, 0004.01, 0038.10, 0052.01, 0035.04, 0012.11, and 0055.03 for all issues related to tank waste disposal and the TWTF.

Comment Number 0035.05

Martin, Todd

Comment I would like to address the cost estimates and how they effect the TWRS EIS, particularly in regards to Yucca Mountain.

If you look at some of the simple technical assumptions that are made in the EIS, such as waste loading, the amount of waste that gets into the glass, it dramatically affects cost.

The waste loading has been altered by a mere factor of a little bit more than 10 percent over the last couple of months. Some of the blending assumptions have been changed.

What does that do to cost? If you look at the preferred alternative, it changes the repository cost from four billion dollars all the way up to 12 billion dollars. That is a big impact for such a small change.

The no separations options, change the canister size. What does that do to the cost? It changes the repository cost from about 13 billion all the way up to over 250 billion dollars.

These overly conservative assumptions and the uncertainty with the repository are driving the costs that we see in this EIS. That is inappropriate, and the stakeholders have made that clear in the past.

Response The repository fees presented in the Draft EIS for the ex situ alternatives were overly conservative, but consistent with the published information DOE had at the time the Draft EIS was published. The Final EIS has been modified based on new guidance from the repository and an independent technical review of the Draft EIS. Please refer to the response to Comment numbers 0004.01 (repository fees and associated uncertainty), 0008.01 (canister size assumptions and associated changes in repository costs), 0027.11 (HLW waste loading), 0035.04 (comprehensive repository issues), and 0081.02 (separation of respository costs from alternative costs).

Comment Number 0036.01

HEAL

Comment Unfortunately, the repository plays an important role in the cost analysis of EIS alternatives. The EIS does include the speculated repository cost as a separate cost item, allowing the careful reader to see the role the repository plays in cost. This is an improvement. But many will not read beyond the Summary -- where the total cost is the only number available. The EIS itself makes a very good case for removing the repository cost numbers:

(The estimate of repository disposal costs)"... is an estimate based on numerous assumptions. Nor should the assumptions used in the analysis be interpreted as final DOE policy. The program is in the early stages of development and design concepts for items such as the repository surface facility, underground layouts, and waste packages are very preliminary. The techniques used to estimate the total system cost were appropriate to the limited level of design development and entail a corresponding level of uncertainty ... There is a high degree of uncertainty in using a fixed cost per canister for geologic disposal over the wide range in the number of canisters that would be produced for the TWRS alternatives." (p. 3-37)

In other words, there is almost no basis for the repository disposal costs and they should not be trusted.

The continued high-profile role of the speculated repository is unacceptable. It goes against past stakeholder values and common sense. Further, the EIS itself says that DOE will bring the program to a safely stored state at Hanford, regardless of the repository's existence. Each of the ex situ alternatives will include onsite storage sufficient for ALL the waste. According to the EIS, "This would allow each of the alternatives to operate independent of the acceptance schedule for the potential geologic repository" (p. 3-38). The Final EIS must be rewritten in such a way as to clearly put the repository in perspective and dramatically reduce the role the repository plays in the document.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Final EIS has been revised to discuss HLW disposal at the geologic repository

and the associated cost separately. See Volume One, Section 3.7 and Volume Two, Section B.9 for the revised discussion of HLW disposal at the geologic repository. Please refer to the response to Comment numbers 0004.01, 0008.02, 0035.04, and 0081.02.

Comment Number 0036.02

HEAL

Comment The EIS is biased to maximize the cost impact of the national repository.

Over the last few months, changes in waste loading, blending, and canister assumptions have maximized repository costs. The assumption changes are a radical departure from past TWRS assumptions and are not based on any evident engineering data.

Assuming waste loadings similar to those in Tri-Party Agreement studies results in the following repository fees:

- about $4 billion dollars for the "Phased Implementation" alternative.
- about $13 billion for the "no separations" alternative.

After the assumptions were changed, the "Phased Implementation" repository fee rose to about $12 billion and the "no separations" skyrocketed to over $250 billion. Meanwhile, the repository fee for extensive separations stayed relatively constant.

These assumptions may seem minor, but obviously have a large -- and inappropriate -- impact.

Response DOE and Ecology acknowledge that the repository fees presented in the Draft EIS for the ex situ alternatives were overly conservative. The data to support the TWRS EIS assumptions, analysis, and calculations were cited in the Draft EIS and engineering data packages, and calculations were provided for public review in DOE Reading Rooms and Information Repositories. The Final EIS has been modified based on new guidance from the repository and an independent review of the Draft EIS. Please refer to the response to Comment numbers 0004.01, 0008.02, 0035.04, and 0081.02.

Comment Number 0037.03

Eldredge, Maureen

Comment I am concerned about the cost estimates in the program, particularly including repository costs. It does not make any sense. It is ludicrous. We do not have a repository. DOE needs to wake up to that fact.

We are not going to get a repository any time soon, not by 2015. It is just not going to happen. We do not know what the repository, if we ever get one, will look like. We do not know what its loading requirements will be. We do not know what its technical capabilities will be. We do not know what its size will be.

Any predictions of cost for a repository are highly speculative. Even if Yucca Mountain by some chance happened to open in any kind of reasonable time frame, the first people in line are the commercial nuclear utilities.

And believe me, they are going to make sure they keep their place first in line. And they are going to make sure all of their waste gets into the facility before any defense waste gets a chance.

Even if defense waste gets in the door, only 10 percent of the repository is slated to be for defense high-level waste. And I am afraid that we are going to run out of space at Yucca Mountain at least very soon, if it opens at all.

Then we are looking at a really fun option of going for a second repository. It is just not going to happen. And it is time to start making plans and start looking at the future with more reasonable expectations.

Response The siting, design, and licensing of a geologic repository to isolate spent nuclear fuel and HLW for long-term protection of public health and safety of the environment is a highly technical and complex process. As stated in Volume One, Section 6.2, the current program planning assumption is that any DOE material qualified and selected for emplacement in the first repository would be disposed of beginning in the year 2015.

As stated in the EIS, current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository. The ex situ alternatives presented in the TWRS EIS were developed to be consistent with this policy. Current projections for commercial spent nuclear fuel and defense HLW exceed the statutory limit of 70,000 equivalent metric ton heavy metal (MTHM) in the first repository. The need for a second repository will not be addressed until between January 1, 2007 and January 1, 2010 when the Secretary of Energy is required to report to the President and Congress under the Nuclear Waste Policy Act. Please refer to the response to Comment numbers 0004.01, 0008.02, 0012.20, 0035.04, and 0069.04 for additional information.

Comment Number 0038.10

Reeves, Merilyn

Comment The cost of the national repository, which you have heard about tonight, it should be removed from the EIS. The hypothetical, national repository has been a driver for the tank waste treatment and disposal decisions. And this is not in the best interest of cleanup at Hanford.

The Tank Waste Task Force of 1993 was very clear, quote, let the ultimate best form for the waste drive decisions, not the size, nor the timing of the national repository.

The repository costs are not broken out in the summary, misleading the reader by not communicating the importance of repository costs for each option. And the speculated cost of repository should be removed from the EIS.

Response The presentation of the cost estimates has been revised for the Final EIS by separating the cost and discussion regarding HLW disposal. See Volume One, Section 3.7 and Volume Two, Section B.9 for HLW disposal costs. There are real costs associated with disposal of HLW at the geologic repository, and removal of these cost estimates from the EIS would not allow for an equitable comparison among the alternatives as required under the NEPA process. It is necessary to show these costs in the EIS to fully inform the public and the decision makers of the total cost of the alternatives. Please refer to the response to Comment numbers 0004.01, 0008.01, 0035.04, 0052.01, 0069.04 and 0081.02 for additional information on issues related to cost estimates, the geologic repository, waste loading and waste forms, and interim onsite storage.

Comment Number 0050.01

Boldt, A.L.

Comment I have a comment on the Draft EIS disposal cost. The geologic disposal cost presented in the Draft EIS are based on the linear extrapolation of the average container disposal cost provided by the document from DORW0479 referenced in the EIS, Analysis of Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program. This analysis cost in this document was for a specific scenario of waste in a number of canisters. The linear extrapolation of this average container cost - disposal cost from this previous reference to all the TWRS alternatives does not meet the requirements of the Nuclear Waste Policy Amendments Act of 1987 and the Federal Register Notice 52161, the Civilian Radioactive Waste Management Calculating Nuclear Waste Disposal Fees for the Department of Energy Defense Program Waste.

Federal Register Notice 52161 identifies, in detail, the method to be used in estimating the disposal fees for the Department of Energy Defense Program HLW share of the Civilian Radioactive Waste Management System costs. The Federal Register Notice 52161 cost allocation is based on the concept of full cost recovery with sharing formula supplied to all fixed and variable cost system or system cost components. The assumption of the linear extrapolation of average container disposal cost in the Draft EIS, greatly under estimates the disposal cost for the Extensive Separations alternative and greatly over estimates the disposal cost of the No Separations alternative. Example, disposal cost variability for alternate HLW container sizes and high-level waste volumes resulting from No Separations, intermediate separations, and extensive separations using the methodology of the Federal Register Notice 52161 are provided in a document by TRW for Environmental Safety Systems and it has long numbers on the copy I will give you but it is assessed on the pre-closure system cost health and safety in facts of Hanford high-level vitrification options on the civilian radioactive waste management system. This document is dated April 27, 1995.

I am requesting with the Draft TWRS EIS be revised to incorporate high-level waste disposal costs calculated with methodology specified in Federal Register Notice 52161.

Response Please refer to the response to Comment numbers 0004.01 (repository costs related to canisters) and 0081.02 (separation of repository, retrieval, and treatment costs).

Comment Number 0052.02

Pollet, Gerald

Comment What we need to remove from your total cost estimates is the entire set of repository fees. It is not sufficient to say that we broke out the repository fee in the details because you are still presenting a total range of cost estimates that the public and media and the decision makers are actually going to look at and they're going to say by gosh, that No Separations alternative costs a quarter trillion dollars. What kind of lunatic wanted No Separations? And what the decision makers, public, and media will not know is that, in fact, No Separation alternative actually has a rather reasonable price tag of below 30 billion dollars and that 211 billion dollars is a hypothetical repository fee for a hypothetical repository. A fee charged by the department to itself for repository which it admits in the EIS will never have the capacity for this. So it is a hypothetical fee for a hypothetical repository that the one certainty is does not have the capacity for it ever opened. There is something wrong with that picture and presenting it to decision makers, the public, and the media, it is apparent to the casual observer that someone is trying to skew the results.

Response DOE and Ecology have revised the Final EIS in response to public comment and put the costs of the repository into a separate presentation. The estimated costs for disposal of the HLW at the potential geologic repository are included in the Final EIS because there would be real costs associated with packaging, transport, and placement of HLW in a geologic repository. Eliminating the repository fees from the cost estimates presented in the EIS would not provide all of the costs associated with the alternatives and would bias presentation of the alternatives. Please refer to the response to Comment numbers 0038.10 and 0081.02 for discussion of repository costs as these issues relate to the alternatives analysis and the response to Comment numbers 0037.03 and 0008.02 for a discussion of the proposed geologic repository availability and statutory capacity.

Comment Number 0052.05

Pollet, Gerald

Comment One last closing thought for our comments tonight which is if you have a hypothetical repository fee for the hypothetical space at a hypothetical repository and the hypothetical land, then for the very real cost to the three tribes to the future generations of this region why isn't there assigned a cost for the permanent use of land in the leave it in place alternatives that are clearly being shown a preference through out all the cost estimates in this EIS. You need to consider internalizing the externalities and I would say that is less hypothetical and I think that the public could provide you and the tribes some very real cost estimates for creating a sacrifice found under the leave it there scenarios.

Response The cost estimates for the in situ or ex situ alternatives do not include cost associated with permanent land commitment, or land use restrictions associated with groundwater contamination. The amount of land committed to waste management and disposal was estimated for each of the alternatives, as was the extent of a groundwater contamination and associated human health impacts. The costs associated with long-term loss of land use or groundwater use can be understood within the overall context of the relative difference among various alternatives land use and groundwater use restrictions. The more land or groundwater is restricted the higher the cost. So while absolute dollar estimates are not provided the EIS does provide an appropriate level of analysis to support the comparison of alternatives. Land use issues related to Tribal Nation concerns are described in Volume One, Sections 5.5 and 5.19. Please also refer to the response to Comment numbers 0072.26, 0072.22, and 0036.18.

Comment Number 0055.04

Martin, Todd

Comment A third point would be that the repository should not be driving decision making at Hanford.

Response DOE and Ecology acknowledge the concern expressed in the comment. NEPA requires that all reasonable alternatives be evaluated. Consideration of geologic repository availability was included in the evaluation of the ex situ treatment alternatives in the EIS to the extent that availability was assumed; a limit would be placed on the accepted volume, type, and final waste form of Hanford materials, and the interim storage facilities would include a 50-year design life to provide sufficient time for availability. Data that support the impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and the public during the comment period. Please refer to the response to Comment numbers 0008.02, 0035.04, 0037.03, 0038.10, and 0052.01.

Comment Number 0055.05

Martin, Todd

Comment I want to address cost estimates in Yucca Mountain. I think people have heard that several times but I want to address some of the specifics. In looking at the numbers, you change a few assumptions here and there and it is amazing what it does to those cost numbers. For example in Phased Implementation when we look at the repository cost. You shift the waste loading, the amount of waste that goes into the glass by a mere 10 percent into essentially a percentage that is much lower than I have ever seen in any documents. What does that do to the repository cost for that option. Moves from 4 billion dollars to 12 billions dollars. Just a little assumption like that. Let us look at the no separation option. You take a fairly large canister, your repository cost is about 13 billion dollars. Shrink that canister down a bit and it jumps to 252 billion dollars. These are the kind of assumptions that I think that Mr. Pollet pointed out appeared to have been skewed to maximum the impact of the Yucca Mountain on the EIS. And I would agree with that assertion.

Response The changes in repository cost were a result of changes to the waste loading, HLW canister size, and use of a blending factor to account for uncertainties in the ability of the retrieval operations to deliver a uniformly blended waste feed stream to the treatment facilities. The variation in estimated repository cost based on waste loading and canister size is included in the cost ranges presented in the EIS. Please refer to the response to Comment numbers 0035.04. 0038.10, and 0081.02.

Comment Number 0057.04

Garfield, John

Comment The logic of the repository cost for example in the intermediate separations adding up to $12 billion dollars does not make sense from even the simplest technical that any member of the public can understand. The Hanford contribution to the repository in total is about 1 percent of the total radionuclides if all the high-level wastes goes to the repository and about 1 percent of the heat. Whether or not content into the small number of canisters or leave it in a large number of canisters will not significantly drive the repository costs. That is a fairly straight forward and simple approach or way of thinking about that problem that everyone can understand. Attributing $12 billion dollars to that repository or $211 billion dollars for the No Separations case does not stand up to the simplest scrutiny.

Response The amount of HLW that ultimately could be accepted at a national repository is a function of available subsurface area and emplacement constraints among HLW and spent nuclear fuel (SNF) within this area. In addition, there is a statutory limit on emplacement of HLW and SNF in a first repository (70,000 MTHM) until a second repository is in operations. As a planning basis, the Department has allocated 10 percent of that statutory capacity of the first repository for defense SNF and HLW.

The physical amount of available subsurface area for HLW and SNF disposal, and the associated number of packages of HLW and SNF, would be defined through repository design and performance assessment activities, based on information collected during repository scientific investigations. Neither of these activities are completed. However, for planning purposes, the repository Advanced Conceptual Design assumes that 12,900 canisters of defense HLW, each containing 0.5 MTHM, can be accommodated within the statutory limit.

A number of factors are important in estimating disposal costs including number and size of canisters handled, number of waste packages, operation and capital costs, and number of shipments to a repository. In addition, there are common costs that must be allocated among waste generators, such as development and evaluation costs, to ensure full cost recovery. Using radionuclide inventory of Hanford HLW relative to other wastes would not provide an equitable basis for cost estimating. For more information on this issue, refer to the response to Comment number 0005.08.

A number of factors go into the repository cost estimate including heat load, canister size, waste package design, and number of waste packages. Looking at Hanford contribution of the repository cost solely from the standpoint of radionuclide contribution to the repository would not provide a straightforward and understandable basis for cost estimating. Please refer to the response to Comment numbers 0004.01, 0008.01, and 0081.02 for additional information on repository cost estimates.

Comment Number 0062.05

Longmeyer, Richard

Comment One of the things that would need to be re-looked at is if the Yucca Mountain facility is not going to become a reality, how would that affect the prioritization of these different plans. And my guess is that the Yucca Mountain facility, or any national repository for nuclear wastes, will never receive any nuclear wastes from across state lines in my lifetime, and probably not in the lifetime of my children. And so that means that we need to re-look at this, and prioritize them again. Doing so would probably leave us with three options. The in situ vitrification, the ex situ vitrification with onsite storage, and the Phased Implementation, which you have now with onsite storage. And so, those would be the three that I would recommend we look at more closely.

Response Current national policy calls for disposal of spent nuclear fuel and HLW in a geologic repository. DOE and Ecology developed the ex situ alternatives in accordance with this policy. In response to concerns regarding the timing and availability of the geologic repository to accept HLW from the Hanford Site, the Final EIS has been revised in

Volume One, Section 3.4 and Volume Two, Appendix B to include the impacts associated with onsite interim storage of treated HLW for 50 years. The environmental impacts associated with the in situ alternatives identified in the comment are provided in the EIS in Volume One, Section 5.0 and associated appendices. Volume One, Section 5.12, and Volume Three, Appendix D contain discussions of the transportation risk associated with offsite disposal. Please refer to the response to Comment numbers 0008.02 (repository availability and related uncertainties) and 0037.03 (statutory limits), and 0052.01 (interim HLW onsite storage) for more information.

Comment Number 0072.84

CTUIR

Comment P3-28: PP 5: Does this mean you are only going to use one multi-purpose canister? Please explain in more detail in order for the readers to grasp how many and how much.

Response One type of multi-purpose canister was assumed as an overpack used for handling and interim onsite storage. This multi-purpose canister is referred to as a Hanford Multi-Purpose Canister (HMPC) throughout the document. The text has been revised in Volume One, Section 3.4 to discuss the relationship between the primary HLW canisters and the HMPC.

Comment Number 0077.05

ODOE

Comment A large part of the cost shown for the vitrification alternatives included charges to dispose of the waste to the national high-level waste repository. These charges should not be used to decide whether to put the waste in a stable and durable form.

Several alternatives call for removal of all wastes from the tanks and vitrification. They differ in the methods used, complexity, speed, and cost. The repository charges should be used as one criteria in deciding among these alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please also refer to the response to Comment numbers 0004.01, 0035.04, 0052.01, and 0081.02 for more information regarding disposal costs, assumptions, and presentation in the Final EIS.

Comment Number 0079.05

Knight, Paige

Comment Repository costs must not be included in the total cost of any plan implemented. Cleanup dollars must go first towards stabilizing waste in a quality form that is not water soluble. Repository room must be considered. If Yucca Mountain is ever a viable option, it will only hold a small portion of Hanford waste. So the form of the waste must be not only stable, but retrievable. My reasoning there is that more than likely the waste in any kind of form is going to be sitting at Hanford for at least 40 years, and I would suspect much more than that.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0008.01, 0038.10, and 0081.02.

Comment Number 0081.05

Pollet, Gerald

Comment More importantly is the next bullet in our advice. Accept the fact that interim storage at least, at least, of the waste in an environmentally safe form will occur for some time at Hanford. Select a waste form that will ensure safe interim storage of this waste. The message was, Hanford is going to be the home for the high-level nuclear waste. Select the best form, and don't even put into the mix the theoretical cost of the repository, which the Department will charge itself, nor the theoretical capacity of it, because it doesn't have the capacity to handle it anyway, under any scenario here. We request that this advice be addressed, and placed in the front of this EIS. And it be addressed in the summary and throughout. We request that the repository costs be relegated to an appendix, and the total cost summaries be redone to show the total cost without the theoretical hypothetical self-dealing charge for replacing waste in the repository. When that is done, we should examine carefully the no separation versus the extensive separation scenarios. And we should see how much we pay for unproven technology under extensive separation, versus no separation and intermediate separation.

Response The storage of the HLW at the Hanford Site for 50 years has been included in the ex situ alternatives. Please refer to the response to Comment number 0089.18. Current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository and the ex situ alternatives were developed to be consistent with this policy. DOE and Ecology have revised the presentation of the cost estimates for HLW disposal for the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B. This will allow the reader to readily compare the estimated cost for waste treatment among the alternatives. There are real costs associated with packaging, transport, and placement of canistered HLW into a geologic repository, and failure of the EIS to present these costs would provide an incomplete picture for the decision makers and public. Please refer to the response to Comment numbers 0004.01, 0035.04, 0038.10, and 0069.04.

The EIS presents in Volume One, Section 3.4 and Volume Two, Appendix B, alternatives that are based on 99 percent retrieval with no separations (the Ex Situ No Separations alternative), intermediate separations (the Ex Situ Intermediate Separations alternative), and extensive separations (the Ex Situ Extensive Separations alternative). A summary comparison of these alternatives is provided in the Summary and a summary of the environmental impacts of each alternative is presented in Volume One, Section 5.14.

Comment Number 0089.18

Nez Perce Tribe ERWM

Comment Since the possibility exists that Yucca Mountain repository may not open, the design life of the onsite facility storing the vitrified high-level waste must be sufficient for the permitting and construction of an alternate high-level waste repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume One, Section 3.4, the Summary, and Volume Two, Appendix B.3 have been revised to include reference to the 50-year design life for the interim HLW storage facilities, which is based on a conservative estimate for approval and availability of the geologic repository. Please refer to the response to Comment numbers 0008.02, 0035.04, and 0052.11.

L.3.4.2.2 Alternatives Costs

Comment Number 0005.12

Swanson, John L.

Comment I applaud you for giving cost RANGES in comparing the different alternatives, but I am very surprised that you did not include the (large) uncertainties in HLW repository disposal costs in many of these ranges. In recent years, there have been reports of attainable cost savings through the use of higher waste loadings in HLW glass and the use of larger canisters; such savings could give estimated repository disposal costs only one-fourth as large as the values you give.

Response DOE and Ecology considered HLW disposal fees in the total cost range (treatment cost + repository fee) for the ex situ alternatives presented in the EIS. For example, when comparing the treatment cost range to the total cost range, the total cost range is not the sum of the treatment cost range and the repository fee. This methodology addressed only TWRS-specific parameters, mainly waste loading and canister size, in the cost uncertainty analysis. Uncertainties in the repository program are not within the scope of the EIS. However, 50 years of storage of the HLW is included in the ex situ alternatives to account for the uncertainty of when a repository may be available to accept waste for disposal. Please refer to the response to Comment numbers 0081.02, 0072.80, and 0008.01 for further discussions of repository and canister issues.

Comment Number 0005.13

Swanson, John L.

Comment Because of the large uncertainty in HLW repository disposal costs, I feel that it would be a more fair comparison of the costs of the alternatives in the Summary if you split out those estimates-something like "The cost of this alternative, exclusive of the HLW repository fee, is estimated to be in the range of ___ to ___. Based on the assumptions adopted for this EIS, the HLW repository fee for this alternative is estimated to be __; the use of other assumptions regarding higher waste loading in glass and the use of larger canisters could lower this estimated fee to ___."

Response DOE and Ecology recognize the concern regarding the cost uncertainty associated with the repository. The Final EIS has been revised to discuss HLW disposal at the geologic repository, the associated cost separately, and potential impacts (e.g., accidents during transportation). The Summary, Section S.8, Volume One, Sections 3.7 and 6.0, and Volume Two, Section B.9 contain a discussion of HLW disposal at the geologic repository. Please also refer to the response to Comment numbers 0081.02, 0008.01 and 0005.12 for further information regarding repository availability, cost estimate methodology, and assumptions.

Comment Number 0005.14

Swanson, John L.

Comment The more I look into your cost ranges, the more confused I become. For example; a) Footnote (3) to Table S.7.6 says that the relatively large ranges in costs for three of the alternatives is primarily a result of assumptions made for repository fee, but two of the three alternatives identified in this footnote do not fit this situation. b) Tables 3.4.13 and 3.4.14 contain footnotes indicating that the cost ranges are dependent on the canister size used, but the tables themselves give only individual values for the repository fees. Why aren't the repository fee ranges used given in the tables? Also, if the cost ranges resulting from canister size increase are given for this/these alternative(s), why aren't they given for the other alternatives as well? The way you have it is a mixture of "apples and oranges." c) Section B.8.3 ("Cost Uncertainty") does not do anything to help me, either-except to emphasize that "assumptions drive conclusions."

Response The footnote in question (footnote number 3 of Table S.7.6) is intended to provide the reader a summary-level explanation of why the cost ranges vary widely for the ex situ alternatives. The difference between the high and low cost range for the Ex Situ No Separations (Vitrification) alternative is $184 billion, the range for the Ex Situ No Separations (Calcination) alternative is $47 billion, and the range for Ex Situ Intermediate Separations and Phased Implementation alternatives is approximately $10 billion. The ranges estimated for these alternatives are greater than the other alternatives mainly because of repository fee assumptions. Technical assumptions regarding the HLW canister sizing have been revised for the Final EIS, which reduce the large cost ranges associated with the ex situ alternatives that produce large volumes of HLW. Additional detail on how the cost uncertainty and ranges were estimated is provided in Volume Two, Appendix B. Please refer to the responses to Comment numbers 0081.02 and 0005.03 for more information on uncertainty.

The Volume Two, Appendix B discussion on cost uncertainty is intended to provide an overview of the methodology and the analysis results. The detail input output data are included in the technical backup data that is publicly available as part of the TWRS EIS Administrative Record.

As noted in the response to Comment number 0005.12, the uncertainty in HLW disposal fees that would result from a variation in the number of HLW packages is included in the total cost range for each ex situ alternative. This allows for an equitable comparison among alternatives.

Comment Number 0052.03

Pollet, Gerald

Comment The costs have some other strange anomalies. For instance, some of the cost estimates for vitrification alternatives today are basable upon some market considerations in terms of what vendors are saying they believe they will be able to bid.

Response None of the cost estimates for the alternatives presented in the Draft EIS were based on privatization of the tank waste treatment. Privatization is an implementation strategy and as such was not addressed in the EIS. For a discussion of this, see Volume One, Section 3.3. All of the cost estimates were developed using the same methodology to provide an equitable comparison among the alternatives. Privatization issues are discussed in the response to Comment number 0060.01.

Comment Number 0052.04

Pollet, Gerald

Comment But what is kind of incredible in this EIS is continuing the historic practice at this site of having a capital contingency built into all the cost estimates of not just 30 percent here but 30 to 50 percent. It is really hard to talk about how the TWRS program is reaming in its costs when its capital cost estimates have a contingency added in of 30 to 50 percent. It is very disturbing and from point of view of how this is then presented to Congress, what we have is a set of alternatives that may emerge that are the ones that are necessary to meet the legal requirements of removal, retrieval, and treatment which are inflated because of their capital considerations by 50 percent and which are inflated by up to $211 billion dollars by a hypothetical repository fee and then we wonder why Congress may not want to fund vitrification.

Response The use of contingencies in cost estimates is standard practice throughout the public and private sector. This is especially true of conceptual estimates for any large construction projects. The use of a contingency in the capital cost estimates is a means to quantify the uncertainty inherent with conceptual designs. The use of contingencies is appropriate for all construction projects, especially projects involving the complexity of the TWRS program. Cost estimates associated with the repository are provided in response to Comment numbers 0004.01 and 0081.02. Capital construction costs are discussed in the response to Comment numbers 0055.06 and 0081.03. DOE-Richland Operations Office (DOE-RL) prepares an annual budget, which would include the budget required for the TWRS cleanup for that year. However, only Congress has the authority to appropriate funds.

Comment Number 0055.06

Martin, Todd

Comment On the costs more generally, I trust the costs in this document about as far as I can throw this document which needless to say without doubt is not very far. Most of the people in this room remember the Hanford Waste Vitrification Plant. This was a 1-ton a day high-level waste vitrification facility. This was the cornerstone of Hanford cleanup that as I recall is supposed to be running in about 3 years but we canceled the program. That was projected to cost about 1.3 billion dollars. Pretty hefty. I look at this EIS and I see that a low-level waste facility (vitrification facility) it is 20 mt per day. Twenty times the throughput is going to be built for 248 million dollars. I do not get it. I do not see the basis for those costs and I simply do not buy it. Further, to compare more of an apples to apples, we look at the high-level waste vitrification facility that is in the EIS. This a 1 metric ton a day facility, it is essentially HWVP. The 1.3 billion dollar facility. What is it in this EIS? 232 million dollars. I can not imagine that it can be built for that. In other words, total for the Phased Implementation alternative, DOE is going to built two low-level waste vitrification facilities with an agent pre-treatment on both of those and one high-level waste facility for 1.4 billion dollars. Essentially the cost of HWVP. I say no way. If that is true, why are we doing privatization? We can take the budget authority that has been given about 2 years and we have got the full cost of one of these facilities. This does not assume any efficiencies from privatization. These are government-owned, contractor-operated facilities, built under a traditional contracting mechanism. Essentially, until a formal credible data package has been done to support the Phased Implementation, the preferred alternative in this EIS, this EIS should go forward no further. Should go no further.

Response DOE and Ecology acknowledge this concern regarding the cost estimates and have reviewed and revised the Phased Implementation cost estimate as appropriate for the Final EIS. These revised cost estimates are shown in Volume One, Section 3.4 and Volume Two, Appendix B and are reflected in the Summary. The Hanford Waste Vitrification Plant (HWVP) cost estimate is not directly comparable to the capital cost estimate for the Phase 1 HLW facility because it includes support facilities and infrastructure that are estimated as separate components for Phased Implementation.

The Phased Implementation alternative was developed by scaling appropriate components from the Ex Situ Intermediate and Extensive Separations alternative. The capital cost was estimated using the "six-tenths rule" and the relative plant capacities for Phased Implementation were estimated in the absence of more definitive data. DOE and Ecology acknowledge that there is uncertainty introduced into the cost estimates by scaling and this is captured in the cost uncertainty analysis. The cost uncertainty analysis results in a cost range within which the final cost would be expected to fall. Total capacity cost breakdowns for a combined separations LAW facility and a detached HLW treatment facility are generally 35 percent equipment, 20 percent material, and 45 percent labor (WHC 1995j).

The cost estimates input data, methodology, and calculations are available in the reference documents included in the EIS and available for public review in DOE Reading Rooms and Information Repositories.

Comment Number 0057.06

Garfield, John

Comment There are a few other less important comments that I will make. One is with regard to the cost estimates for the combination case and to some degree the Phased Implementation case. Parsons has used 6/10ths power rule to arrive at those costs for lack of any conceptual design basis to make those estimates. That rule is applicable in the commercial industry for chemical processes because those plants are largely equipment-driven. 50 to 85 percent of those plant costs are equipment and when you vary the capacity that the capital cost of the facility does, as a rule, from varied by the 6/10ths power rule. Nuclear facility equipment costs only amounts to 10 to 20 percent of the total capital cost. That same 6/10ths power rule can not be used for a shielded nuclear processing facility. It makes no sense to do that and the cost have been skewed for using that. That adjustment should be made and can be made fairly easily.

Response The Phased Implementation alternative and combination alternatives were developed by scaling appropriate components from the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives. The capital cost was estimated using the "six-tenths rule" and the relative plant capacities for the Phased Implementation alternative in the absence of more substantive data. Some uncertainty is introduced into the cost estimates by scaling and this is captured in the cost uncertainty analysis presented in Volume Two, Appendix B. The cost uncertainty analysis results in a cost range within which the final cost would be expected to fall. Total capital cost breakdowns for a combined separations LAW facility and a detached HLW treatment facility estimated for the Ex Situ Intermediate Separations alternative are 35 percent equipment, 20 percent material, and 45 percent labor (WHC 1995j).

The cost estimating methodology has been reviewed and revised cost estimates have been completed for the Phased Implementation and combination alternatives, and for other alternatives as appropriate. These revised costs are shown in Volume One, Section 3.4 and in Volume Two, Appendix B.

Comment Number 0069.04

Pollet, Gerald

Comment The TWRS EIS skews the costs of the alternatives as well. This, coupled with the risks, presents a very biased picture in the EIS of the alternatives. First off, you see this is how their rank ordered in the EIS, as it will be presented to decision makers, and is being presented to you, the public. Leaving waste behind has a cost range of 23 to 28 billion. Extensive separation comes in close behind it, 27 to 36 billion. This is the Tri-Party Agreement path, called Phased Implementation, 32 to 42 billion, building just one plant basically with multiple melters, and calling it all high-level waste, glassifying it all, this astonishingly high price tag. Anyone rational would throw it out.

The repository fee, once it's removed ... excuse me, what I was saying was, the Nuclear Waste Policy Act does, indeed say how you should calculate a repository fee if your going to use it here.

It is not the way it is calculated here. Secondly, it should not be used at all because this waste will never fit into the proposed hypothetical repository at Yucca Mountain. So what is the fee for? It's a hypothetical fee the Department charges itself for a hypothetical repository that will not have room.

So all of a sudden, we have a drastic change in the order of the alternatives. In fact, what we get is, let me just present the conclusion, the Ex Situ/In Situ Combination goes from being least cost by 4 to 8 billion, to only being 1 to 7 billion dollar lower cost then getting all the waste out of there. The Extensive Separations goes from number 2 to number 4 and number 5. It goes from having a cost advantage of 5 to 6 billion dollars over the Tri-Party Agreement, to having a 5.4 to 6.4 billion dollar disadvantage over the Tri-Party Agreement path. It is an effort to skew the data here, and present it in a skew manner to decision makers. And the No Separations alternative, which gets wastes out of tanks fastest, with least research and development, actually shows up as having potentially the lowest range costs. Thank you.

Response The Phased Implementation alternative involves building two separations and LAW treatment facilities and one HLW vitrification facility during Phase 1 to demonstrate the treatment technologies. Following Phase 1, Phase 2 would be implemented, which would involve building full-scale treatment plants to treat the remainder of the tank waste. For a description of the Phased Implementation alternative, please refer to Volume One, Section 3.4.

The purpose of the Nuclear Waste Policy Act is to: 1) establish a schedule for the siting, construction, and operation of repositories that will provide a reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level radioactive waste and such spent nuclear fuel as may be disposed of in a repository; 2) establish the Federal responsibility, and a definite Federal policy, for the disposal of such waste and spent fuel; 3) define the relationship between the Federal Government, State and affected Indian Tribal governments with respect to the disposal of such waste and spent fuel; and 4) establish a Nuclear Waste Fund, composed of payment made by the generators and owners of such waste and spent fuel, that will ensure that the costs of carrying out activities related to the disposal of such waste and spent fuel will be borne by the persons responsible for generating such waste and spent fuel. The Nuclear Waste Policy Act does not provide a methodology for calculating the repository fee for disposal of HLW in a geologic repository. For the Final EIS, repository fees were recalculated. For more information, please refer to the response to Comment numbers 0004.01 and 0036.01.

Current national policy calls for the disposal of spent nuclear fuel and HLW in a geologic repository. The current inventory of commercial spent nuclear fuel and defense HLW exceeds the statutory limit for the first repository. The disposal of all commercial spent nuclear fuel and defense HLW will require increasing the limit of the first repository or constructing a second repository. DOE is currently characterizing one site, Yucca Mountain, Nevada, for a geologic repository. The law requires that the Secretary of Energy report to the President on or after January 1, 2007, but not later than, January 1, 2010, on the need for a second repository. Within this context, none of the alternatives addressed in the TWRS Draft EIS exceed the capacity for geologic disposal, even though many of the alternatives would generate more canisters of HLW than the repository program is currently using for planning purposes. Based on revised canister size and other recalculations completed for the Final EIS, the EIS has been revised in Volume One, Sections 3.4 and 6.0, and Volume Two, Appendix B, to address the repository capacity issue relative to TWRS alternatives.

Failure to recognize that each of the ex situ alternatives would have cost impacts associated with HLW disposal would provide unequal information for the reader. Please see the response to Comment numbers 0081.01, 0081.02, and

0035.04.

Comment Number 0072.92

CTUIR

Comment P 3-36: PP 4: S 2: By what factor? Or by a factor of what?

Response Capital cost contingencies were included in the alternative cost estimates as described in Volume One, Section 3.4 and Volume Two, Appendix B. These contingencies are included to account for the uncertainty associated with the conceptual-level designs developed for analysis in the TWRS EIS. The contingency factors used ranged from 25 to 50 percent with a typical value of 40 percent. The higher contingencies were applied to the more conceptual facilities and the lower contingencies were applied to the more defined facilities. This is consistent with industry standards and practice. Please refer to the response to Comment numbers 0052.04, 0055.06, and 0057.06 for related information on the use of contingencies in cost estimating.

Comment Number 0072.93

CTUIR

Comment P 3-36: PP 6: Please explain how the R&D cost is to be assumed for the phased alternative.

Response Because Phase 1 would be a demonstration process, the research and development cost for the treatment process was assumed to be an integral part of the Phase 1 operating cost. The research and development cost associated with the waste retrieval and transfer function was included at the same level as the other ex situ alternatives. There are development programs currently ongoing at the Hanford Site that are covered under the TWRS program or other programs.

Comment Number 0077.04

ODOE

Comment Also, the cost analyses do not include the lost value of the lands or the costs from harm to future generations or the environment. Ultimately, the costs of these alternatives would prove to be much greater than removing and cleaning up the wastes, as called for by the preferred alternatives.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Analyzing the harm to future generations from an economic standpoint is not included in the EIS; however, lost habitat, health risks, health consequences, and probabilities of accidents to future generations were among the impacts analyzed by DOE and Ecology. Land use commitments are addressed in Volume One, Section 5.7, anticipated health effects in Section 5.11, and comparison of potential consequences from accidents in Section 5.12. For the Final EIS, a Native American scenario was added to the analysis presented in Volume One, Section 5.11. Please refer to the response to Comment numbers 0036.18, 0052.05, 0072.22, 0072.55, 0072.198, 0072.225, and 0072.34 for related discussions..

The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0081.01

Pollet, Gerald

Comment We are concerned that the Department of Energy falsely inflated the costs of waste removal and glassification options to justify leaving waste in the tanks. We are also concerned that the rate the costs have been presented would erroneously lead policy makers to the conclusion, when combined with the use of erroneous assumptions as to risk, lead to the conclusion that in fact it would be cost affected to leave waste behind.

Response The cost estimates are an equal analysis of the total life-cycle costs of each alternative and reflect the best available cost information given that the engineering is still at a conceptual stage. The estimates are available for inspection by the public in the TWRS EIS Administrative Record. Please refer to the response to Comment number 0081.02 for a discussion of how the repository costs were recalculated for the Final EIS. For responses to specific comments regarding risk assumptions, please refer to the response to Comment numbers 0069.08, 0069.09, 0069.03, 0069.06, 0069.07, 0081.07, and 0069.11.

Comment Number 0081.03

Pollet, Gerald

Comment And what is interesting is it has the least technical question. And the EIS is based, in terms of these costs, costs include a 30 to 50 percent capital cost contingency. This is pretty bazaar. We're spending 10's of millions of dollars on research development design phased approach.

We are spending 10's of millions of dollars on design, which ought to drive down contingencies. 30 to 50 percent contingency is the way Hanford has done business with capital construction projects in the past. It is sinful. It is not going to be able to continue. If we eliminate, and we use different factors for contingency, take a look at the fact that a no separation alternative means you build one plant with the simplest technology, vitrification. You vitrify everything. You don't try to separate. You just vitrify. You do not have to build a multi-billion dollar separation plant. You do not have to build separate low activity and high activity vitrification plants. You could, and this EIS fails to consider the alternative which was eliminated earlier in this process, of having a very simple separation of low activity and high activity, in terms of which melter waste is directed too, at the front-end of such a plant. If we look at the cost issue alone, the no separation option actually drives down into the cost range, and perhaps will compare more favorably than the Ex Situ/In Situ Combination even.

The cost assumptions, as with all other assumptions, are critical. Building in 30 to 50 percent contingencies for one set of options is not acceptable for this type of policy decision making. And we can't afford to continue with 30 to 50 percent contingencies for capital costs at Hanford.

Response As noted in the response to Comment number 0052.04, the use of contingencies in capital cost estimates is standard practice throughout the public and private sector. All of the alternatives presented in the EIS include contingencies in the capital cost estimates. During design development for the alternative selected, the cost estimate would be refined and the contingency reduced. The cost estimate for a large facility would typically have some contingency remaining at the start of construction. The capital cost estimate as well as the contingency estimated for the Ex Situ No Separations alternative is smaller than the Ex Situ Intermediate and Extensive Separations alternatives because one treatment facility is constructed instead of two. The contingency factor for the Ex Situ No Separations alternatives provides an equal presentation to the public and the decision makers. Capital construction costs are also discussed in the response to Comment numbers 0055.06, 0057.06, and 0081.03.

A single facility designed to vitrify both HLW and LAW would not be precluded by the EIS for any of the alternatives that include separation of the HLW and LAW. The impacts associated with a single treatment facility would be bounded by the alternatives presented in the EIS. The separations processes included in the EIS cover a reasonable range of representative technologies. The separation of the waste into HLW and LAW streams is bounded with no separations on the low end, extensive separations on the high end, and intermediate separations in the middle.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please also refer to the response to Comment number 0072.05 for a discussion of the development of the alternatives for analysis in the EIS.

Comment Number 0089.04

Nez Perce Tribe ERWM

Comment Purification and removal of sodium nitrate and other major wastes from tanks prior to segregation of LAW and HLW should be considered for volume reduction and cost savings. Possible removal of sodium nitrate for industrial or certain agricultural use should be considered. Another option may be reacting the sodium nitrate with an organic reducing agent to produce sodium carbonate, nitrogen, ammonia and water, greatly facilitating waste reduction. Options such as these need to be considered to reduce vitrification volumes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume reduction measures for the waste have been considered, including calcination and the clean salt process. These measures are addressed in Volume Two, Appendix B, Section B.3. Removal of sodium nitrate, such that this compound would be safe and suitable for industrial or agricultural uses would be limited because complete radionuclide removal to form a purified waste would be extremely difficult.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment number 0072.05 for related discussion.

Comment Number 0090.01

Postcard

Comment Please listen to us say no:

to falsely inflating the cost of glassifying Hanford's High-Level Nuclear Wastes by $211 billion.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Please refer to the response to Comment numbers 0004.01, 0009.04, 0008.01, 0038.10, 0081.01, and 0081.02, for discussions regarding how repository costs were calculated and presented in the EIS..

Comment Number 0092.01

Hanson, Mary

Comment I certainly feel that as a lay person, I have every right to the most conservative principles being used in this situation and I certainly, personally and I think I stand for others here, do not consider cost to be important. Money can be made, the environment can not be remade. Now the total defense budget for this country is somewhere around 260 billion dollars per year. That is a lot of waste. In my opinion, that it is throwing money at defense. Most of it. Playing games, testing this and that and so forth. This is a real problem. This is a real security problem and if it were up to me I would put probably half the defense budget on it. So I do not consider money to be something that you can quote, "balance against health." I do not think money is something you balance against the environment. You can not balance a nonrenewable resource like the environment against a renewable resource like money. So I am very strongly in favor that this be done in the economic, in a conservative manner, economically speaking but I certainly feel that if the public really was as aware as everyone in this room is of what the issues are, they would vote very high amounts of money to deal with this threat to our security.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Cost estimates presented in the Draft EIS have been reviewed and revised, as appropriate in the Final EIS.

The alternatives and impact analysis presented in the EIS were based on conservative principles, consistent with the requirements of NEPA to bound the potential impacts and to address a range of reasonable alternatives. For more information on this topic, please refer to response to Comment number 0072.05 or in the EIS Volume One, Section 3.3. Please also refer to the response to Comment number 0081.01 for a discussion of issues related to the presentation of costs.

Comment Number 0098.01

Pollet, Gerald

Comment The Department of Energy's presentation tonight and at prior meetings and in these materials show ... say ... claim that this unproven technology of so-called in situ vitrification, sticking electrodes into the ground and melting the ground into glass. The presentation said that this would comply with Washington State law. Nothing could be further from the truth. Washington State first off has in the model toxic control act and our dangerous waste regulations a presumption that we will favor removal. That is the law. Leaving it in place when you have an alternative of removal and retrieval is never allowable under Washington State law. We have a set of priorities for dealing with waste. Hanford does not get to make an exception for itself although it sure does try most of the time.

Response The disposal of HLW by ISV would comply with Washington State law if the hazardous waste components are adequately treated to remove the hazardous characteristics or immobilize the hazardous components. The treatment and disposal would be subject to review and permitting by Ecology. Washington State law does not apply to disposal of the radioactive components of the HLW. For a discussion of regulations applicable to the HLW, see Volume One, Section 6.1. For related discussion regarding technical uncertainty, please refer to the response to Comment number 0012.04. Because the information contained in the Draft EIS is correct, no change to the text was made.

L.3.4.2.3 Assumptions

Comment Number 0005.39

Swanson, John L.

Comment The paragraph beginning at the bottom of page 3-31 is interesting. It starts out by saying that the residual contaminants would be insoluble, and then goes on to make the conservative assumption that 1 percent of the water-soluble contaminants would also be present. This conservative assumption drives conclusions, as discussed in (18) above [Comment number 0005.18].

Response DOE and Ecology recognize the concern expressed in the comment regarding conservative assumptions used in the impact analysis and the extent to which these assumptions affect the calculated risk values. The analysis performed for the Draft EIS assumed, for the ex situ alternatives, that 1 percent of the original inventory would remain in the tanks as residual waste that could not be retrieved. This assumption is bounding (e.g., provides a reasonable upper limit) with respect to the impact analysis, because it includes 1 percent of the water soluble contaminants. The Final EIS has been revised to include Volume Five, Appendix K, which will provide a nominal case analysis using best estimate assumptions. The nominal case analysis was based on 1 percent residual volume that was modified to reduce the inventory of soluble constituents. Using this assumption will result in a risk range and will enable the reader to see the variation in the long-term risk as a function of nominal and bounding assumptions. Please refer to the response to Comment numbers 0072.59, 0072.51, and 0072.05.

Comment Number 0005.40

Swanson, John L.

Comment On page 3-34 it is said that the assumption of cullet in a matrix material as the waste form for onsite LAW disposal "--provides a conservative analysis of the long-term impacts--." This statement is true only if conservative assumptions were made regarding the performance of the matrix materials. Were those assumptions conservative? Are they spelled out somewhere? (Page 3-66 contains a statement in opposition to the one on page 3-34; "The potential benefits of a matrix material and glass cullet combination as a disposal form are reduced contaminant release rates and--." Thus, the assumption of cullet in a matrix material does NOT provide a conservative analysis of the long term impacts, as is stated on 3-34).

Response In order to bound the impacts associated with the LAW disposal vaults, the releases from the LAW vaults were calculated under the assumption that the matrix material provided no reduction in the release rates from the LAW disposal vaults. DOE and Ecology believe that using a matrix material with glass cullet would reduce the release rates from the LAW disposal system. The two statements do not conflict with each other. Cullet, as opposed to monolithic pours, would be more easily leached; therefore, cullet is considered the more bounding (higher) approach in the environmental impacts analysis. Assumptions associated with release rates and associated impacts to groundwater are discussed in Volume Four, Appendix F.

Comment Number 0005.42

Swanson, John L.

Comment The last sentence on page 3-35 says that it has been determined that a bleed stream would be required to avoid a continuous buildup of Tc-99 in the vitrification off-gas stream. I do not believe that is necessarily true, and wonder who made that determination (and on what basis). The data I have seen indicate that some melters can retain a significant fraction of the Tc in the glass; thus, Tc in the off-gas from such melters would stop building up when that in the feed plus recycle equals that in the glass.

Response DOE and Ecology acknowledge the concern regarding the constituents that would require the use of a bleed stream for the off-gas recycle system. The EIS discussion includes technetium-99 and mercury as representative examples of the type of volatile constituents that could build up in the off-gas recycle streams. The LAW vitrification processes addressed in the EIS are based on a combustion fired melter. This melter type raised the concern regarding retention of volatiles and semivolatiles in the glass during technical review of the Preliminary Draft EIS. The requirements for a bleed stream were noted and included in the EIS.

As indicated in the comment, a bleed stream may not be necessary to avoid a continuous buildup of technetium-99 in the off-gas recycle stream, but based on available information, it appears probable that a bleed stream would be required. The functional requirements and sizing of the off-gas recycle system would be developed during the detailed design phase following selection of an alternative.

Comment Number 0012.20

ODOE

Comment Vitrification of the wastes greatly reduces the risk to the public and the environment. Even the least capable glass waste forms represent a dramatic improvement over the current conditions. Wise selection of pretreatment and segregation options and glass specifications may greatly reduce the long-term costs and risks to the public. These should not however delay decisions to proceed with cleanup and vitrification of Hanford's tank wastes.

There is no assurance that any of the vitrified waste will leave Hanford. As a consequence, it is essential that the vitrified waste contain all of the radioactive wastes for so long as they remain hazardous.

The vitrification alternatives do not specify the physical or chemical properties or requirements for the glass products. There is no specification for how durable the glass waste form must be, or for how long the glass must contain the radioactive wastes. Specifications must require the product glass be durable enough to contain the radioactive components for as long as they remain hazardous. This requirement is relatively easy to meet for short half-life isotopes such as strontium-90 and cesium-137. It is more difficult for long half-life isotopes which easily migrate in water, such as cesium-135, iodine-129, technetium-99, and neptunium-237. These isotopes are volatile and are difficult to incorporate into glass. Additionally, the long lived actinides also must be retained until they are no longer hazardous.

The common glasses used for the immobilization of high-level nuclear waste are not durable enough to contain these materials for the times needed. The borate content of these glasses is often controlled at high levels to reduce the melt temperature of the glass and to lower its viscosity. As the borate content is increased, the durability of the glass decreases. Glasses are attacked by organic acids such as humic and fulvic acids from the decay of vegetation which are often found in surface waters. Because the repository is expected to be deep underground, the water which may reach the repository is unlikely to contain large amounts of organic acids. Accordingly, the performance and durability studies of waste glasses for disposal to a national high-level nuclear waste repository have not analyzed the impact of organic acid corrosion on glass wastes, however this is particularly important if the glass waste remains at Hanford and may be subject to corrosion by surface waters.

If the durability of the glass cannot be assured and other barriers provide inadequate protection for the glassified wastes which may remain at Hanford, the radioactive isotopes with half-lives over one thousand years should be removed from the water soluble fraction of the wastes. These should be incorporated into better waste forms, or blended and glassified with the waste which will be sent to the national high-level nuclear waste repository. These isotopes include cesium-135, iodine-129, technetium-99, neptunium-237, and all long half-life actinides.

The durability requirements for glassified wastes to be sent to the proposed national high-level nuclear waste repository are not sufficient to assure protection of human health and the environment at Hanford. The physical conditions onsite are vastly different, and the geologic isolation provided by a deep repository is not available. The EIS must consider changing climate conditions. Hanford cannot be assumed to remain an arid area for as long as these wastes remain hazardous.

As the geologic barrier is not present at Hanford, and the glass wastes may exhibit more rapid corrosion from surface water, additional barriers to contain the waste should be included. The containers for the glass should be of sufficient chemical resistance and durability to protect the glass from the environment for as long as the wastes remain hazardous. The containers should be resistant to corrosive attack and embrittlement from exposure to the glassified wastes. Welding or other sealing of the containers should be done in such a manner as to avoid creating brittle areas in the container. Embrittled containers are likely to fail far more quickly.

Type 309 and 304L stainless steels have been proposed for use at Savannah River and West Valley, New York for containing glassified waste. High-carbon 309 stainless steel is easily embrittled by chloride ions. It should not be used. Low-carbon 304L stainless steel has insufficient molybdenum content to allow long term corrosion protection from the waste. If corrosion resistant stainless steel is used, it should contain at least three weight percent molybdenum to minimize corrosion from chloride and fluoride. It should also be very low carbon steel. Other high resistance alloys should be considered.

Response The alternatives presented in the Draft EIS provide a range of treatment, including disposal of HLW onsite as part of the in situ and combination alternatives. To be consistent with current national policy, all ex situ alternatives that include retrieval and treatment of the tank wastes are based on the assumption that the HLW would be disposed of in a geologic repository. The EIS does analyze permanent near-surface disposal of LAW under the ex situ and combination alternatives and disposal of HLW in place under various in situ and combination alternatives. To address public concerns with the availability of the geologic repository, all ex situ alternatives have been revised in Volume One, Section 3.4 to include interim onsite storage of the immobilized HLW for 50 years.

The ex situ alternatives that produce borosilicate HLW glass comply with the DOE OCRWM Waste Acceptance Systems Requirements document, which requires that the waste form meet performance criteria. The alternatives that do not produce a borosilicate HLW glass are identified as non-conforming to the geologic repository and are potentially not as acceptable and require resolution to make them acceptable which would make them subject to delayed acceptance.

Alloy specification for the HLW canisters would be accomplished during final design of the waste package. Embrittlement, corrosion, and material incompatibility are issues that will be evaluated during canister design and material selection. However, please note that the HLW canister presently has no long-term disposal function. This function is allocated primarily to the waste package disposal container.

DOE and Ecology acknowledge that technical issues requiring evaluation remain before the long-term impacts associated with permanent near-surface disposal of canistered HLW can be assessed. Please refer to the response to Comment numbers 0008.01 and 0008.02.

Comment Number 0019.04

WDFW

Comment The author states that "for the analysis performed in this EIS, a Hanford barrier was used to bound impacts." At this point in time, a cursory effort to bound impacts (resources) of a Hanford barrier should only require volume of soil needed and/or potential acreage impacted. A supplemental EIS can discuss borrow sites and alternatives.

Response DOE and Ecology acknowledge the concern expressed in the comment. However, the Hanford Barrier is the most extensive system for a surface barrier proposed for use on the Hanford Site. The assumption to apply this multi-layered barrier technology serves as the basis for comparison of the impact of changes within an alternatives, as well as between alternatives. The selection of borrow sites is an issue that would be addressed for tank farm closure which will be the subject of a future NEPA analysis. Please refer to the response to Comment number 0019.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0027.11

Roecker, John H.

Comment Waste Oxide Loading

The use of a 20 percent waste oxide loading is overly conservative and biases the alternatives analysis. A waste oxide loading of 25 percent has normally been used for design and analysis purposes. Studies are also underway for loadings in the 30-35 percent range.

Response The TWRS EIS uses bounding assumptions for HLW oxide loadings for all ex situ alternatives to provide a comparable and bounding analysis in the absence of definitive information. DOE and Ecology are aware that higher HLW oxide loadings have been used for process design and acknowledge, in Volume One, Section 3.4 of the EIS, that current development work may result in higher waste loading factors. Given the uncertainty associated with the characterization data and assumptions made for separations efficiencies, DOE and Ecology believe that a 20 weight percent waste oxide loading is a reasonable assumption for the purpose of calculating impacts. Waste loading is also discussed in the response to Comment numbers 0035.04 and 0027.11. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0040.02

Rogers, Gordon J.

Comment The 100-year limit for retaining administrative control is ridiculous, and is not applied to any other human activity.

Response Federal regulations (40 CFR 191) state that to provide the confidence needed for long-term compliance with the requirements for the disposal of HLW, active institutional controls over disposal sites should be maintained for as long as is practical. However, institutional controls are limited to 100 years when considering the isolation of the wastes from the accessible environment. As is stated in Volume One, Sections 3.4.2 and 3.4.3, the 100-year period is an assumption that has been applied to all alternatives analyzed in EIS to provide an equitable basis for comparison of impacts among alternatives. As required by the regulations, the administrative controls would be maintained by DOE and Ecology as agencies of the Federal and state governments. For related discussions, please refer to the response to

Comment numbers 0101.01 and 0040.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0052.01

Pollet, Gerald

Comment Going to start tonight by asking that a little more attention be paid in the materials and the Final EIS through the advice of the Tank Waste Remediation System Task Force. The Task Force urged the three agencies from our putting together this EIS to explicitly not utilize a hypothetical repository in assessing costs and it is nice to go right after someone else whose commented on the same issue.

The TWRS Task Force said we have to assume canisters stay at Hanford. That is not only a reasonable alternative, unfortunately it is the realistic alternative, and it is not appropriately considered in the EIS. So what we need to see is - what are the long-terms costs and impacts from having canister storage here at Hanford.

Response The Tank Waste Task Force report recommended that DOE "accept the fact that interim storage, at least, of the waste in an environmental safe form will occur for some time at Hanford." The report also directed DOE to "assume temporary storage will occur at Hanford but did not assume that all radionuclides should be here forever" (HWTF 1993). The EIS, for all ex situ alternatives, assumes interim storage at the Hanford Site in an environmentally safe manner for up to 50 years and ultimate disposal of HLW offsite at the potential repository. If HLW storage extended beyond 50 years, appropriate NEPA review would be required. Please also refer to the response to Comment numbers 0035.04, 0081.02, 0038.10, 0008.02, and 0004.01 for related information.

Comment Number 0062.03

Longmeyer, Richard

Comment We've talked a little bit about the new tanks that are being filled with wastes from current tanks that are leaking. That also raises a safety concern in that, as was stated, this sludge that remains behind in the single-shell tanks that did leak, actually becomes more dangerous than when there was water in the tank. Dangerous in terms of the material itself, and danger of actual exposure to the outside from explosions, and so forth. So that is a concern.

Response A description of the saltwell pumping program, which is a required action under the Tri-Party Agreement, is provided in Volume One, Section 3.4 and Volume Two, Appendix B. An analysis of safety issues is performed prior to removing liquids to ensure that removal can be performed safely. The SSTs in question that have been pumped have been included in the accident and consequence analysis presented in Volume One, Section 5.12 and Volume Four, Appendix E. The unit liter doses from these tanks were compared with the unit liter doses from the rest of the SSTs and all of the DSTs. The bounding unit liter doses were used to calculate the consequences to bound the analysis.

Comment Number 0064.01

Roecker, John H.

Comment The second point I'd like to bring out is what I call data manipulation. There are examples throughout the EIS where data has been, what I call, manipulated to present a specific case, or to present certain agendas. I can give you some examples, in fact I will give you written comments on the ones that I have found. But as an example, where you talk about the high-end and the low-end of the number of canisters for the two different processes. The low-end you reference a Westinghouse document, and for the high-end you reference a DOE document. Being a little suspicious, and having a little experience with what was going on, I went back to look at those specific documents. The Westinghouse document is an engineering document, which has some pretty good estimates in it. The DOE document is a review of a systems requirements document of DOE that had a high number in it to make some very specific points. To use those numbers in the EIS, I think, is misleading. Because they do not accurately represent the engineering and technical data that is available.

Response The EIS presents an unbiased assessment of the potential impacts associated with each alternative. Please refer to the response to Comment number 0027.02 for a discussion of this same issue and Comment numbers 0081.02, 0008.01, 0069.04, 0035.04, and 0038.10 for a discussion of cost estimates.

Comment Number 0072.85

CTUIR

Comment P3-31: PP1: It should be assumed that there will be leaks and more leaks from the SSTs and DSTs during the administrative control.

Response DOE and Ecology realize that it is difficult to accurately predict the number or severity of tank leaks that will occur in the future. There are factors that will increase the number of leaking tanks, primary of which is the age of the tanks. As the tanks get older, the probability of a leak increases. There also are factors that will decrease the number of leaking tanks. The primary factor in decreasing leaks is the interim stabilization of the tanks by removal of the free liquid from the pore space and other voids in the tank solids; sealing the entrances to the tanks to prevent fresh liquid from accidentally entering the tanks; and placing covers over the tanks to inhibit the infiltration of precipitation. Once these measures are in place, leaks from the tanks would be very small. Because there was no inherently accurate method of determining future leaks, the assumption was made that at some predetermined time in the future (after the loss of administrative control), all the tanks of a given type would leak. This assumption allows an equitable comparison of the long-term environmental impacts of the various proposed alternatives. Please refer to the response to Comment numbers 0005.37, 0029.01, and 0072.70 for related information.

Comment Number 0072.86

CTUIR

Comment P 3-31: PP: Is the required depth to ground water, in the case of leaking tanks, at the minimum to the bottom of the leakage? Or is the required depth from the bottom of the tank? Please explain this with a description of the reasoning involved.

Response Releases for the tanks, whether from in situ or ex situ alternatives, are assumed to be from the bottom of the tank. This is a bounding assumption that results in the highest predicted contaminant concentration in groundwater.

Comment Number 0072.88

CTUIR

Comment P 3-31: PP 6: The efficiency goal should state no more than 1 percent of the solid-dry tank inventory would remain as a residual and no more than .1 percent liquid tank inventory remain as a residual following waste retrieval activities.

Response The Tri-Party Agreement (Ecology et al. 1994) includes a milestone that directly impacts the TWRS program. Milestone M-45-00 requires tank residues not exceeding 10.2 m^3 (360 ft^3) in each 100 series tank, and tank residues not exceeding 0.85 m^3 (30 ft^3) in each 200 series tank. This milestone provides the basis for the TWRS EIS assumption of 99 percent removal for ex situ alternatives. An overview of retrieval and transfer from the tanks is provided in Volume Two, Section B.3.5.3. Further evaluation of the residual inventory would be performed in a future NEPA analysis on closure of the tank farms. Please refer to the response to Comment number 0089.03, 0089.07, and 0005.18 for related residual waste information. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.89

CTUIR

Comment P 3-34: PP 7: Assuming that a LAW activity waste cullet provides the basis of conservatism is wrong. The technical staff of the SSRP suggests that all LAW waste be vitrified into glass and poured into canisters for the lowest risk levels.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The referenced language in Volume One, Section 3.4 is a discussion of waste composition for the various alternatives. A disadvantage of cullet is its high surface to volume ratio, which results in lower long-term performance. Therefore, the calculations of leach rates are higher (more bounding from an impact assessment standpoint) for cullet than for other glass forms. In the area of long-term environmental impacts, this lower long-term performance manifests itself as greater amounts of contaminants leaching from the cullet. Changing to another waste form that would have potentially better long-term performance may be achieved during the final design of the alternative selected. Because the information contained in the Draft EIS is correct, no change to the text was made. Please refer to the response to Comment number 0005.40.

Comment Number 0072.90

CTUIR

Comment P3-3: PP 8: The public has stated numerous times that grout for use as a way of stabilizing tank waste in any form is unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Grouting liquid waste streams is included in Volume Two, Appendix B as a reasonable immobilization technology in the EIS; however, it is not a technology included in the preferred alternative. For a discussion of NEPA requirements to analyze reasonable technologies, please refer to the response to Comment number 0072.05. Grout is discussed in the response to Comment numbers 0005.18, 0009.03, and 0072.179.

Comment Number 0072.178

CTUIR

Comment P B-37: Sect.B.3.0.6: Please explain how soda lime glass can be upgraded to the standards of the only standard HLW form, borosilicate glass in terms of leachability, thermal-breakdown, expansion, and ability to capture and isolate radionuclides.

Response Soda-lime glass would have different characteristics than borosilicate glass in terms of leachability, thermal expansion, and physical processing parameters. As stated in Volume Two, Section B.3, borosilicate glass currently is identified as the only standard HLW form to be accepted at the potential geologic repository. Other types of glass could be selected for the vitrification of HLW or LAW; however, they would have to meet the NRC waste form requirements and support the repositories ability to meet long-term performance requirements.

Under the Ex Situ No Separations alternative, all of the sodium present in the tank waste would be included in the vitrified waste stream. Because of this, the glass more closely approximates a soda-lime glass. The repository Waste Acceptance Systems Requirements Document currently includes only borosilicate glass as an acceptable glass composition; however, it identifies that other waste forms may be addressed in the future. The acceptability of alternative glass compositions would be based on waste form performance testing. Please refer to response to Comment numbers 0012.20, 0012.11, and 0035.04 for a related discussion.

Comment Number 0072.179

CTUIR

Comment P B-38: The use of grout is unacceptable and has been thoroughly denounced by the public. The grouting of LAW which will contain discrete particles of hi-activity radionuclides is unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.90, which addresses the consideration of grout as a waste form in the EIS.

Comment Number 0072.194

CTUIR

Comment P B-157: Sect. B.5.0: The information on how closure activities would affect remediating the tank waste should include carrying all of the listed closure options through the alternatives process in order to adequately present the information. Simply choosing a single representative approach to tank closure (closure as a landfill) is insufficient and in the light of the importance of this retrieval EIS. The closure options presented must indicate whether they do or do not preclude one or more of the alternatives. Additionally the closure options must necessarily conform to the law ALARA conditions for the purposes of reducing risks to future generations. This information is simply not here and raises doubt that the representative approach is truly representative.

Response Please refer to the response to Comment number 0072.08 for a discussion of the reasons closure alternatives cannot be assessed at this time and 0072.50 for information on alternatives that would preclude closure options. Closure of the tank farms will be addressed in a future NEPA analysis when sufficient information is available on past practice releases, releases during retrieval, and tank

residuals. Please refer to the response to Comment number 0101.06 for a discussion of issues related to analysis that would be required to support closure alternatives analysis. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.195

CTUIR

Comment P B-158: Sect. B.6.0: The inclusion of the Hanford Barrier and the exclusion of all other closure activities may preclude adequate justification of the alternative section due to the fact that providing one option is not providing a choice of options. Please insert the other closure activities options or remove section B.5.0 tank closure because it is not within the scope of this EIS.

Response Closure is not included in the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. However, Volume One, Section 3.3 and Volume Two, Section B.5 address how tank waste remediation and closure are interrelated because some of the decisions made regarding how to treat and dispose of tank waste may impact future decisions on closure. To provide information on how closure activities would be affected by remediating the tank waste, a representative approach to tank closure (closure as a landfill) has been included in each of the TWRS alternatives to allow an equitable comparison of the alternatives. The Hanford Barrier described in Volume Two, Section B.6 is included as a representative approach to tank closure. Please refer to the response to Comment numbers 0101.06, 0019.03, 0019.04, 0052.01, 0072.50, and 0101.05 for related discussions. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0081.04

Pollet, Gerald

Comment The Tank Waste Task Force, convened by the Department of Energy, U.S. EPA, and Washington Department of Ecology, urged that the Department of Energy abandon making decision making on the basis of high-level nuclear waste canisters, and their theoretical costs for being placed into a repository. Our advice was, now I need to turn to the appropriate page, on page 11 of the Task Force Report under Values, under Waste Form and Storage. Let the ultimate best form for the waste drive decisions, not the size or timing of the national repository. This EIS has failed to consider that advice.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0081.02, 0008.02, 0035.04, 0038.10, and 0052.01 for a discussion regarding task force advice.

Comment Number 0089.03

Nez Perce Tribe ERWM

Comment Listed below are our general statements regarding the EIS.

Some necessary topics are not properly considered in the EIS. An example is the proposal to leave 1 percent of the waste in the tanks. We believe that with the technology currently proposed, if 99 percent of the waste can be removed, then it is also possible to remove much of the remaining 1 percent of the tanks wastes. This question will definitely be pursued by ERWM during soil and groundwater remediation, which are not part of the EIS. For proper soil remediation, beneath the tanks following closure or tank removal, it is imperative that no waste be left in the tanks.

Response The amount of residual waste that ultimately remains after retrieval will depend on the effectiveness of the retrieval technology. For the purposes of NEPA analysis, the assumption that 1 percent of the waste would remain in the tanks was assumed in the EIS analysis. For a discussion of this issue, please see the response to Comment numbers 0005.18 and 0089.07. Further experience with waste retrieval will be required before the issue of the extent of retrieval can be fully resolved. Please refer to the response to Comment numbers 0101.06, 0072.08, and 0072.88 for related information concerning tank waste residuals, soil and groundwater contamination, and closure.

L.3.4.2.4 Miscellaneous Issues

Comment Number 0005.41

Swanson, John L.

Comment The word "grouting" at the start of the last paragraph on page 3-34 appears to be out of place, and appears to belong instead at the start of the first paragraph on the next page.

Response "Grouting" does belong with the paragraph at top of page 3-35 of the Draft EIS. The two sentences following the word "grouting" are out of place. The text of the Final EIS has been corrected.

Comment Number 0005.43

Swanson, John L.

Comment On page 3-36 is discussed the use of sodium from the FFTF to make sodium hydroxide for use during enhanced sludge washing. Is this really worthy of mention? Was the cost of conversion of sodium to sodium hydroxide (which has some safety problems) included in the cost estimates?

Response Fast-Flux Test Facility (FFTF) sodium disposal is worthy of mention because of the potential amount of material that may require disposal considerations in the near future. A cost analysis of the conversion facility and the process safety issues were not performed and would need to be addressed before a decision was made to use FFTF sodium as a source of material for separations chemicals. The use of sodium from FFTF was included in the EIS as an example of Sitewide waste minimization activities that could be considered.

Comment Number 0008.04

Evett, Donald E.

Comment On the subject of groundwater, I believe the method of retrieval using the articulated arm to reach into the tanks and recover waste would be an excellent method and it would reduce the amount of leakage, which is of paramount importance.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. As indicated in Volume One, Section 3.4, the articulated arm retrieval method would be used in situations where conventional technology is not effective or inefficient for the particular tank waste type or form. Using the articulated arm technique and others is also key to removing as much of the tank waste as possible to minimize or eliminate any materials that could be released to the environment. DOE and Ecology will analyze the data collected during the demonstration phase to select the most effective removal method for the tank and tank waste type.

Comment Number 0068.03

Martin, Todd

Comment The last point I want to make is that a clear lesson that we've learned from Hanford and from the nuclear weapons complex is that postponements and delays lead to greatly increased obligations in the future. We've learned that in spades, at least I hope we've learned that. And I'm not sure that the Federal government has learned that. The American people are certain of that. That means we need to get on with it now, otherwise it's going to cost that much more in the future.

Response DOE and Ecology share the desire to proceed with remediation at the earliest possible date. Delays can be costly. DOE intends to allow sufficient time to design adequate actions that are supported by factual information, that incur a reasonably acceptable level of technical risk (i.e., high probability that the action will work and accomplish the desired result), and that are implemented in a managed and cost-effective way. Please refer to the response to Comment numbers 0009.19, 0060.02, 0098.02 and 0078.07.

Comment Number 0072.82

CTUIR

Comment P 3-27: Sect. 3.4.1.1: First bullet: What exactly is "managing operations" and are these the operations included in the 1997 RDS for fail-safe management?

Response Managing operations, as listed in the first bullet in Volume One, Section 3.4, includes the activities listed in the bullets that follow as well as tank farms and associated facilities management (as a program), and the relationship of the TWRS program to the Hanford Site Operations system. Consequently, the management issues relevant to each activity (e.g., personnel, safety, quality, and milestone status) are relevant on a programmatic level across Tank Farm Operations. Tank farms management is one operation described in the 1997 Risk Data Sheet (RDS) for fail-safe management. The 1997 RDS was prepared for the Hanford Site as a single operation.

Comment Number 0072.83

CTUIR

Comment P 3-28: PP 4: how much exactly will these controls increase the cost of maintenance and monitoring activities.

Response The operating cost and schedule impacts associated with placing all 177 tanks under flammable gas controls (if this were to occur) is not fully known at this time. One of the factors that will influence the cost and schedule impacts would be resolution of the flammable gas safety issue for the tanks.

Comment Number 0072.87

CTUIR

Comment P 3-31: PP 4: How can you fill a tank full of liquid with rocks and not have liquid overflow?

Response As discussed in the description of the alternatives in Volume One, Section 3.4 and Volume Two, Appendix B, for the In Situ Fill and Cap alternative, as much water as possible would be removed from the liquid waste streams through evaporation at the 242-A Evaporator. The amount of water that can be removed from a liquid waste stream at the evaporator is limited by the saturation concentration of the evaporated waste stream. Following transfer of the evaporated liquids back to the tank, salt-cake formation would begin in the DSTs similar to what has already happened with the DSTs. This would allow for additional evaporation of the liquids. If the In Situ Fill and Cap alternative were selected for implementation, further analysis may indicate a need for additional evaporation using in-tank technologies for selected tanks.

Comment Number 0072.91

CTUIR

Comment P 3-36: PP 1: Exactly what is "some low temperature process"? How much will this process cost? Is this process figured in the privatization process, and what are the risks associated with this? How much extra waste is going to be generated with this process? What will this waste be classified as?

Response Calculations performed for the Ex Situ Intermediate Separations alternative off-gas recycle bleed stream resulted in an estimate of 3,500 m^3 (930,000 gallons) of liquid waste. This waste stream would be dilute and the volume could be reduced by evaporation. The stabilization of this waste stream would require a low-temperature stabilization and treatment technology such as encapsulation, hydraulic cements, or organic polymers to immobilize the waste and limit further volatilization. The development and selection of this process would occur during the detailed design phase. An individual cost estimate for this process was not included in the alternative cost estimates developed for the EIS. The cost would be minor compared to the total alternative cost and would be well within the estimated cost range.

Each of the alternatives that involve high temperature waste treatment technologies, such as vitrification, would have to deal with the volatile chemical and radionuclide emissions in the off-gas system. The risks during remediation are included in the analysis performed for each of the alternatives in Volume One, Section 5.11 for health impacts during remediation. The post-remediation risks that would result from disposal of the stabilized off-gas recycle bleed stream is assessed in the Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds.

An estimate for the total volume of immobilized waste that would be generated has not been made for the alternatives. A volume estimate would be made during the detail design phase when the characteristics of the bleed stream were developed and the immobilization technologies were evaluated.

Following stabilization, this waste stream would be classified as LAW. The classification and handling of this waste stream would be consistent with established Hanford Site solid waste disposal practices.

Comment Number 0072.180

CTUIR

Comment P B-39: S 2: Please explain how the amount of tertiary waste generated would be primarily a function of the number of operating personnel.

Response The primary component of tertiary waste is personal protective equipment. Therefore, because the number of operating personnel required to wear personal protective equipment when the potential exists for contact with hazardous or radioactive substances is higher for the alternatives that include the more complex remediation activities, the amount of tertiary waste generated also would be higher.

Comment Number 0089.05

Nez Perce Tribe ERWM

Comment Offsite disposal of LAW should be considered in the EIS.

Response DOE and Ecology acknowledge the recommendation expressed in the comment. Offsite disposal of all waste at the potential geologic repository is addressed in the EIS under the Ex Situ No Separations alternative. Offsite disposal of the LAW was not considered to be a reasonable alternative because of the cost and human health impacts of transporting the waste and because there would be no compensating benefits to offsite disposal. Please refer to the response to Comment number 0005.03 for a discussion of the assumptions used in the alternative analyses.

Comment Number 0089.11

Nez Perce Tribe ERWM

Comment Page B-72, Paragraph 1

We have some questions about the plan for the cross-site transfer line. Apparently this line will be sloped to at least 0.25 percent grade to preclude accumulation of solids. ERWM questions the thought behind those plans, the elevations at 200 West and 200 East are nearly the same but 5 miles apart. How will the line be constructed and this slope engineered?

Response Specifications for the cross-site transfer line are not included in the scope of this EIS; however, the SIS Final EIS addresses the cross-site transfer line in detail (DOE 1995i). The SIS EIS was referenced during preparation of the TWRS EIS. According to the SIS EIS, the line would slope up from the 200 West Area to a midpoint, and then down to the 200 East Area to ensure that the line will drain.

L.3.4.3 No Action Alternative (Tank Waste)

Comment Number 0072.94

CTUIR

Comment P 3-40: Sect 3.4.2: No Action Alternative: Technical staff of the CTUIR do not agree that this alternative is a responsible action, given that the contents have half lives that number in the thousands.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, compliance to existing regulations, potential risk, or any other factor used in the analysis of alternatives. Furthermore, the CEQ requires that the TWRS Draft EIS identify and analyze a range of reasonable alternatives for the proposed action, as well as for the No Action alternative. All data that support the cost and impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and the public during the comment period. Please refer to the response to Comment numbers 0072.80 and 0072.10 for more information concerning the No Action alternative and NEPA requirements for reasonable alternative analysis.

Comment Number 0072.181

CTUIR

Comment P B-41: Sect. B.3.1: A one hundred year administrative control period does little to protect human health and environmental impacts from long lived (>10,000 year 1/2 life radionuclides).

Response Although DOE has no plans to abandon the Site after 100 years, it is not reasonable to assume that administrative controls will extend to 10,000 years. In order to show potential impacts that could occur if administrative controls were lost, a 100-year administrative control period was assumed. This assumption is consistent with standard impact assessment methods for hazardous and radioactive waste sites. Please refer to the response to Comment numbers 0072.80, 0040.02, and 0101.01 for discussions related to DOE assumptions associated with the 100-year administrative control period and the analysis of long-term impacts resulting from the loss of institutional controls.

Comment Number 0072.182

CTUIR

Comment P B-43: Sect. B.3.1.4: Please insert the statement 'some tanks may not last fifty years'.

Response Volume Two, Appendix B addresses actions that would be taken in the event that a tank leaks within the estimated design life of 50 years, as well as the integrity testing to be conducted within any applicable 50-year design life. "Continued management would include maintaining spare DST space to accommodate leak recovery in the event of a DST leak. Tank conditions would be continually monitored, and those tanks determined to be leaking would require recovery of the leakage from the tank annulus." Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.4 Long-Term Management Alternative

Comment Number 0038.01

Reeves, Merilyn

Comment I would like to point out that one of the things that the Hanford Advisory Board did was to commission a special report, a report to look at whether or not we should build six new massive tanks, double-shelled to hold waste because we were not looking at any other end point.

A report was prepared by Dr. Glen Paulsen, Dr Frank Parker, and Dr. Michael Cavanaugh, noted experts in the field.

And from this report it became clear that they recommended that no new monies be spent for the construction of new tanks to store the tank waste at Hanford.

The Board adopted this. This is a savings of approximately 300 to 400 million depending on which report you look at.

I think that this also puts in place the Long-Term Management alternative in the EIS that would have required replacement of all the double-shelled tanks in the year 2035, and again in the year 2085.

And so I believe that our consensus advice, which was listed as consensus advice number 22 in which we endorsed the recommendations of this report should put to rest whether or not we should embark on any scheme to just continue to build double-shell tank for storage of these wastes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. The range of alternatives must include a No Action alternative and then may include other reasonable alternatives to allow an analysis of a full range of alternatives. Within the range of considered alternatives is the Long-Term Management alternative, which contains the provision for building two sets of DSTs at 50 and 100 years in the future. Including this alternative in the EIS serves a useful purpose, because while it does not contain provisions for immobilizing the tank waste, it does contain provisions for maintaining the SSTs in a relatively dry condition and for retanking the wetter DST wastes on a periodic basis. Please refer to the response to Comment number 0072.05 for a discussion of how the alternatives were developed to comply with NEPA requirements to analyze a range of reasonable alternatives.

Comment Number 0072.95

CTUIR

Comment P 3-43: PP: The argument for long term management seems poor given that a large amount of SST waste has already leaked to the ground, and that the transfer of tank waste simply for maintenance reasons has inherent risks that are unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires that all reasonable alternatives be evaluated, regardless of cost, compliance to existing regulations, potential risk, or any other factor used in the alternatives evaluation process, which would include the Long-Term Management alternative evaluated in the EIS. Please refer to the response to Comment numbers 0072.05 and 0038.01 for related discussions. All data that support the cost and impact analysis of each alternative are presented in an objective and unbiased format for comparison by the decision makers and by the public during the comment period. DOE and Ecology are aware that the vadose zone has been contaminated beneath the tanks. Existing contamination is presented in Volume One, Section 4.2, and cumulative impacts of existing contamination, TWRS alternatives and other Hanford Site actions are presented in Volume One, Section 5.13. The potential risks associated with moving waste from one tank to another one are analyzed in the EIS in Volume One, Section 5.11 and Volume Three, Appendix D for routine operations during remediation and Volume One, Section 5.12 and Volume Four, Appendix E for accident risks.

Comment Number 0072.96

CTUIR

Comment P 3-45: Sect. 3.4.3.5: Post Remediation: this section needs to have an account of the remediation of the extra ground used.

Response This comment refers to the post remediation section for the Long-Term Management alternative. The extra ground would be the surface area overlaying the 26 new DSTs that would be constructed as part of this alternative. As explained in Volume One, Section 3.4.3.1, this alternative is similar to the No Action alternative in that administrative controls over the Hanford Site are assumed to be maintained for 100 years. No remediation activities would be performed. The consequence is stated in Section 3.4.3.5 that there would be no post-remediation activities associated with the Long-Term Management alternative. Because there is no remediation of the extra ground, no account of this activity has been provided in the EIS.

Comment Number 0072.183

CTUIR

Comment P B-44: Is there a sludge well pumping operation ongoing?

Response DOE and Ecology believe that the comment is referring to saltwell pumping. Saltwell pumping of the SSTs to remove interstitial liquids is an ongoing operation that is scheduled to be completed in the year 2000. Saltwell pumping is an activity that would be a part of continued operations under all alternatives as indicated throughout Volume One, Section 3.4.

L.3.4.5 In Situ Fill and Cap Alternative

Comment Number 0072.184

CTUIR

Comment P B-48: Sect. B.3.3: This alternative is unacceptable as are all in situ alternatives. Language clearly defining that in situ alternatives are against the law must be inserted here.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The Summary, Section S.7, discusses regulatory compliance for each alternative and indicates which alternatives would fail to comply with applicable laws and regulations. Regulatory compliance also is addressed in Volume One, Sections 3.4 and 6.2 and Volume Two, Appendix B. In each of the sections cited, it is clearly stated that this alternative would not comply with certain laws and regulations. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.6 In Situ Vitrification Alternative

Comment Number 0014.01

Bullington, Darryl C.

Comment It is impossible to take seriously any document that includes a proposal to spend 16 to 23.8 billion dollars and use one-quarter of the available electricity of the Washington Public Power Supply System to vitrify 73 million curies of hazardous radioactive solids and surrounding soils contaminated with thousands of gallons of cesium-137 containing liquid (a volume of over 20,180 cubic yards per tank) to a depth of sixty feet by inserting electrodes and heating to 2,600 to 2,900 F. Before I would even waste the paper to evaluate such a scheme I would have to see some demonstration using noncontaminated materials at a place and in a way that would not be a hazard to the public and people involved. To design any system that could contain <u>all</u> of the gases that would be suddenly released from such an event or a heat shield needed to protect the operating deck above the tanks, and enclosed, should melting such a mass even be possible, is beyond all imagination. To perform such a full-scale demonstration for $70 million is also highly suspect.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. ISV is a commercially available technology that has been successfully demonstrated on a smaller scale and is a reasonable alternative for analysis in the TWRS EIS. The EIS does discuss the technical uncertainties associated with implementing this alternative in the Summary, Section S.7, Volume One, Section 3.4, and Volume Two, Appendix B. Please refer to the response to Comment numbers 0072.80 and 0072.05 for discussion of NEPA requirements for reasonable alternatives analysis.

Comment Number 0023.01

Geosafe

Comment The ISV alternative should provide an objective evaluation for selecting the size of the tank farm containment facility. The confinement facility as shown in Figure 3.4.5, which encloses an entire tank farm, may have some distinct advantages but it poses significant design and construction difficulties. A smaller containment facility could be more easily constructed that encloses only one tank at a time. The smaller facility could be moved into position using a crawler system similar in design to that proposed for the decommissioning of the 100 Area Reactors (WHC MLW-SVV-037106). Two sets of crawlers could be used to move multiple containment facilities. Although not stated in the EIS, it is presumed the need to enclose an entire tank farm was based on the premise that a structural load could not be supported by the dome structure of the tanks and would result in their collapse. For the ISV alternative, the void spaces in the tanks will be filled with sand or other material and can be made suitable for load bearing. The smaller confinement facility would be significantly easier to construct, maintain and decontaminate after project completion. In addition, the smaller facility should significantly reduce the degree of technical difficulty in implementing the ISV alternative and potentially lower its cost as well.

Response Alternative configurations for the tank farm confinement facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the TWRS EIS. This proposed size reduction ultimately could result in a confinement facility that would be mobile, and could be moved from tank to tank within a tank farm. A large facility would not impose a bearing load on the individual tanks because its perimeter would lie outside of the tank farm. Because a smaller confinement facility potentially would impose a bearing load on adjacent tanks, a design solution to this problem would have to be formulated before the smaller confinement facility could be considered practicable. Filling the adjacent tanks with sand would be among those considered.

One potential problem area not discussed in the comment is the off-gas collection and treatment equipment and facilities. With a large confinement facility, the off-gas would be ducted to stationary treatment facilities. With the smaller, mobile confinement facility, the solution might be to move the off-gas treatment facility when the confinement facility is moved, or alternately, to re-route the off-gas ducting when the confinement facility is moved. This is one of a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion in the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers.

The Draft EIS addressed the full range of reasonable alternatives. The alternative is bounded by the alternatives addressed in the Draft EIS, and DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. For a discussion of the approach used in the EIS to develop and analyze alternatives, please see Volume One, Section 3.3 and refer to the response to Comment number 0072.05.

Comment Number 0023.02

Geosafe

Comment An objective evaluation should be provided for selecting the size of the ISV equipment. The evaluation should discuss the advantages and disadvantages of using a large ISV system versus using a smaller system more closely resembling commercially available equipment.

The concept of treating a tank with extremely large melts significantly increases the difficulty and the technical Implementability of the ISV alternative. The ISV system proposed in the EIS is 40 times larger (4 Mw vs. 160 Mw) than existing equipment and is capable of treating a tank in one setting. Geosafe believes treating tanks in large settings may pose significant operational problems. We believe a more workable approach is to treat tanks with smaller multiple ISV settings so as to have better control on the release of vapors from in and around the tank.

Another factor to consider with a large-scale ISV systems is power level fluctuations caused by startup or shut down. It is envisioned that power line fluctuations caused by a 160 Mw system may be unacceptable for the regional power grid unless special arrangements are provided.

In summary, smaller ISV units that treat tanks in multiple settings would greatly increase the technical Implementability of the ISV alternative and potentially reduce costs. Schedule requirements could be maintained by using multiple ISV systems operating simultaneously at various tank farms. In addition, the research and development time required for the smaller ISV unit would be significantly shorter than the 160 MW unit.

Response Alternative configurations for the power supply facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the EIS. A large facility potentially could impose load fluctuations on the regional power grid, although with proper planning these fluctuations could be effectively managed. Because a smaller power supply facility potentially would melt only a portion of a tank and its contents, a solution to this problem would need to be formulated before the smaller power supply facility could be considered practicable. Using multiple power supply units would be one solution among those considered. That multiple smaller power supply units potentially would reduce costs may be premature. For the majority of process equipment, purchasing a single large unit rather than multiple smaller units is generally more economical. To state that the research and development time required for the smaller power supply facility would be significantly shorter than for the larger unit also may be premature. Using multiple ISV settings would allow better control on the release of vapors from in and around the tank also would be considered premature until further studies have been completed. These are a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers.

The Draft EIS addressed the full range of reasonable alternatives. As the alternative identified in the comment is bounded by the alternatives addressed in the Draft EIS, DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers. Please refer to the response to Comment numbers 0023.01 and 0072.05.

Comment Number 0023.03

Geosafe

Comment Two techniques should be evaluated for reducing the processing depth of ISV which is specified in this document as 60 ft. Implementation of one or both of these techniques will decrease the technical difficulty of implementing the ISV alternative.

The first option would involve the removal of overburden to expose the dome structure of the tank. The overburden could be subsequently added to the tanks to eliminate internal void spaces. This would decrease the required processing depth of ISV to approximately 45 ft for the largest volume tanks.

The second option would involve the intentional lowering of the tank dome structure into the tank to reduce the effective processing depth from 45 ft to 33 ft for the largest tanks. This would be accomplished by first covering the contents of the tanks with an adequate depth of soil to provide radiation shielding. Next the center portion of the tank would be cut into pieces and lowered into the tank on to the soil. Following the removal of the dome structure, additional soil would be placed in the tank to provide a level surface to begin ISV operations. It is recognized that cutting into a tank will present some added risk that will need to be evaluated.

Response Further research and investigation associated with ISV is possible. This particular comment deals with potential solutions to the problem of having ISV operate at depths of approximately 60 feet. The suggestions for using the tank overburden to reduce tank voids; and subsequently lowering the tank dome into the tank before vitrification are examples of areas where further investigation may prove to be of value; however, substantial safety considerations would need to be overcome. Added risk from exposing and cutting into the tanks has not been evaluated. These are several areas where further detailed study could potentially result in an improved process. To address this issue, the cost estimate includes additional costs for technology development for this alternative. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers. Please refer to the response to Comment number 0023.01.

Comment Number 0023.04

Geosafe

Comment Following treatment of the tanks with ISV, there is no need for the tanks to be capped with the Hanford barrier. A simpler and less expensive cover to minimize the downward percolation of water could be used. The Hanford barrier is designed to provide plant, animal and human intrusion into a waste zone using a thick zone of crushed rock and to prevent the downward percolation of water. Since the ISV monolith is already a rock "cap" of considerable structural strength the need for a biointrusion zone is unnecessary.

Response ISV will leave the tank contents in a form unique to that alternative. However, the remaining waste form is still radioactive and some means must be employed to prevent access by humans, animals, and plants. The Hanford Barrier was used for this purpose as a potential form of closure, which is applicable to all the alternatives. Closure or dispositioning of the tanks is further discussed in Volume One, Section 3.3 and in Volume Two, Section B.5.0 of the EIS. Tank waste remediation and tank farm closure issues cannot be separated; therefore, an assumption common to all alternatives was included in the alternatives evaluation, but not evaluated as a single, specific action. Because the information contained in the Draft EIS is correct, no change to the text was made. Please also refer to the response to Comment number 0019.04 for a discussion of the Hanford Barrier.

Comment Number 0023.05

Geosafe

Comment The ISV cost estimate should discuss the following costing assumptions: (a) are individual tank depths being taken into consideration for estimating treatment volumes, e.g. the 500,000 gal tanks are 18 ft deep and the million gal tanks are 32.5 ft deep, (b) is the area between tanks being vitrified and (c) is soil beneath the tanks being treated.

Response DOE and Ecology have presented life-cycle cost estimates for each alternative. These estimates are based on conceptual designs for the alternatives. Because of the conceptual nature of the alternatives, there is a level of uncertainty associated with the life-cycle cost estimates. To account for the variations cited in the comment, such as variations in tank sizes and variability of the volume of treated material, an uncertainty analysis has been completed for the tank waste alternatives. The resultant cost range for each alternative is shown in Volume Two, Section B.8.0 of the EIS. Other information on the cost estimates is contained in Volume One, Section 3.4.1.7 and Volume Two, Section B.3.0.8 of the EIS. Only the contaminated soil between the tanks and immediately around and below the tanks is assumed to be vitrified. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.06

Geosafe

Comment Page 3-52, 4th par. "Each vitrification system ... consuming 160 Mw of power." Power consumption rates should be discussed for all alternatives and not be specifically limited to the ISV alternative. ISV is an extremely efficient vitrification technology. On average ISV consumes 800 Kw-hrs of electricity to vitrify a ton of material which is considerably lower than other vitrification technologies. The power consumption rates as listed in Table B.11.0.3 for the ISV alternative is 7,690 Gwh, which is less than the "ex situ no separation" alternative (8,800 Gwh) and the "ex situ extensive separation" alternative (41,600 Gwh).

Response The preliminary calculations used in the EIS show that ISV has a power consumption lower than other alternatives. To provide a side-by-side comparison of the resource consumption of the alternatives, DOE and Ecology have presented the material in summary form in Volume Two, Table B.11.0.3. To provide a complete narrative description in Volume One, Section 3.0, the EIS presents the information for each alternative under six headings: Process Description; Construction; Operation; Post Remediation; Schedule, Sequence and Costs; and Implementability. The Process Description for each alternative describes the major pieces of equipment for each process, giving a description of some of the major equipment used in the process. The section to which the comment refers is the Process Description for ISV, and the power supply was described as one of the major equipment items of this process. For other alternatives, the major equipment items will be different because the process is different. Because this section is a process description, it should not be interpreted as attempting to portray ISV as having obvious advantages or disadvantages. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.07

Geosafe

Comment Implementability: 1st bullet, The degree of uncertainty of the ISV alternative will be significantly reduced by using smaller ISV units as discussed above.

Response The concept of treating tank waste with large-volume melts may have more technical issues associated with the implementability of the ISV alternative. The configuration proposed in Comment number 0023.01 is smaller in size than the facility depicted in the EIS. This is one of a number of areas where further detailed study potentially could result in an improved process with fewer issues regarding technical implementability. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding.

Comment Number 0023.08

Geosafe

Comment Implementability: 2nd bullet, We agree that substantial research and development activities would be required to implement the 160 MW ISV system and for this reason have recommended using smaller ISV units closer to the scale of our commercial 4 MW system. Geosafe has already proposed a concept to DOE for treating the single shell and double shell storage tanks using our 4 MW ISV system (see attached white paper dated December 1995). The 60 ft depth limitation for processing the large volume tanks can be reduced by implementing the techniques discussed in comment A 3. [Comment number 0023.03]

Response Alternative configurations for the power supply facility for ISV are possible. The configuration proposed in the comment is smaller than the facility depicted in the EIS. It should not be inferred that the use of a smaller power supply is a feature of any particular vendor or that the use of a smaller power supply constitutes an endorsement by DOE or Ecology. Because a smaller power supply facility would potentially melt only a portion of a tank and its contents, a solution to this problem would have to be formulated before the smaller power supply facility could be considered to be practicable, and substantial research, development, and demonstration activities still would be required. There are a number of areas where further detailed study potentially could result in an improved process. In these areas of potential improvement, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts presented to the decision makers as bounding. The EIS analysis bounds the information suggested by the commentor. For a discussion of the technique of reducing the depths of the tanks, please refer to Comment number 0023.03. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.09

Geosafe

Comment Implementability: 3rd, bullet, The possibility of an uncontrolled reaction occurring in a tank is mainly limited to 38 tanks containing organics or ferrocyanide material. The DOE Radioactive Tank Waste Remediation Focus Area is currently evaluating the explosive issue concern. Potentially, ISV treatability testing will be required to fully address this concern.

Response Further treatability testing will be required to fully address the concern of uncontrolled reactions in the tanks if the contents were vitrified. There may be answers to the situation that are inherent with ISV, which is that extensive mixing of contents of different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been limited, and it may be premature to state that the problem is mainly limited to 38 tanks containing organics or ferrocyanide material. Until further investigations have been completed, DOE and Ecology believe that the statement in the EIS that further analysis is required remains correct. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.10

Geosafe

Comment Implementability: 4th bullet, We agree that the tank farm containment facility is highly conceptual and recommend that it be scaled down in size from the proposed 500 ft wide by 600 ft long facility to an approximately

120 ft square facility which covers only one tank. The technical difficulties of constructing the smaller facility are minimal.

Response The large tank farm confinement facility is highly conceptual in nature. The area discussed at this point is that further development would be required before any confinement facility, regardless of size, would be expected to comply with current DOE facility design requirements. A confinement facility that is 120 feet on a side is still sufficiently large that additional design study would be required. The technical difficulties that may be expected in designing and constructing the smaller confinement facility would be less than those expected in designing and constructing a much larger confinement facility. It may be optimistic to state that these technical difficulties would be minimal. This is one of a number of areas where further study potentially could result in a process with fewer issues regarding technical implementability. In these areas, the configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that were likewise bounding. These bounding impacts are those presented to the decision makers. The EIS bounds the information suggested in the comment. Please refer to the response to Comment number 0023.01 regarding the use of smaller ISV units.

Comment Number 0023.11

Geosafe

Comment Implementability: 5th bullet, The use of a smaller tank containment facility will eliminate most of the construction difficulties. Using a smaller mobile containment facility will allow construction activities to take place in a clean area, thereby eliminating the risks and added expense of working in or around a tank farm exclusion zone.

Response The large tank farm confinement facility may be more difficult to construct. The area being discussed in the EIS at this point is the atypical nature of the design of the large confinement facility and restrictions associated with working in and around the tank farms. While a smaller confinement facility could be constructed adjacent to the tank farms and then moved into position to assume that this will eliminate the risks and added expense of working around the tank farms would be considered premature. This is one of several areas where additional design study potentially could result in process improvements and potentially could result in a process with fewer issues regarding technical implementability. In these areas, the configuration used in the EIS represented a bounding condition, resulting in environmental impacts that also were bounding. Please refer to the response to Comment number 0023.01 regarding the use of smaller ISV units.

Comment Number 0023.12

Geosafe

Comment Implementability: 6th bullet, Inspection of the final waste form can be done by core drilling through the vitrified monolith after a period of cooling. Core drilling is routinely performed on commercial ISV projects to verify waste treatment for project closure. In the past, core drilling has been used to sample untreated tank wastes and should be easily adaptable to sampling a vitrified waste form which is easier to handle. Secondary wastes generated from the drilling can be recycled to future melts. If a core sample fails to meet waste acceptance testing, the area from which it was taken can be retreated by ISV.

Response Methods exist for the sampling of the in situ vitrified product. Many cores would likely be necessary for each tank and the cuttings from the core would require special handling and disposal. While the secondary wastes generated can be returned to the untreated tanks, other problems may be encountered during the development and operating phases of the core drilling system. The core drilling of vitrified HLW is an area that would require additional research and development to investigate further and determine its workability. If core drilling becomes an accepted technique for determining the acceptability of the waste form, the design of the confinement facility would include provision for equipment to accomplish the core drilling. Inspection and potential pretreatment of the final waste form are implementability problems that remain to be solved.

Comment Number 0023.13

Geosafe

Comment Implementability: 7th bullet, Use of the proposed smaller tank confinement facilities will be significantly reduce decontamination and decommissioning problems.

Response The large tank farm confinement facility may be difficult to decontaminate and decommission and these difficulties should be fewer for a smaller facility. Further study could result in an improved process. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.14

Geosafe

Comment B-53, 3rd par., last sent., A reference should be provided for the current research which is addressing depth-enhancement techniques.

Response A reference has been added to the last sentence of the referenced paragraph in Volume Two, Appendix B.

Comment Number 0023.15

Geosafe

Comment B-53, 4th par., Elimination of interstitial spaces between soil particles is not the only mechanism for volume reduction. During ISV treatment a significant volume of tank wastes will be vaporized due to the decomposition of nitrates, nitrites, carbonates and sulfates. This will result in a volume reduction that is expected to exceed 50 percent by volume. In addition, the ISV process will not produce significant quantities of No_x that require special off-gas treatment. The high operating temperature of the ISV melt and its reducing environment will decompose nitrate and nitrite into N_2 and O_2 gas.

Response Elimination of interstitial spaces between soil particles is not the only mechanism for volume reduction. A reduction in volume due to decomposition of the tank wastes will occur. However, at this time, no ISV facilities have been designed for use at the Hanford Site. Until design and testing have been completed, to consider that the ISV process will not produce significant quantities of nitrogen oxides requiring special off-gas treatment is premature. ISV most closely resembles a batch process, where the nature of the reacting materials and the reaction products change as a function of time. Temperature also changes with time during ISV, starting with the cool tank wastes and glass formers and ending with molten glass at a very high temperature. Therefore, while extremely high temperatures will enhance the dissociation of nitrate and nitrate, nitrogen oxides will be produced until those temperatures are reached, and the off-gas treatment system must be able to treat all of the vapors evolved. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.16

Geosafe

Comment B-56, Figure B3.4.3., The NO_2 burner is configured as a lime spray dryer.

Response The essential function of the nitrogen oxide burner is correctly depicted on the flow diagram in Volume Two, Appendix B. The streams entering and leaving the unit are shown correctly. Because the essential function of the unit has been depicted, no changes to the EIS have been made.

Comment Number 0023.17

Geosafe

Comment B-57, 1st par., Treating the area between the tanks unfairly increases the cost of the ISV alternative and should not be included unless other alternatives address this concern. Potentially, an ISV option could be included which addresses the treatment of contamination below and around the tanks.

Response The inclusion of extra material in the zone of vitrified material is unique to the ISV alternative. Treating the area between the tanks would occur as a consequence of the nature of the ISV process, and doing so would not unfairly increase the cost of the ISV alternative. Because of the in situ nature of the process, ISV must have a vitrified zone that extends beyond the tank dimensions to ensure that the tank and its contents have been vitrified. This zone would not exist for the ex situ alternatives, for which retrieval activities will be performed that would be bounded by the tank walls. Because of the technical uncertainty in determining the dimensions of the zone of vitrified material during the melting operation, the preparers of the engineering data package (WHC 1995f) made the assumption to extend the dimensions of the vitrified zone beyond the tank dimensions to include the extent of the tank farms. Using this assumption ensured that the preconceptual costs, energy consumptions, and glass former usages were reasonable. For use in the EIS, these conservative assumptions and resulting calculations form a bounding condition. The use of this bounding condition will result in environmental impacts that are likewise bounding. NEPA requires that bounding conditions be equally compared for the environmental impacts that potentially may result from all alternatives evaluated. Please refer to the response to Comment numbers 0023.01 and 0001.01 for other discussions of subsurface barriers.

Comment Number 0023.18

Geosafe

Comment B-63, last par., The ISV flow diagram (Figure B.3.4.3) does not show a water quench system, venturi scrubber, solids separator, chiller or mist eliminator, which are the standard ISV off-gas treatment system components.

Response Figure B.3.4.3 depicts the major features of the ISV process. At the point when further engineering design potentially would be done, an expanded set of process flow diagrams would be developed. Because the description of the process in Section 3.4.3 of Appendix B refers to the water quench, scrubber, solids separator, chiller, and mist eliminator, no changes to the EIS have been made. These treatment systems were included in the design for the process, but were considered too much detail for presentation in the EIS. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.19

Geosafe

Comment B-64, 3rd par., The degree to which organics and ferrocyanides present an explosive issue in the tanks is presently unknown and is currently being researched by DOE. At most an estimated 38 tanks potentially contain high enough concentrations of these contaminants to be of concern (PNL 10773).

Response The degree to which organics and ferrocyanides present an explosive issue currently is under investigation. There may be answers to the situation that are inherent with ISV, which is that extensive mixing of the contents of different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been limited, and it may be premature to state that the problem mainly is limited to 38 tanks of organics or ferrocyanide material. Until further investigations have been completed, the statement in the EIS that safely treating reactive materials requires further analysis is correct. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.20

Geosafe

Comment 1st bullet, Geosafe agrees that the proposed ISV alternative is more conceptual in design than the ex situ vitrification alternative but has made the following recommendations to significantly decrease the degree of uncertainty associated with cost, schedule and resource requirements.

- Use smaller ISV equipment and multiple melts to treat tanks
- Use a smaller moveable tank containment building
- Reduce tank effective height to lower treatment depth and volume.

Response Additional areas for further research and investigation associated with ISV are possible. Using smaller ISV equipment and multiple melts, smaller, moveable confinement facility, and tank overburden to fill voids and lowering the tank dome into the tank are areas where further investigation may be valuable. The configuration selected for inclusion into the EIS represented a bounding condition, which would result in environmental impacts that also were bounding. These bounding impacts were presented to the decision makers. Please refer to the response to Comment numbers 0023.01, 0023.03, and 0023.11. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.21

Geosafe

Comment 2nd bullet, The degree of uncertainty for the ISV alternative can be reduced by using smaller equipment which is considered highly feasible given the current understanding of the technology.

Response Alternative configurations for the tank farm confinement facility for ISV are possible. The configuration proposed in Comment number 0023.01 includes a confinement facility that is 120 feet on a side. The area under discussion in the EIS is the higher degree of uncertainty for the exact equipment required for ISV versus ex situ alternatives. The 120-foot confinement facility is still several times larger than that used in current development work for ISV. To state that this configuration is highly feasible could be considered premature. Comment number 0023.01 discusses concerns related to the movement of a smaller confinement facility and its off-gas facilities. Because these concerns remain as issues and problems to be resolved, the EIS is correct in referring to the degree of uncertainty involved. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.22

Geosafe

Comment 3rd bullet, Implementing the recommendation to use a smaller containment facility will eliminate all these concerns except for the need to characterize the tanks. Tank waste characterization is a generic concern that is applicable to all treatment alternatives and is not limited to the ISV alternative.

Response Vitrifying one tank at a time will not require the characterization of an entire tank farm if a smaller, mobile confinement facility were to be used. ISV by its very nature does not retrieve the tank contents. Consequently, there is no opportunity to advantageously blend the tank contents, as would be the case if several tanks were retrieved at the same time as in the ex situ alternatives. To consider the smaller confinement facility will eliminate all these concerns except the need to characterize the tanks would be premature. Still, ISV is basically a batch process (or potentially a semi-continuous process). One characteristic of a batch process is the changing nature of the reactants and products as a function of time. The system must be able to process the expected products, and this requirement does not change with the size of the confinement facility. Further detailed study would result in an improved process; however, no changes to the information presented in the EIS are required. Please refer to the response to Comment number 0023.01.

Comment Number 0023.23

Geosafe

Comment 4th bullet, An estimated 20 tanks potentially contain organics at concentrations that may represent an explosive concern. Research on treating these problem tanks could be conducted while other non-effected tanks are being processed.

Response The degree to which organics present an explosive issue is currently under investigation. Extensive mixing of waste from different tanks to mitigate potential uncontrolled reactions is not included in the process. At present, the testing of the heating of tank contents has been very limited, and it may be premature to state that the problem mainly is limited to 20 tanks containing organics. Concurrent research and testing on treating these problem tanks could be conducted while other non-affected tanks are being processed. This research must be successfully completed before this method could be used to remediate tanks that may present an explosive concern. Until further investigations have been completed, the statement in the EIS that the safety of drying some waste types is uncertain remains correct, and as a result, no changes to the EIS have been made. The potential for fires and explosions in the tanks is addressed in Volume One, Section 5.12 and Volume Four, Appendix E. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0023.24

Geosafe

Comment 5th bullet, Geosafe recommends using smaller ISV units which should significantly reduce the uncertainties associated with off-gas treatment. The high operating temperature of ISV has been demonstrated to effectively decompose nitrogen compounds without the formation of NO_xS and greatly reduces off-gas treatment concerns. The calcium sulfate waste stream should not be recycled because the sulfates will be reintroduced back into the off-gas.

Response There is the potential for the production of a secondary waste stream of potentially contaminated calcium sulfate from ISV. This waste stream should not be recycled because the sulfates may not be incorporated into the melt and may be reintroduced into the off-gas. However, at this time, no ISV facilities have been designed for use at the Hanford Site and none have been designed of the size needed to vitrify the tank waste anywhere in the world. Numerous ISV facilities have had problems with off-gas treatment and fires. Until development work has been completed, to state that the high operating temperature of the ISV process would effectively decompose nitrogen compounds without the formation of nitrogen oxides and greatly reduce off-gas treatment concerns would be considered premature. ISV most closely resembles a batch process, where the nature of the reacting materials and the reaction products change as a function of time. Temperature changes also occur with time during ISV, starting with the cool tank wastes and glass formers and ending with molten glass at a very high temperature. So while extremely high temperatures will enhance the dissociation of nitrate and nitrate, nitrogen oxides will be produced until those temperatures are reached. The off-gas treatment system must be able to treat all of the vapors that are evolved. Because these uncertainties will remain regardless of the size of the ISV units, no changes to the EIS have been made. Please also refer to the response to Comment number 0023.01 for a discussion of smaller ISV units.

Comment Number 0023.25

Geosafe

Comment 6th bullet, The 60 ft depth limitation is overly conservative and can be reduced by removing overburden from the tanks and lowering the effective height of the tank as discussed in comment A 3. [Comment number 0023.03]

Response Please refer to the response to Comment numbers 0023.03 and 0023.08.

Comment Number 0023.26

Geosafe

Comment 7th bullet, The use of the proposed smaller tank containment facility (120 ft by 120 ft) will eliminate structural design and costing uncertainties.

Response The EIS addresses only the uncertainty that remains in the design of the large (i.e., 500- by 600-foot) confinement facility. At this time, no ISV facilities have been designed for use at the Hanford Site. Until additional technology development has been completed, it would be considered premature to state that the use of the smaller confinement facility will eliminate structural design and costing uncertainties. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.27

Geosafe

Comment 8th bullet, Verification of the ISV monolith can be performed by core sampling which is a well demonstrated technology. Allowances will have to be made for coring of a radioactive glass monolith but it is feasible given an enclosed system and sufficient concern for safety issues. Secondary wastes generated from coring can be directly recycled to future melts thus eliminating waste disposal concerns.

Response DOE and Ecology agree with the comment that methods exist for the sampling of the in situ vitrified product. The core drilling of vitrified HLW is an area that would require additional research and development to determine its workability. If core drilling becomes an accepted technique for determining the acceptability of the waste form, the design of the confinement facility would include provision for equipment to accomplish the core drilling. While the comment is correct in stating that the secondary wastes generated can be returned to the untreated tanks, it is possible that other problems will be encountered during the development and operating phases of the core drilling system. The text referred to in the comment discusses the fact that inspection and potential pretreatment of the final waste form are problems of implementability that remain to be solved. Despite the fact that methods are available for sampling the vitrified waste form, the technical problems associated with this issue remain to be solved. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.28

Geosafe

Comment 9th bullet, The use of the smaller ISV system will eliminate concerns regarding movement of the off-gas system.

Response The EIS addresses the uncertainty that remains in the design of the off-gas treatment facilities. Until additional technology development has been completed, to state that the use of the smaller ISV system will eliminate concerns regarding movement of the off-gas system would be considered premature. Please refer to the response to Comment number 0023.24. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.29

Geosafe

Comment 10th bullet, The use of a smaller ISV system will greatly reduce the time needed to retreat a specific area in a tank if it fails to meet the treatment criteria.

Response The EIS addresses the uncertainty that would occur in the operations schedule if an area as large as a complete tank has to be retreated as a result of unsuccessful ISV. Until additional technology development has been completed, to state that the use of the smaller ISV system will greatly reduce the time needed to retreat a specific area in a tank if it fails to meet the treatment criteria would be considered premature. The time required to retreat a tank is not a function of the size of the confinement facility. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0023.30

Geosafe

Comment 11th bullet, The concern of mixing fluxants into deep zones of the tank can be reduced by implementing the treatment depth reduction techniques recommended in comment A 3 (See Comment number 0023.03). Geosafe has already demonstrated the mixing of fluxants at full scale with excellent results.

Response Thermal mixing is well known in conventional electric furnaces and should work well for ISV. Because thermal mixing in electric furnaces is a natural phenomena, its presence does not constitute an endorsement of the application of a particular technique or equipment. The statement in the EIS refers to further development work that may be required. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.97

CTUIR

Comment P 3-48: Sect. 3.4.5: In Situ Vitrification Alternative: this section does not adequately discuss how all of the vitrified ground and waste is to be verified for vitrification, and how this verification process will include leakage, migration, below the area of impact. This process has not been adequately explained for the purposes of this EIS.

Response Further technology development regarding the implementation of the ISV alternative may be required. Volume One, Section 3.4.5.7 and Volume Two, Section B.3.4.4 discuss the issues applicable to the implementability of this alternative including inspection of the final waste form to confirm that all of the waste is stabilized and the waste form is acceptable. One possible method of verification would be drilling through the vitrified mass to ensure that vitrification was complete, but these drill holes would not necessarily confirm any potential migration that may exist below the vitrified mass. Migration in the vicinity of the vitrified mass could be verified by drilling additional boreholes near each tank farm when ISV had been completed. Please refer to a related discussion on verification in the response to Comment number 0023.12.

Comment Number 0072.98

CTUIR

Comment P 3-54: Sect. 3.4.5.7: Implementability: How is excess melting going to be addressed, Please describe the fractionation process of the melt? What are the anticipated cooling times, and how have these times been calculated, are they based on the fractionation process? If the times are not based on the fractionation process what exactly are they based on? What is the verification process for the vitrification, the fractionation, the cooling, the immobilization?

Response Many crucial questions must be answered before the ISV alternative can be implemented. Volume One, Section 3.4.5.7 contains discussions of the substantial research, development, and demonstration activities that would be required. Inspection of the final waste form to confirm stabilization of the waste is one area requiring more information. The implementability of this alternative is not known at this time. To account for these uncertainties, additional technology development time and costs were incorporated into the analysis of these alternatives. The information requested is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives. Implementability was one factor analyzed for the technologies included in the alternatives analysis.

Comment Number 0072.99

CTUIR

Comment P 3-54: The technical uncertainties associated with this process are just as great for the MUSTs because the contents of the MUSTs have been inadequately described within this EIS.

Response As is explained in Volume Two, Section A.2.3, definitive characterization data do not currently exist for the inactive MUSTs. Because they received the same waste products that are contained in the tanks, the concentration of constituents is expected to be approximately the same. Volume Two Table A.2.3.1 lists the current estimated waste volumes for the MUSTs and briefly comments on the use of each tank. ISV of the small MUSTs may present less of a technical challenge because the size of the melt more closely conforms with previously demonstrated vitrification processes. Please refer to the response to Comment numbers 0012.14, 0072.169, 0029.01, and 0060.02 for a discussion related to MUST contents.

Comment Number 0072.185

CTUIR

Comment P B-53: Sect. B.3.4: Same comment as above. [Please refer to the response to Comment number 0072.195.]

Response Please refer to the response to Comment number 0072.195.

Comment Number 0102.01

Eister, Warren

Comment The Draft Environmental Impact Statement for the Hanford Site Tank Waste Remediation System - Summary (DOE/EIS-0189D) seems to suggest the choice system would be In Situ Vitrification (Figure S.6.2 along with Tables S.7.2 and S.7.3).

It is very reassuring that decisions made more than twenty years ago continue to be re-evaluated. Unfortunately those decisions have been extremely difficult to implement.

However, in spite of the continuing unresolved difficulties, this EIS Summary reports that DOE has already adopted the Phased Implementation System which is dependent on potential geologic repositories and involves extensive process and transportation activities.

Is the In Situ Vitrification technology being developed with the same level of effort as the Phased Implementation?

Would this In Situ Vitrification System be applicable to the:

- Savannah River site?
- Spent fuel from the nuclear power reactor program?
- TRU waste?
- Low-level wastes?

Are there other technologies being sought that would allow the spent fuel from the nuclear power program to remain in the vicinities of the current power plant sites?

Response The preferred alternative for tank waste identified in the Draft EIS and Final EIS is Phased Implementation not ISV. DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0072.05 regarding NEPA requirements for the analysis of alternatives and Comment numbers 0055.03 and 0005.07 for a discussion of the role of the EIS in the decision making process. Repository costs and uncertainties analysis results for each alternative have been included in Volume Two, Appendix B and Volume Five, Appendix K, respectively, in the Final EIS.

The TWRS EIS focused on tank waste remediation alternatives. Technology evaluation was limited to those technologies currently available or for which sufficient development information was available. DOE is not currently developing any remedial technologies. Potentially-applicable ISV technologies are under commercial development. Technologies development and/or evaluation would be conducted during the detailed design and demonstration phases of the preferred alternative. Issues related to ISV technology applicability at other DOE sites, for commercial nuclear power programs, or to other radioactive waste types beyond those required for the alternatives evaluation were not considered because they are beyond the scope of the EIS.

Please refer to the response to Comment number 0037.03 for more information concerning interim onsite storage of HLW and compliance issues related to the Nuclear Waste Policy Act.

L.3.4.7 Ex Situ Intermediate Separations Alternative

Comment Number 0005.45

Swanson, John L.

Comment Page 3-59 contains a sentence regarding the Tri-Party Agreement requiring the retrieval function to remove waste to an extent based on volume or as much as is technically possible, WHICHEVER IS LESS. I believe you mean to say remove the MOST, leaving the LEAST - but that is not what the sentence says.

Response The cited text has been revised as follows, "The Tri-Party Agreement (i.e., Milestone M- 45-00) requires that the removal function remove waste to the extent that SST waste residuals meet specific volume requirements based on tank type, or that as much waste is removed as technically possible, whichever action results in the least residual waste volume" (Ecology et al. 1994).

Comment Number 0005.46

Swanson, John L.

Comment Page 3-67 defines an off-gas stream from a vitrifier as a "gaseous air stream containing combustion gases." This is true for a combustion-fired melter, but how about a joule-heated melter?

Response Volume One, Section 3.4.6.2 states that fuel-fixed melters have been included for analysis in the EIS. It is further stated that future evolution may result in another melter configuration. With either the joule-heated or fuel-fixed melter, a large quantity of off-gas with contaminants such as SO_x and NO_x must be treated. The total volume of gas with a fuel-fixed melter would be greater with the use of kerosene and oxygen for the fuel, but the total amounts of SO_x and NO_x would not differ greatly. The fuel-fired melters considered provide a more conservative analysis in the design and treatment of the off-gas for discharge to the environment. Please refer to the response to Comment numbers 0005.42, 0072.91, 0023.01, 0023.15, 0023.24, 0023.28, and 0072.101 for discussions of issues related to off-gassing. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0005.47

Swanson, John L.

Comment Page 3-67, last paragraph of 3.4.6.2 ("Driving heavy equipment--") seems to be out of place. This same paragraph appears in similar locations for other alternatives too; the same comment applies in those sections as well.

Response Because this is an issue common to many of the alternatives, a better location for a one-time entry to the section has been determined. This discussion on mitigating a potential accident has been moved to a discussion of elements common to the alternatives in Volume One, Section 3.4 and Volume Two, Appendix B. This statement of concern appears on several pages within Volume One, Section 3.0 and Volume Two, Appendix B.

Comment Number 0027.10

Roecker, John H.

Comment Technical Uncertainty

To state that the technical uncertainty of the intermediate and extensive separations alternatives are both moderate is erroneous and misleading to those who are not familiar with the technologies involved. Intermediate separations requires three technologies, all of which have been demonstrated, while extensive separations requires at least ten, most of which have not been demonstrated. This misleading information needs to be corrected.

Response The degree of technical uncertainty provided in the Summary assigns a high, medium, or low ranking for the entire remediation alternative. DOE and Ecology acknowledge that there is a higher level of technical uncertainty with extensive separations than with intermediate separations. However, overall, both alternatives fall into the moderate category. Additional discussion regarding technical uncertainty is provided in Volume One, Section 3.4 and Volume Two, Appendix B and the response to Comment number 0005.03.

Comment Number 0036.16

HEAL

Comment The EIS states that intermediate separations would reduce the waste going to the repository. It adds, "The other goal of separations would be to limit the generation of additional waste during the separations processes" (p. 3-65). What does this passage mean?

Response Limiting the generation of additional waste during the separations process means that design and implementation of the HLW/LAW separations processes would consider the volume of LAW along with the volume of HLW that would be generated. One means of accomplishing this would be to limit the introduction of sodium hydroxide during the enhanced sludge washing process, which would limit the overall amount of sodium in the resulting LAW form.

Comment Number 0057.03

Garfield, John

Comment With respect to primarily the cost, the EIS references the document from '94 Boomer et al. That document compares two alternatives that are nearly identical to intermediate separations, then extensive separations is called clean and enhanced sludge washing in that document. It shows a cost penalty for using clean of $7 billion dollars compared to enhanced sludge washing. Those same alternatives show a $3 billion dollar advantage in the Environmental Impact Statement Draft. That is a $10 billion dollar swing. That deserves investigation. The repository comments convey part of that. The rest relates back to my earlier remarks about the headquarters influence.

Response The cost estimates were reviewed and revised for the Final EIS. The waste loading and blending assumptions that impact the volume of HLW have been revised to reflect the recommendations of an independent technical review team. The size of the HLW canisters has been revised to reflect recent DOE-RW findings that a longer canister for Hanford HLW is technically feasible. These changes, as well as the resulting cost impacts, were revised and are included in Volume One, Section 3.4 and Volume Two, Appendix B. For more information on issues relating to HLW canisters and repository costs, please refer to the response to Comment numbers 0081.02 and 0008.01.

Comment Number 0057.05

Garfield, John

Comment The next comment I would like to make is that the chosen case built around the extensive sep..or excuse me the intermediate separations data of without repository cost shows it $30 billion dollars. That estimate assumes a stand-alone high-level waste treatment facility which would cost in the vicinity of $1 to $2 billion dollars and add another equivalent amount in operating costs. There is some recent data developed using a single facility but which can be - its mission can be modified both in terms of scope and capacity to accommodate both low-level treatment at a smaller scale through the 200-ton per day capacity 1 to 200-ton per day capacity for the full scale low-level treatment and then can be converted for high-level treatment. That is the only sane approach to this problem. Building three demonstration plants and two full-scale plants is a lunacy that will cost us $30 billion dollars. A simpler facility approach that I just described would cut those costs in approximately half and, in fact, the studies release from the DOE reading room suggests that cost is about $16 to $18 billion dollars. That should be the basis for the EIS intermediate separations case.

Response DOE and Ecology recognize that there are opportunities for optimizing the costs estimated for each of the alternatives addressed in the EIS. As discussed in the EIS, the alternatives were developed to bound the impacts associated with remediating the tank waste. Process and facility design optimization would not be precluded with the selection of any of the alternatives presented in the EIS. For more information on the topic, please refer to response to the Comment number 0072.05.

The Draft EIS addressed the full range of reasonable alternatives. The alternative identified is bounded by the alternatives addressed in the Draft EIS, and DOE and Ecology believe that including the requested alternative would not provide valuable additional information to the public or decision makers.

Comment Number 0072.100

CTUIR

Comment P 3-56: Sect. 3.4.6: Ex Situ Intermediate Separations Alternative: The separation of the Waste streams into HLW and low activity waste seems confusing. Low activity waste is waste that is a subset of HLW? What are the legal requirements for classifying waste as LAW? Have the Affected Tribes been consulted regarding this?

Response LAW is the waste remaining after removal of as much of the radioactivity from HLW as practicable. The definition of LAW is provided in Volume One, Section 1.0. DOE and the NRC have had formal discussions on tank waste classification and LAW regulation; however, DOE would need to formally solicit an opinion from the NRC regarding the classification of LAW. Volume One, Section 6.2 provides additional information on tank waste classification and the results of the discussions between DOE and the NRC. Criteria must be formalized as to the extent to which the HLW in the tanks must be separated for the residual waste to meet requirements for incidental waste, LAW, as well as the DOE and Washington State definitions of LLW and hazardous waste requirements of the State of Washington. Design specifications for HLW and LAW treatment will require that waste forms meet applicable criteria for disposal in the potential geologic repository or as LAW for onsite disposal, respectively.

DOE plans for onsite near-surface disposal of LAW date back to the 1988 Hanford Defense Waste EIS ROD (DOE 1987). That NEPA process, as well as subsequent consideration of onsite disposal of LAW during the 1989 and 1994 Tri-Party Agreement negotiations, and the Tank Waste Task Force process (HWTF 1993), provided interested parties as well as Tribal Nations with the opportunity to comment on the planned onsite disposal of LAW. The TWRS EIS and the public involvement process for Tri-Party Agreement amendments associated with the privatization initiative provided additional opportunities for Tribal Nation input into the decision-making process related to this issue. The Tribal Nation consultation process is discussed in the response to Comment number 0072.149.

Comment Number 0072.101

CTUIR

Comment P 3-56: PP 3: The LAW is to be quenched into a 'cullet', this indicates that there is going to be an additional secondary waste stream generated from the reaction of molten silicates, nitrates, hydroxides, oxides, metals and water. What will be done with this waste stream. Will this waste stream be classified as High level liquid waste? The off gasses that are produced are supposedly going to be treated in some fashion, please explain how this is to be accomplished including feed rates, volume of off gas produced, filter failure rates, retrievable useable material, and indicate where this process has been proven including references.

Response The technical data that served as a basis for developing the Ex Situ Intermediate Separations alternative are referenced in the EIS (WHC 1995 n, j, i and Jacobs 1996) and are available for review as part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories.

Quench water is a secondary waste stream that would contain contaminants as a result of quenching the molten LAW glass in order to produce the cullet. This quench water would be recycled extensively either as quench water or back to the front of the process to be added to the LAW stream for vitrification. This liquid waste stream would not be expected to be classified as HLW.

The amount of secondary waste generated during operations of the Ex Situ Intermediate Separations alternative would consist primarily of off-gas and liquid effluent emissions identified in Volume Two, Table B.11.05. The off-gas and liquid effluents would be treated to remove contaminants to the maximum extent possible before being discharged. The HLW vitrification process would result in gas flows out the stack of approximately 3,500,000 metric tons (mt) over the life of the facility. The radiological and chemical concentrations to be released from the stack were calculated and used in the routine risk assessment. The liquid effluent from the HLW vitrification facility was estimated to be 1,200,000 mt (before recycle) based on material balance calculations. Volume Two, Section B.3 describes the liquid effluent processing of secondary radioactive waste streams for all alternatives. In addition to these emissions, secondary waste consisting of contaminated filters and spent ion exchange resins would be generated during treatment operations.

The generation of off-gas during the vitrification process would result from the evaporation of water, thermal destruction of chemical compounds, evolution of volatile compounds, and the entrainment of particulates in the off-gas stream. A detailed description of the off-gas system is provided in Volume Two, Section B.3. Control technologies that would be employed to reduce emissions include: quench towers, venturi scrubbers, chillers, demisters, high-efficiency particulate air (HEPA) filtration, sulfur recovery, and NO_x destruction. The off-gas emissions from the vitrification plants are included in the risk assessment. The off-gas treatment processes that would be used are the same technologies that have been successfully used in commercial and defense nuclear industry as well as the chemical processing industry.

Comment Number 0072.102

CTUIR

Comment P 3-56: PP 5: What is the amount of secondary waste generated from this process? Will there be material that can be recycled? Will the secondary waste stream have to be reprocessed for additional radionuclide removal?

Response Secondary waste streams will include treatment for removal of radionuclide and chemical contaminants to the maximum extent possible before discharge. Off-gas streams will include various technologies to treat chemical and radionuclide emissions during operations. Liquid effluents would be collected and sent to the onsite Liquid Effluent Treatment Facility for treatment. Please refer to the response to Comment numbers 0072.101 and 0072.109.

Comment Number 0072.103

CTUIR

Comment P 3-59: top of the page: Where does the strontium end up with this process, in the liquid or the solids phase?

Response The strontium will be mainly in the HLW solid phase during the enhanced sludge washing process used for the Ex Situ Intermediate Separations alternative. A small amount, approximately 6 percent of the strontium and decay product activity, would end up in the LAW.

Comment Number 0072.104

CTUIR

Comment P 3-59: Sect. 3.4.6.2: What was the process for determining the average feed stream, and what are the expected ranges for this feed stock in relation to the glass content and characteristics? What will be the process for determining what to do, in the case of 'out of operating' mode? Will this process entail stocking waste from the other tanks in order to blend the feed mixture? If this is the case, has this information been costed out to show how many and how large these out of ground tanks will be?

Response The technical data that served as a basis for developing the Ex Situ Intermediate Separations alternative is referenced in the EIS (WHC 1995i, j, n and Jacobs 1996) and available for review as part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. Additional details regarding the facility layout, including the melter feed system and associated tankage, are provided in Volume Two, Section B.3.

The average feedstream was developed by taking the average overall chemical and radiological inventory including dilution water that would be added during waste retrieval operations. The material balance calculations assumed that the tank waste would be adjusted to 5 molar soluble sodium during retrieval and transfer. It is expected that there will be some variation in the feed stream composition during the waste treatment process. Compositional limits for waste feed would be established during the detail design phase and would take into consideration the affect of variability in the waste feed on the vitrification process, the acceptability of the glass, as well as safety concerns. Blending of the waste during retrieval and the ability to sample and blend waste in the lag storage area would minimize the variance in the waste feed. The lag storage and melter feed system would provide further opportunity for waste feed conditioning. The engineering data developed include the necessary equipment and processes to blend the waste feed and no additional out of ground tanks are required.

Comment Number 0072.105

CTUIR

Comment P 3-61: Sect. 3.4.6.2:. PP 3: S 1: The figure 3.4.9, depicts a sluicing module at the end of the end effector. If sluicing has to be discontinued because of tank leakage, please describe this sluicing module, and why it is depicted.

Response The sluicing module referred to in the comment would minimize the amount of water introduced to the tank during retrieval as compared to articulated arm method of sluicing. The articulated arm would be deployed when there was concern about the integrity of the tank or a potential for tank leakage. Other types of engineered modules, such as mechanical end effectors, could be used for selected retrieval operations with the articulated arm. Please refer to the response to Comment number 0029.01 for additional information concerning sluicing.

Comment Number 0072.106

CTUIR

Comment P 3-66: PP 1: S 7: Within this sentence there is a reference that silica is sand. Silica is not sand. Sand can consist of many things, including silicon dioxide.

Response Sand is commonly defined as loose, fine particles of disintegrated rock. The sentence that is referred to in the comment is describing glass formers, some of which may be either silica or sand (depending on the desired composition of the glass).

Comment Number 0072.107

CTUIR

Comment P 3-66 PP 2: S 1: Quenching molten glass will not necessarily make gravel sized pieces, in addition the pieces formed will have a high percentage of fractures, and necessarily a very large surface area, please explain how these cullets are better at resisting aging, and weathering, and where are the references for this process?

Response The treatment facilities that would produce glass cullet as a waste form would have equipment in place to produce uniform-sized cullet. Glass fines would be screened and recycled back to the melter and oversized cullet would pass through a roll crusher to produce cullet of acceptable size for handling. Glass cullet would have a larger surface area-to-volume ratio as compared to monolithic pours of glass (e.g., glass logs) in canisters. This discussion is included in Volume Two, Section B.3 of the EIS. Glass cullet would have higher leach rates than monolithic pours of glass due to the higher surface area-to-volume ratio. The acceptability of HLW glass cullet produced under the Ex Situ No Separations alternative is identified in Volume One, Sections 3.4 and 6.2 and Volume Two,

Appendix B. The increased leaching for cullet was taken into account when the impacts associated with the immobilized LAW were analyzed in the EIS in Volume One, Section 5.2 and Volume Four, Appendix F. Please refer to the response to Comment numbers 0035.04, 0012.11, and 0052.11 for a discussion of waste form and storage issues.

Comment Number 0072.108

CTUIR

Comment P 3-67: PP 2: What does partial recycle of off gas mean? Does this mean that there is going to be a substantial amount of off gas released to the environment? Has this been incorporated into the risk section? Have the impacts of this off gas been assessed as to their affects to Native Americans?

Response Each tank waste alternative that uses high-temperature processing (vitrification or calcination) would make extensive use of recycle streams to recycle back into the treatment process volatile radionuclide and chemical constituents captured in the off-gas system. These recycle streams would minimize the generation of secondary waste. It has been determined that a bleed stream would be required for each alternative to avoid a continuous buildup of certain volatile radionuclides and chemical constituents, namely technetium and mercury, in these recycle streams. Complete recycle of the more volatile constituents is not possible. The off-gas emissions estimates used for risk assessment were developed considering volatility and the ability of the off-gas treatment system to capture and recycle individual constituents.

Please refer to the response to Comment numbers 0072.207 and 0072.91 for discussions on assessment of Native American risk resulting from routine air emissions during remediation. The Tribal consultation process is discussed in Comment number 0072.149.

Comment Number 0072.109

CTUIR

Comment P 3-68: PP 4: Bottom of the Page: One 22 metric ton per day HLW does not seem like enough, especially since there is going to be down times for change outs, plugging, melt inconsistencies, spills, and other process related problems. Wouldnt it be more prudent to plan for additional melt capacity above and beyond the 20 mt as allowances for capacity needs? Additionally, what is the total amount of secondary waste generated with his process? How will this compare to the global vitrification process already in use in France, and the United Kingdom? What are the expected off gases, and what are the treatment process being proposed? Are these gasses being addressed in the risk portion of this document?

Response The 20 mt (22 ton) melter capacity for HLW vitrification under the Ex Situ Intermediate Separations alternative was calculated using a 60 percent overall operating efficiency along with a 13-year operating duration. The 60 percent overall operating efficiency takes into account down time due to process-related problems.

The amount of secondary waste generated during operations of the Ex Situ Intermediate Separations alternative would consist primarily of off-gas and liquid effluent emissions identified in Volume Two, Section B.11, Tables B.11.05 (radiological) and B.11.06 (nonradiological) The off-gas and liquid effluents would be treated to remove contaminants to the maximum extent possible before being discharged. The HLW vitrification process would result in gas flows out the stack of approximately 230,000 mt over the life of the facility. The radiological and chemical concentrations that would be released from the stack were calculated and used in the routine risk assessment. The liquid effluent from the HLW vitrification facility was estimated to be 72,000 mt based on material balance calculations. Volume Two, Section B.3 describes the liquid effluent processing of secondary radioactive waste streams for all of the alternatives. In addition to these emissions, secondary waste consisting of contaminated filters and spent ion exchange resins would be generated during treatment operations.

A discussion of foreign vitrification technologies can be found in Volume Two, Section B.9. A comparison of secondary waste generation at foreign vitrification facilities was not made; however, the generation of gaseous and liquid effluent streams would be expected to be the same for similar waste types and processing rates. Regulatory requirements for gaseous and liquid discharges would control the number and type of treatment technologies employed to reduce the risks to human health and environment. These requirements would be different in foreign countries. The Hanford Waste Vitrification Plant Foreign Alternatives Feasibility Study indicated that plants operating in foreign countries would require additional process equipment for treating melter off-gas and other effluents to meet United States environmental requirements.

The generation of off-gas during the vitrification process would result from the evaporation of water, thermal destruction of chemical compounds, evolution of volatile compounds, and entrainment of particulates in the off-gas stream. A detailed description of the off-gas system is provided in Volume Two, Section B.3. Control technologies that would be employed to reduce emissions include: quench towers, venturi scrubbers, chillers, demisters, HEPA filtration, sulfur removal, and NO_x destruction. The off-gas emissions from the vitrification plants are included in the risk assessment.

Comment Number 0072.110

CTUIR

Comment P 3-70: Sect. 3.4.6.5: Post Remediation: this section has to be, either removed or changed to reflect the clean closure option. Additionally during closure, the tanks are not supposed to have residual equal to 1 percent but should be less than 1 percent. The MUSTs, pump pits, valve boxes, and diversion boxes, final disposition has not been firmly established within this EIS. If these ancillary equipment are to be dealt with under clean closure conditions then they need further definement in terms of their contents, their extent of contamination and their disposal.

Response Closure is not included in the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. However, Volume One, Section 3.3 addresses how tank waste remediation and closure are interrelated because some of the decisions made regarding how to treat and dispose of tank waste may impact future decisions on closure. There are three representative types of closure addressed. These include clean closure, modified closure, and closure as a landfill. The referenced paragraphs are included in Volume One, Section 3.4 to illustrate the type of activities following remediation rather than specifying the type of closure. The value of, "... a residual equal to no more than 1 percent ...," was used to bound the impacts from the tank residuals. Closure of ancillary equipment also is not included in the scope of this EIS. Issues related to tank farm closure are discussed in Comment number 0072.08. Please refer to the response to Comment numbers 0012.14, 0072.50, and 0101.06 for MUST characterization and issues related to closure. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.111

CTUIR

Comment P3-72: Sect. 3.4.6.7: Implementability: bullets 3,6: If Low Activity Waste has not been thoroughly described, and permitted, how does this EIS propose to deal with the enormous amount of uncertainty involved throughout all the process stages? This is not the easiest way of dealing with the waste. Because the Nuclear Regulatory Commission has not finished with the negotiations, why in Section 3.4.6.5., does it mention that this LAW be buried under the Hanford Barrier? Burying this waste in a cullet form under the Hanford Barrier is the same as saying DOE made the waste, used their contractors to partially treat it, buried it and then walked away leaving the Affected Tribes to deal with the consequences. This is not acceptable. The ex situ intermediate separations alternative therefore is not acceptable. Changes made to this alternative, such as determining the LAW disposal criteria will necessarily need CTUIR input.

Response DOE and Ecology acknowledge the concerns regarding uncertainty expressed in the comment. To develop engineering data required to perform impact analyses for each of the alternatives, assumptions were made regarding the technologies that have been configured to create a remediation alternative, including process stages and waste form. Also, for the purposes of comparing alternatives, a single and consistent method of closure was assumed for all of the alternatives. Closure as a landfill covered by a Hanford Barrier was chosen as the representative closure method for analysis. This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. Please refer to the response to Comment number 0072.08 for more information regarding closure. Although these assumptions were based on best information available, applications of a similar technology, or engineering judgement, there are uncertainties associated with each of the alternatives. Major assumptions and uncertainties are addressed in Volume One, Section 3.4. Additional uncertainty analyses were completed for the Final EIS, and are included in Volume Five, Appendix K.

DOE and Ecology acknowledge the concerns regarding LAW expressed in the comment. LAW is the waste remaining after removal of as much of the radioactivity from HLW as practicable. DOE and the NRC had formal discussions on the way tank waste is classified and how the LAW portion might be regulated in the context of the previously planned grouted LAW. 58 FR 12344, March 1993, states that disposal of residual waste from the DST waste would only be a small fraction of the reprocessing wastes originally generated at the Site; residual waste material should be classified as incidental waste, since they are wastes incidental to the process of recovering HLW; the residual activity of these incidental wastes would be below the concentration limits for Class C wastes under the criteria of 10 CFR part 61; and the disposal of the residual would not be subject to NRC licensing. Section 6.2 provides additional information on tank waste classification, and the results of the discussions between DOE and the NRC. However, criteria must be formalized as to the extent to which the HLW in the tanks must be separated for the residual waste to meet requirements for incidental waste (LAW) as well as the DOE definition of LLW and State of Washington definition of hazardous waste. Design specifications for HLW and LAW treatment will require that waste forms meet applicable criteria for disposal in the potential geologic repository, or as LAW for onsite disposal.

LAW disposal in onsite near-surface vaults was incorporated into the Ex Situ Intermediate Separations alternative, as well as all other ex situ alternatives except Ex Situ No Separations, because that is the current planning basis for the TWRS program as represented in the Tri-Party Agreement. The planning basis assumes that LAW will be vitrified and disposed of onsite in near-surface vaults. Further, it assumes that LAW will meet NRC criteria for incidental waste based on the extent of separations of LAW from HLW during the pretreatment process.

The disposal criteria for incidental waste is determined by the NRC and is well-established criteria. For the TWRS program, the issue at hand is whether the LAW waste stream, when vitrified, will be classified as incidental waste on the waste specifications. In the requests for proposals for Phase 1 of the privatization initiative, DOE defined the waste specifications for LAW that contractors would be required to meet. The waste specification was prepared to produce a waste that would be classified as incidental waste. DOE will consult with NRC to ensure that the waste meets applicable standards for incidental waste.

DOE and Ecology acknowledge the concerns regarding burial of vitrified cullet expressed in the comment. Cullet has a high surface area-to-volume ratio which results in lower long-term performance, including susceptibility to leaching. However, assuming vitrified LAW in cullet form for all of the ex situ alternatives provides a conservative analysis of the long-term impacts resulting from onsite retrievable disposal of LAW in near-surface vaults. Risks associated with retrievable disposal of LAW in vaults have been analyzed and these are presented in Appendix D.5. In addition, a Native American Scenario has been added to the Final EIS in Volume One, Section 5.11 and Appendix D. DOE and Ecology acknowledge the recommendation regarding consultation with Tribal Nations in determining LAW disposal criteria. Please refer to the response to Comment numbers 0035.04, 0012.11, and 0052.11 for related information.

Comment Number 0072.186

CTUIR

Comment P B-66: Sect. B.3.5: LLW is not the same as LAW, yet it appears that these terms are being used interchangeably. Because of this short time period for the review of this particular EIS. Please check for additional similar situations and correct them as is appropriate.

Response LLW is not the same as LAW. LAW is the waste remaining after removing as much radioactivity as practicable from HLW. The definition of LAW is provided in Volume One, Section 1.0, and addressed in more detail in Section 6.2. The term LAW used in Volume Two, Appendix B on page B-66 describes the waste stream after removal of the HLW components. The term is used correctly so no change to the EIS is warranted. Please refer to the response to Comment numbers 0005.25, 0072.118, 0072.117, and 0072.100 for issues related to regulatory definitions of Hanford tank wastes.

Comment Number 0072.187

CTUIR

Comment P B-95: PP 2: How will the insoluble sludges be suspended in the solution of soluble waste? How much volume of additional chemicals must be added? Will this be done in tank or in a receiving tank?

Response Following retrieval, where the sludges will be mobilized and suspended, the insoluble sludge particles will remain in suspension in the aqueous solution as long as the sludge particles have sufficient velocity. This velocity can be produced by such mechanical devices as pumps and mixers. The additional volume of chemicals to be added and the location of the addition point will be determined during the testing phase for this alternative.

Comment Number 0072.188

CTUIR

Comment P B-95: PP3: Why is it assumed that Cs is the only soluble radionuclide to be removed?

Response The engineering data package used in developing this alternative (WHC 1995j) assumed that only well-documented technologies would be used in developing the Ex Situ Intermediate Separations alternative. Cesium recovery by ion exchange is at present the sole technology that is well-documented for the recovery of soluble radionuclides. This assumption was then carried forward into the EIS. Removal of additional soluble radionuclides was included in the Phased Implementation and Ex Situ Extensive Separations alternatives.

Comment Number 0072.189

CTUIR

Comment P B-107: Sect. B.3.6: Calcining tank waste will result in a form not acceptable at the permanent waste repository.

Response The calcined HLW form would not meet the standard waste form (i.e., borosilicate glass) specified in the current waste acceptance requirements for the potential geologic repository. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not be in compliance with laws and regulations. Please refer to the response to Comment number 0072.80 for a discussion of the NEPA requirement to consider reasonable alternatives regardless of their ability to comply with regulations. Volume One, Sections 3.4 and 6.2 and Volume Two, Section B.3 address regulatory compliance issues related to each of the alternatives. Please refer to the response to Comment number 0012.20 for a discussion of glass types and regulatory licensing issues.

Comment Number 0089.09

Nez Perce Tribe ERWM

Comment Page 3-66, Paragraph 2

It states that, with ex situ vitrification, LAW will be melted and flow into a water bath to break the glass formed into cullets, later the cullets will be bonded in a matrix material before onsite disposal. The EIS does not indicate what matrix material will be used to hold the cullets together. It is a concern that the matrix may not be as resistant to degradation as the vitrified glass allowing breakdown and waste surface area to increase. Whatever the matrix material is it will than also become LAW along with the glassformers used to create the product. Why not leave the LAW as a full size molded product rather than increasing the surface area for chemical breakdown by forming cullets. Surely a suitable configuration can be found for the molded LAW, that will not require forming cullets.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Matrix material composition and final waste form would be evaluated during the detailed design phase that would follow selection of this specific remedy, if this selection occurs. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified low-activity cullet form. Cullet would provide processing and material handling advantages for high-capacity processing facilities; however, cullet has a high surface area-to-volume ratio, which results in lower long-term performance. Please see the response to Comment numbers 0005.40 and 0072.89 for a discussion of how the cullet waste form provides a bounding impact analysis. The response to Comment numbers 0035.04, 0052.11, and 0012.11 contain discussions concerning waste form.

L.3.4.8 Ex Situ No Separations Alternative

Comment Number 0005.48

Swanson, John L.

Comment The second paragraph under "Vitrification Process" on page 3-74 appears to be garbled. On balance, it appears to be addressing LAW vitrification, but it specifically says HLW glass.

Response The second paragraph under Vitrification Process on the referenced page may appear to discuss LAW vitrification, but the section heading is Ex Situ No Separations alternative, meaning that all of the glass waste produced is HLW. The first paragraph under Vitrification Process states that the HLW facility capacity is provided by two melters operating in parallel. The paragraph identifies HLW glass because this paragraph discusses only the HLW process as the only applicable process for discussion under this alternative. The text has been revised to clarify the discussion regarding vitrification under the Ex Situ No Separations alternative in Volume One, Section 3.4.

Comment Number 0057.07

Garfield, John

Comment Other things like the calcination case mentioned two calciners at a processing rate of 200 tons per day. You may be able to accomplish a solidified moltent sodium process at those rates but drying the waste to a calcine form would require something on the order of 20 to 40 calciners. The physics are not there to do it at a 100 tons per calciner. That is a technical error that should also be fixed.

Response A more detailed description of the conceptual calciner is discussed in Volume Two, Section B.3. The discussion in Volume One, Section 3.4 is a summary level discussion. The calciner design is modeled after available laboratory data. Additional details including mass and energy balances for the calcining process are available for review in the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.112

CTUIR

Comment P 3-73: Sect.3.4.7: PP 4: Because this is a retrieval EIS not a closure EIS, this paragraph should be removed, or the language strengthened to indicate that there are several closure options.

Response Cost estimates for the removal and treatment alternatives included several Site closure assumptions (e.g., the Hanford Barrier), which are discussed in Volume One, Section 3.4.1.4, Major Assumptions and Uncertainties to provide an equal basis of comparison among alternatives. The text is considered appropriate within the context of the section and therefore no revisions to the text are required. For an extensive discussion of all issues related to closure, please refer to the response to Comment numbers 0072.08, 0019.03, 0019.04, and 0101.06.

Comment Number 0072.113

CTUIR

Comment P 3-74: Calcination Process: This process results in an unacceptable waste form for the permanent repository and thus this section should be removed or edited to clearly state the consequences of producing an unstable waste form that will spread to the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The information requested in the comment is in the EIS. The Summary, Section S.7.1, Volume One, Section 3.4.7.7, and Volume Two, Section B.3.6.4 discuss the fact that the calcined waste form would not meet the current waste acceptance criteria for the potential geologic repository. NEPA requires that an EIS address the full range of reasonable alternatives, including alternatives that would not be in compliance with laws and regulations. For a discussion of this requirement, see the response to Comment number 0072.80. Volume One, Section 6.2 and Volume Two, Appendix B.3 also address regulatory compliance issues related to each of the alternatives. The radiological impacts of transporting the calcined HLW are analyzed in Volume Four, Section E.7.4.1.1.

Comment Number 0072.114

CTUIR

Comment P 3-76: PP 2: This paragraph relates to a process that produces a product that is unacceptable for the permanent waste facility, this paragraph should be removed or edited to clearly state the consequences.

Response Please refer to the response to Comment number 0072.113.

Comment Number 0072.115

CTUIR

Comment P 3-76: PP 3: S 2: This sentence refers to the closure process which is not within the scope of this EIS and should be removed or edited to clearly state the reasoning and the consequences and additional closure alternatives associated with this action.

Response Please refer to the response to Comment numbers 0072.112 and 0072.08.

Comment Number 0072.116

CTUIR

Comment P 3-77: Sect. 3.4.7.5: This section refers to the closure process and should either be removed or edited to reflect additional closure options such as the clean closure option of removing the tanks and the contaminated underlying soils as not to preclude all closure options.

Response Please refer to the response to Comment numbers 0072.112 and 0072.08.

L.3.4.9 Ex Situ Extensive Separations Alternative

Comment Number 0005.49

Swanson, John L.

Comment The first paragraph on page 3-80 refers to "--multiple complex chemical separations--." It appears to me that the use of the word "complex" is editorializing, and that word should be deleted. The last sentence of that paragraph says "--fewer radioactive contaminants--"; a more accurate statement would be "--lower concentrations of radioactive contaminants--"

Response It is true that the term "fewer radioactive contaminants" would mean less radioactive isotopes in the LAW and "lower concentrations of the radioactive contaminants in the LAW." The text in Volume One, Section 3.4 has been revised to reflect lower concentrations of radioactive contaminants in the LAW.

The term "complex" is intended to give the reader a feeling for the number, complexity, and level of development for the multiple separations processes used for the Ex Situ Extensive Separations alternative; therefore, the term conveys accurate and useful information.

Comment Number 0005.50

Swanson, John L.

Comment The second paragraph on page 3-80 includes Jacobs Engineering as a Site M&O contractor, which is incorrect.

Response The cited statement references information obtained from the Site Management and Operations contractor documents, one of which was prepared by Jacobs Engineering Group Inc. (i.e., Jacobs 1996), and does not state, nor is meant to imply, that Jacobs is the Site Management and Operations contractor. Therefore, the statement has not been revised.

Comment Number 0036.13

HEAL

Comment The EIS is inaccurate in addressing technical risk.

As noted above, DOE has conducted many analyses of the alternatives for treating and disposing Hanford tank wastes. Compared with many of these analyses, the EIS is relatively useless in communicating varying degrees of technical risk.

For example, following is a quote from the EIS on the technical risk involved with the intermediate separations technology: "Performance of key processes (e.g., solid liquid separation) has been assumed in the absence of substantive data" (p. 3-72). Next is a quote addressing the technical risk involved with extensive separations: "The key implementability issue associated with this alternative is that the performance of key separations processes has been assumed in the absence of substantive data" (p. 3-85).

The two above quotes say exactly the same thing: There is no qualitative difference between the technical risk involved in intermediate separations and the technical risk involved in extensive separations. Extensive separations is a complex, essentially science fiction technology that has little chance of becoming practical for use on tank waste. It has not been utilized except on a laboratory scale. Intermediate separations, on the other hand, has been used in several places and is relatively simple. The key concern is whether intermediate separations will work on the scale that it must to be useful to the tank program. The list of concerns with extensive separations is almost as long as the TWRS EIS. The approach in the EIS is tantamount to saying that building a car that can go 250 miles per hour involves the same amount of technical risk as building one that can go 2,500 miles per hour.

The position of the Northwest's stakeholders on this issue is clear: The TWRS Task Force stated:

The high cost and uncertainty of high-tech pretreatment and R&D threatens funding for higher performance low-level waste form, vitrification, and cleanup. Use the most practicable, timely, available technology, while leaving room for future innovation. Keep a folio of technological options and make strategic investments over time to support a limited number of promising options. Give up further research on unlikely options.

The lack of honest, frank text concerning technical risk seriously misleads the public and decision makers and unfairly prejudices judgement on the separations issue.

Response In response to the issue of assessment of technical risk; the EIS discusses the ability to implement the alternatives to provide additional information to decision makers. The implementability of a remedial alternative is a function of its history of demonstrated performance and its ability to be constructed and operated. In the case of both the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives, there is no history of demonstrated performance on the Hanford tank wastes. Bench-scale testing is currently underway for the Ex Situ Intermediate Separations alternative. No testing is underway for the Ex Situ Extensive Separations alternative at the Hanford Site; however, a process that is similar to the Intermediate Separations alternative is being used on the tank wastes at the Savannah River Site. It would be premature to state that intermediate separations has been used in several places and is relatively simple, especially with the operation problems that have occurred at the Savannah River Site. To provide the engineering information required for the EIS, the engineering data packages for both alternatives (WHC 1995e and WHC 1995j) assumed the performance of key processes in the absence of substantive data, leading to the same essential statement in the EIS. The inclusion of both the Ex Situ Intermediate Separations and Ex Situ Extensive Separations alternatives is the result of providing a range of reasonable alternatives to the decision makers, and no change has been made to the EIS. DOE and Ecology believes that the uncertainties are expressed in an unbiased and accurate manner.

Regarding the issue of alternatives that should or should not be considered in the EIS, NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. This range of alternatives must include a No Action alternative, and may then include other reasonable alternatives to allow an analysis of a full range of alternatives. Among the four major categories of alternatives examined in the EIS was a category involving extensive retrieval of the wastes from the tanks. Following retrieval, the HLW is separated from the LAW. The degrees of separation of these two types of wastes may range from no separations, to intermediate separations, to extensive separations. For more information on how the EIS developed alternatives consistent with the recommendation of the Tank Waste Task Force, see the response to Comment numbers 0072.05 and 0038.05. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0055.09

Martin, Todd

Comment The EIS is somewhat inaccurate in addressing technical risk for pretreatment. If you look at the language addressing the intermediate separations essentially sludge washing which we have a pretty good idea of how to do and the extensive separations which I have often characterized as science-fiction technology, the language is almost identical. It basically says there is uncertainty here because these are first of the time processes. I agree with that but one is much more technically uncertain the extensive separations than the other and I think the EIS should reflect that.

Response Please refer to the response to Comment number 0036.13.

Comment Number 0072.117

CTUIR

Comment P 3-81: PP 2-5: the LAW form as described here, is not an acceptable form because it does not meet the regulatory criteria, and the process results in a waste form that is very susceptible to leaching of high activity components. This section also needs to be redone to assume a glass form as the final waste product.

Response The Ex Situ Extensive Separations alternative would meet the requirements for disposal of HLW and LLW. However, residuals left in tanks would not meet the water protection standards if additional closure is not performed. Closure is not included in the scope of this EIS; however, closure for the tanks and residuals would be addressed in a future closure plan. The EPA is considering a rule to further regulate LLW disposal facilities; and the final design of the onsite LAW disposal facility may be impacted by EPA rule 40 CFR 193. A discussion of the ability of each tank waste alternative to enable DOE to comply with Federal and State regulations is included in Volume One, Section 6.2. Specifics of the matrix material and waste form would be final design issues. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified LAW cullet form.

Please refer to the response to Comment numbers 0005.40, 0072.89, and 0072.107 for discussions of the cullet waste form and how cullet provides a basis for a conservative analysis of long-term impacts. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.118

CTUIR

Comment P 3-83: Sect. 3.4.8.4: Operation: The LAW description needs to be edited, removing the last two bullets.

Response Specifics of the matrix material and waste form would be final design issues; however, for the purposes of analyzing the ex situ alternatives in this EIS, LAW was assumed to be produced in vitrified cullet form. The referenced text correctly describes the operations involved in producing this type of waste form. Volume One, Section 3.4 addresses waste composition and the reasons for assuming a vitrified LAW cullet form. Cullet would provide processing and material handling advantages for high-capacity processing facilities; however, cullet has a high surface area-to-volume ratio, which results in lower long-term performance. Assuming vitrified LAW in cullet form for all of the ex situ alternatives provides a conservative analysis of the long-term impacts resulting from onsite disposal of LAW. No change to Volume One, Section 3.4 is required.

For a discussion of regulatory requirements for onsite disposal of LAW please refer to the response to Comment number 0072.111.

Risks associated with retrievable disposal of LAW in vaults have been analyzed and these are presented in Volume Three, Appendix D.5. In addition, a Native American Scenario has been added to the Final EIS in Volume One, Section 5.11 and Appendix D.

Please refer to the response to Comment numbers 0005.40, 0012.11, 0072.11, 0035.04, 0052.01, 0072.89, 0072.107, and 0072.117 for related information. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.119

CTUIR

Comment P 3-84: Sect 3.4.8.5: Post Remediation: second and third paragraphs: these two paragraphs need to be removed because this EIS is a retrieval EIS and closure options are not within the scope. If closure options were within the scope of this EIS then the option would necessarily be clean closure and removal of the tanks, underlying soil contamination, ancillary equipment, and MUSTs as not to prejudice future options for closure.

Response Please refer to the response to Comment numbers 0072.08 and 0072.112.

Comment Number 0072.190

CTUIR

Comment P B-115: Sect. B.3.7: The definition of LAW indicates that there will be a HLW component. This is unacceptable in terms of long term risk.

Response Volume Two, Section B.3.7.1 describes the extent to which the treatment processes are used to separate

HLW from the tanks waste. LAW is the waste remaining after removing as much of the radioactivity as practicable. The definition of LAW is provided in Volume One, Section 1.0, and tank waste classification (e.g., Class A, B, C) is addressed in more detail in Section 6.2. NRC Class A waste contains the least amount of radioactivity. Long-term risk has been analyzed for each of the alternatives and waste forms, and this is presented in Volume One, Section 5.11, and addressed in more detail in Volume Three, Appendix D.4.7. Because the information contained in the Draft EIS is correct, no change to the text was made.

For more information on LAW, LLW, and HLW definitions, please refer to the discussions contained in the response to Comment numbers 0072.100, 0072.111, 0072.117, and 0072.118.

Comment Number 0072.191

CTUIR

Comment P B-119: Fig. B.3.7.2: This figure, to be acceptable, should have LLW exchanged for LAW and interim on site storage exchanged for on site disposal.

Response Figure B.3.7.2 accurately depicts the process flow of the Ex Situ Extensive Separations alternative described in Volume Two, Appendix B, Section B.3.7. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.3.4.10 Ex Situ/In Situ Combination 1 Alternative

Comment Number 0005.09

Swanson, John L.

Comment The two combined ex situ/in situ alternatives discussed in the EIS speak of remediating a large fraction of the risk while remediating only a small fraction of the tanks. Such statements imply a knowledge of tank-by-tank inventory data that is much better than that given in the EIS. What data (or assumptions) were used for these alternatives? What accuracy do they have? Without evaluation of these factors, it is not possible to evaluate whether these combined alternatives are worth considering. Thus I feel that the current presentation of these combined alternatives is very biased in their favor.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The TWRS EIS addresses many potential criteria that could be used to develop a selection process and acknowledges that additional waste characterization and analysis would be required to implement this alternative (Volume Two, Appendix B, page B-127). Please also refer to the response to Comment number 0072.192. The data used for tank-by-tank analysis were based on SST and DST inventory data presented in summary form in Volume Two, Appendix A. DOE and Ecology believe that the existing historical data, laboratory data, and characterization reports, which provide the basis for the tank waste inventory used in the EIS, are adequate for detailed evaluation of impacts. The EIS acknowledges the uncertainties associated with the tank waste inventory, and accordingly uses a bounding approach to impacts assessment based on the available data.

The ex situ/in situ alternatives were developed to assess the impacts of combining two or more of the tank waste alternatives. Recognizing that tank waste differs greatly in the physical, chemical, and radiological characteristics, it may be appropriate to implement different alternatives for different tanks. These alternatives were developed to bound the impacts that could result from a combination of alternatives and are intended to represent a variety of potential alternative combinations that could be developed to remediate the tank waste. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the response to Comment number 0005.03 for a discussion of assumptions and uncertainty ranges used in the alternatives analyses.

Comment Number 0072.120

CTUIR

Comment P 3-86: Ex Situ/In Situ Combination Alternative: Technical staff agree that it may be necessary to implement an alternative treatment process for Tank wastes due to their varied contents, but the alternative of in situ treatment is unacceptable. The people of the CTUIR have been made involuntarily responsible for the waste DOE produced on CTUIR ceded land, and do not and should not, have to bear the responsibility of the enormous excess risk from in situ process. Therefore this alternative is unacceptable both in idea and in implementation.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

NEPA requires DOE and Ecology to examine a full range of alternatives in the EIS. The Ex Situ/In Situ Combination alternative was developed to assess the impacts that would result if a combination of two or more of the tank waste alternatives were selected for implementation. Because the tank waste differs greatly in its characteristics, it may be appropriate to implement different alternatives for different tanks. The Ex Situ/In Situ Combination alternative represents a combination of the In Situ Fill and Cap and Ex Situ Intermediate Separations alternatives, and as such can be considered as one of the reasonable alternatives for evaluation. It is intended to represent a variety of potential alternative combinations that could be developed to remediate tank waste. Because this alternative is one of the full range of alternatives developed in the EIS, the document has not been changed. For the Final EIS, a second combination alternative that was presented in the Draft EIS, has been fully described and impacts have been analyzed. This alternative is described in Volume One, Section 3.4 and impacts of the alternative are described in Volume One, Section 5.0 and associated appendices.

Comment Number 0072.192

CTUIR

Comment P B-126: Sect. B.3.8: This alternative is unacceptable in that there is an illegal in situ component. Additionally the characterization process has not adequately justified that they know where 90 percent of the contaminants that contribute to long term risk are located, or how to get at them for treatment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

The Ex Situ/In Situ Combination alternative was developed to represent a variety of potential alternative combinations that could be developed to remediate the tank waste. Existing uncertainty associated with the tank waste inventory data must be resolved and additional tank characterization is required before final design of any alternative. Please refer to the response to Comment number 0005.09. Several activities that involve collecting and analyzing data on tank contents are ongoing, including the Tank Characterization program. Data obtained from this program would be used for refining remediation process design. Please refer to the response to Comment numbers 0012.14 and 0072.07 for discussions on characterization of tank inventory. Volume Two, Appendix A,

Section A.3 and Volume Two, Appendix B, Section B.1 address tank inventory data and ongoing waste characterization programs, and Volume Three, Appendices D and Volume Four, Appendix E address anticipated risk and accidents. Volume Five, Appendix K addresses the uncertainties associated with human health risks associated with this and other alternatives.

L.3.4.11 Phased Implementation Alternative

Comment Number 0005.51

Swanson, John L.

Comment Page 3-94 says "Separations prior to LAW processing--." I believe that the word IMMOBILIZATION or VITRIFICATION should be substituted for the word PROCESSING.

Response The Phased Implementation alternative description has been revised as follows, "Separations prior to LAW immobilization would be performed to remove the cesium, strontium, technetium, TRU elements, and entrained sludge particles from the waste stream to the extent required to meet LAW product specifications."

Comment Number 0005.52

Swanson, John L.

Comment The first two paragraphs on page 3-99 appear to be "lifted" from a privatization write-up, in that they talk of what functions are to be performed by DOE. This EIS assumes that all the functions will be performed by DOE.

Response Volume One, Section 3.4 has been revised as follows for the Phased Implementation alternative, "The waste (mainly DST liquid waste) would be retrieved and transferred to receiver tanks for LAW treatment." The cited text in Volume One has been revised as follows, "Separated cesium and technetium radionuclides would be stored at the treatment facilities or packaged for interim onsite storage at the Canister Storage Building."

Comment Number 0005.53

Swanson, John L.

Comment On page 3-99 it is stated that Phase 2 sludge washing will be performed in-tank. Is that really the intent?

Response The text regarding sludge washing has been revised in Volume One, Section 3.4 to remove the reference to in-tank sludge washing.

Comment Number 0005.54

Swanson, John L.

Comment I do not understand how the Phased Implementation approach can have R&D costs of only $190,000,000 (page 3-100) when those costs are $820,000,000 (page 3-71) for the intermediate separations alternative, which involves fewer pretreatment steps. Can you explain this?

Response Because Phase 1 of the Phased Implementation alternative would be a demonstration process, the research and development cost for the treatment process was assumed to be part of the Phase 1 cost. Research and development cost associated with the waste retrieval and transfer function was included at the same level as the other ex situ alternatives. Development programs currently are ongoing at the Site that are covered under the TWRS program or under other programs.

Comment Number 0032.05

Heacock, Harold

Comment In regard to the Department's currently planned method of implementing this program which is based upon the privatization of the work performance, we are not addressing that issue at this time. However, we have previously supported the privatization concept in other statements.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Comment numbers 0032.06, 0043.04, and 0060.01 contain information concerning privatization and associated issues related to privatization.

Comment Number 0032.06

Heacock, Harold

Comment Funding of the privatization program through the proposed budgeting set-aside at the expense of other Hanford Site cleanup programs and the concurrent failure to meet all Tri-Party Agreement commitments is not acceptable.

Response Changes to the TWRS program were incorporated into the Phased Implementation alternative, as required by the proposed 1996 Tri-Party Agreement amendments; therefore, Phased Implementation would not deviate from the Tri-Party Agreement or any other applicable regulation. DOE and Ecology intend to comply with all Federal, State, and local regulations and ordinances applicable to tank waste remediation. Funding for privatization is outside the scope of the TWRS EIS. The response to Comment number 0043.04 contains a discussion of privatization issues.

Comment Number 0035.06

Martin, Todd

Comment More specifically, I do not trust the costs just in general in the EIS. For example, the EIS assumes that for about 250 million dollars, the DOE can build a 20-ton a day low-level vitrification facility.

Everybody who has been in Hanford circles for years remembers that the Hanford waste vitrification plant, a one to three metric ton a day facility was going to cost one point three billion dollars.

What does the EIS say DOE can build essentially the same facility now for? About 232 million, about one-fifth the cost.

In totality, in the preferred alternative for phase one the EIS says that the two 20-ton a day vitrification facilities, two pretreatment facilities tied onto the side, and one HLW vitrification facility, in total five facilities, can be built for about one point four billion.

Again, I refer back to the one relatively small vitrification facility that DOE said that it would take one point three billion to build. I say no way can DOE build these facilities for that cost.

Are these costs due to privatization savings? The answer to that is no. The EIS does not deal with privatization. It assumes that these are traditional DOE facilities.

Further, if these costs are actually correct, there is not a need for privatization. The privatization set-aside account that everybody has been wrangling over the last couple of months has more than enough money in it right now to start building these facilities and get on with cleanup.

Either these numbers need to be changed, or we need to switch paths and start building vitrification facilities.

Response Please refer to the response to Comment numbers 0055,06 and 0057.06 for a discussion of the approach used to develop the cost estimate for this alternative.

The HWVP capital cost estimate is not directly comparable to the capital cost estimated for the Phase 1 HLW facility because it includes support facilities and infrastructure that are estimated as separate components for Phased Implementation.

The cost estimating methodology has been reviewed and revised cost estimates have been completed for the Phased Implementation and combination alternatives. These revised costs are shown in Volume One, Section 3.4 and in Volume Two, Appendix B.

Comment Number 0035.07

Martin, Todd

Comment Just in my cursory look at some of the other costs in the EIS things jump out at me. For instance, in the preferred alternative, phase one, basically DOE has to retrieve about 36 tanks to vitrify in that phase.

How much does the EIS say this will cost? Zero dollars. Not a penny. I think there are some retrieval costs there. There must be.

Response During Phase 1, readily retrievable and well-characterized DST waste would be retrieved and transferred to two DSTs used as receiver tanks for the demonstration facilities. This retrieval effort was assumed to be accomplished by using the existing tank farm work force and infrastructure, in the same manner that wastes currently are transferred. The cost associated with DST waste retrieval during Phase 1 was assumed to fall within continued operations. Continued operations costs of $1.58 billion, including 10,000 person-years of labor, were included in the cost estimate for Phased Implementation. The Draft EIS also states that selected SST wastes could be processed during Phase 1. It was assumed that wastes retrieved under retrieval demonstrations (e.g., tank 106-C) could be transferred to the demonstration facilities. Because the cost associated with these retrieval demonstrations is included in other programs, it is not included in the estimate for Phase 1, but is accounted for in the estimate for continued operations of the tank farms. The cost involved would be small in comparison to the overall project costs.

The Phased Implementation alternative identified in the TWRS Draft EIS would produce, during Phase 1, approximately 11 percent of the total LAW volume. Waste retrieval would not be required from 36 tanks during Phase 1.

DOE and Ecology have reviewed and revised the cost estimates for the Phased Implementation alternative for the Final EIS. These revisions are shown in Volume One, Section 3.4 and Volume Two, Appendix B, and are reflected in the Summary.

Comment Number 0036.03

HEAL

Comment The costs in the EIS are incredible and must be redone. The EIS should not be finalized until a formal, credible data package for the preferred alternative is completed.

The EIS assumes the following for Phase 1 of the preferred alternative:

1. The cost of a 100 metric ton per day vitrification facility is half the cost of a 200 ton per day facility. There is no engineering data to support this assumption. In fact, there is data to refute it. About 15 percent of the cost of a vitrification facility is dependent upon its throughput (the rate at which it makes glass). Therefore, the cost of a 100 metric ton per day facility would be less than a 200 ton per day facility -- but not much less -- and certainly not 50 percent less.
2. The "six tenths rule" is an engineering rule used for extrapolating the cost differences between chemical facilities of different sizes. The EIS uses this to determine the costs of vitrification facilities of different sizes. This is a wholly inappropriate use of the rule. Again, it applies for facilities where about 85 percent of the facility cost is dependent upon processing equipment -- primarily chemical facilities. Vitrification facilities only have about 15 percent of their cost dependent on processing equipment. Therefore, vitrification facility costs are not particularly sensitive to sizing differences -- which means use of the "six tenths rule" results in grossly underestimated costs.

These two assumptions have resulted in grossly underestimated costs for the preferred alternative. The EIS estimates the cost of the Phase 1 facilities as follows:

- A 20 metric ton per day LAW vitrification facility can be built for $248 million.
- A 1 ton per day HLW vitrification facility can be built for $232 million.

Comparing these numbers to much more rigorously developed cost estimates we can see exactly how far off the EIS's numbers are. The Hanford Waste Vitrification Plant, which was designed to produce between 1 and 3 tons per day of glass, was estimated to cost $1.3 billion. This is almost exactly the same facility that the EIS says DOE can build for

$232 million.

The EIS claims that for Phase 1 the total capital cost will be $1.4 billion. In other words, DOE is going to build two 20 ton per day LAW vitrification facilities, a one ton a day HLW vitrification facility and two pretreatment facilities for about the same cost as the one ton per day Hanford Waste Vitrification Plant!

Response Please refer to the response to Comment numbers 0035.04, 0035.06, 0055.06, and 0057.06.

Comment Number 0036.04

HEAL

Comment If the costs in the EIS are indeed accurate, there is no need for privatization.

If DOE's cost estimates are accurate, there is no need to take the extra risks of privatization. All of DOE's cries that there is not enough money to build vitrification facilities are false. The money DOE is currently putting in a set aside fund for privatization is more than enough to build these vitrification facilities.

Response Phased Implementation approach reduces the technical risk associated with tank waste remediation over a full implementation alternative. Phased Implementation also provides a greater opportunity to reduce overall program costs by applying lessons learned and experience gained during Phase 1 to the design and construction of the full-scale Phase 2 treatment facilities. The cost estimates developed for the TWRS EIS were developed using common assumptions. The Phased Implementation alternative cost estimate assumed the same contracting strategy, government-owned and contractor operated, as the other alternatives. As discussed in Volume One, Section 3.3, the EIS does not address the contracting strategy that would be used to privatize tank waste remediation. Please refer to the response to Comment number 0043.04 for more information.

Comment Number 0036.05

HEAL

Comment A cursory review of the cost estimates identified many other problems. Following are just a few: The EIS assumes that tank farm operation costs will be the same for both the Phased Implementation and Ex Situ Intermediate Separations alternatives. This is a faulty assumption. The Intermediate Separations alternative would begin treating waste in 2004 at a relatively high rate, resulting in tanks being emptied. This would allow DOE to dramatically reduce its tank farm operation costs. The estimate for operations for Intermediate Separations is $8.6 billion.

The operations estimate for the Phased Implementation alternative is also $8.6 billion. It should be much higher. Phased Implementation will treat waste at a much slower rate than Intermediate Separations, requiring DOE to fund operations programs for a longer period of time and thus at a higher level.

Response A difference in the rate at which the cost declined for different rates of processing is expected. Many of the factors that would control the ongoing tank farm operations cost would be the monitoring and maintenance requirements and how these requirements were reduced for individual tanks and tank farms. The monitoring and maintenance requirements for a tank farm may not be appreciably lower until all of the tanks within that tank farm are empty. The tank retrieval sequencing and blending strategy, which have not been finalized, would identify when waste retrieval from individual tanks and tank farms would be complete.

Because of the conceptual level of development, it was assumed for the purposes of the TWRS EIS that continued tank farm operations cost for Phased Implementation would be the same as for the Ex Situ Intermediate Separations alternative. In fact, the difference between level funding and the annual reductions in operating cost associated with the Ex Situ Intermediate Separations alternative for the years 2004 through 2011 totals $141 million or approximately 1.6 percent of the total $8,600 million used in the TWRS EIS for continued tank farm operations.

DOE and Ecology have reviewed and revised the cost estimates appropriately for the Phased Implementation alternative. These revised cost estimates have been presented in the Final EIS in Volume One, Section 3.4 and Volume Two, Appendix B.

Comment Number 0036.06

HEAL

Comment To support the Tri-Party Agreement, DOE must retrieve waste from 36 tanks in Phase 1 of the Phased Implementation alternative. The EIS estimates that this will cost $0. Surely there is a cost associated with retrieving the high-level waste from 36 tanks.

HEAL finds the estimates in the EIS to be utterly devoid of credibility and insists that the EIS not be finalized until a credible, formal data package for the preferred alternative is completed.

Response Please refer to the response to Comment number 0035.07 which addresses a similarly worded comment.

Comment Number 0036.11

HEAL

Comment The EIS must require vitrification as technology for tank waste treatment.

For all alternatives, except the Phased Implementation alternative, the EIS assumes vitrification will be the immobilization technology. The EIS provides no rationale as to why this alternative does not also require vitrification. Given that it is the preferred alternative, this is even more disturbing.

Vitrification has been the technology that stakeholders have found acceptable. It balances the concerns for a safe waste form with a relatively available technology that allows DOE to "get on with it." Any changes to the assumed use of vitrification must be accompanied by a compelling argument outlining any emerging technologies that better respond to stakeholder values. HEAL has not seen such an argument, and strongly doubts that one could be made.

The TWRS privatization initiative, upon which the Phased Implementation alternative was designed, also fails to require vitrification as a technology. It appears that this EIS has been designed to "fit" the decision to not require glass as a waste form in the privatization Request for Proposals.

Response Please refer to the response to Comment number 0035.02 which addresses a similarly worded comment.

Comment Number 0036.15

HEAL

Comment EIS does not show any effects of privatization.

DOE has spent over a year in an unsuccessful attempt to sell its privatization plan to the public. Cost is one of the many concerns that the public has raised with DOE. DOE has consistently held that privatization would cost 30 percent less than a traditional approach. DOE has been unable to furnish the public with any information that supports the above assertion.

The EIS continues the information void concerning the benefits of privatization. The EIS refers to privatization in the description of the Phased Implementation alternative, "under Phased Implementation, either DOE or a private contractor would design, build, and operate ... (the facilities)" (p. 3-23). As was pointed out above, DOE has held that the differences between a traditional government-owned, contractor-operated approach, and the contractor-owned and operated privatization approach were "revolutionary." Yet the EIS fails to show the different impacts of this revolutionary approach. Worse, the EIS is not explicitly clear about which approach -- privatization or traditional GOCO -- is being analyzed.

The EIS does allude to how the cost estimates for Phased Implementation were reached. It was developed by, "... combining applicable components from other ex situ alternatives and applying rations as required to account for differences in facility sizes and capacities and the degree of separations in LLW and HLW" (p. 3-99). Engineering data in the TWRS program over the years has shown that facility capacity and size do not have a large impact on facility cost.

The cost savings that DOE claims are virtually guaranteed are not evident in the EIS. The Tri-Party Agreement case is estimated to be $30-41 billion and Phased Implementation $32-42 billion. Where are the savings?

Response The EIS addresses the potential environmental impacts associated with a Phased Implementation approach to tank waste remediation. It was assumed for cost estimating purposes that the Phased Implementation alternative would use the traditional government owned-contractor operated contracting strategy. This was done to allow the reader to make an equitable comparison among the alternatives. A potential exists to reduce the cost for tank waste remediation by allowing the market place to establish, through the competitive bidding process, the cost for waste treatment. Cost savings projections that might result from privatization are not included in the EIS in an effort to maintain the competitive bidding process.

The fact that privatization is not addressed in this EIS is discussed in Volume One, Section 3.3. DOE believes that privatization will result in an overall cost savings for the project but has not published an estimate of savings that may result. The 30 percent figure identified in the comment is reasonably consistent with the cost savings resulting from other activities the federal government has privatized. Privatization is not within the scope of the EIS. Please refer to the response to Comment numbers 0036.05, 0036.04, 0055.06, and 0057.06.

Comment Number 0037.05

Elredge, Maureen

Comment Mostly I am concerned with further cost estimates throughout the EIS. They seem to be questionable. And I am particularly concerned that the preferred alternative is widely perceived as a privatization alternative which is supposed to save money, and yet this is not made evident in the document.

I want to urge you to use extreme caution both in assuming that the preferred alternative will be cheaper, and even more so in assuming that a privatization scheme will be a success.

When the cleanup program was being pummeled in Congress and the media last year, privatization was held up as the Holy Grail, sort of along the lines of please give us another chance. We will bring in corporate America. They will fix everything. We will be fine. Please give us our money.

We do not need Holy Grails. We need progress. We need action on the ground now. If privatization efforts fail it will be a disaster not only for Hanford but for the entire cleanup program. Thank you.

Response Please refer to the response to Comment number 0036.15, which addresses a similarly worded comment.

Comment Number 0038.06

Reeves, Merilyn

Comment The Board is troubled by some aspects of the preferred alternative, and where the EIS has not considered the impacts of privatization as a contractor mechanism.

Response Please refer to the response to Comment numbers 0036.15, 0036.05, 0036.04, and 0057.06 for discussions related to this issue.

Comment Number 0038.07

Reeves, Merilyn

Comment The concerns the Board has voiced have to do with liability in privatization, budget, regulatory, logistics, and public participation issues.

The Board has been dubious of DOE's ability to privatize, and has been disappointed in DOE's lack of responsiveness to the Board's concern.

Response Because the issues identified in the comment are not within the scope of the EIS, no modification to the document is warranted. Please refer to the response to Comment numbers 0036.04, 0036.05, and 0036.15.

Comment Number 0038.08

Reeves, Merilyn

Comment In regard to the specific technical approach, the Board has not been adverse to Phased Implementation. DOE has not made a case for that, privatized or not.

Response The TWRS EIS does not address privatization. The Phased Implementation alternative is based on the same common assumptions as the other alternatives to ensure comparability of the environmental impacts. However, the Phased Implementation alternative does address the technical requirements of remediating tank waste with a phased approach and impacts associated with that approach. Please refer to the response to Comment numbers 0043.04 and 0035.15, for more information.

Comment Number 0038.09

Reeves, Merilyn

Comment Phased Implementation can save money over the course of the program. The Board does remain dubious that Phased Implementation will save money, and will likely be more expensive. Again, our main concern has been with DOE's particular program of privatization.

Response The costs estimates developed for the TWRS EIS were developed using the same basis for all alternatives. The Phased Implementation alternative represents the traditional government-owned contractor-operated contracting strategy as described in Volume One, Section 3.3. Please refer to the response to Comment number 0036.15 for more information.

Comment Number 0038.11

Reeves, Merilyn

Comment The Board is concerned by the preferred alternative's effect on the Tri-Party Agreement. The Board has been and remains a staunch supporter of the Tri-Party Agreement.

The Phased Implementation approach has resulted in an unfavorable impact to the Tri-Party Agreement. The Tank Waste Task Force stated the following about the Tri-Party Agreement, quote, Tri-Party Agreement is in need of strengthening and improvement.

The Tri-Party Agreement should increase meaningful public and tribal involvement in all key Tri-Party Agreement decisions, with the public and the tribes as a partner in the goals, scope, pace, and oversight of the cleanup.

The process of the goal in the site specific advisory board and ongoing oversight of the agreement and improving pubic involvement is essential to achieving successful and satisfactory cleanup.

And our Board is trying to carry on these traditions. As we stated earlier, amendment four to the Tri-Party Agreement was judged to be very responsive to the above concerns.

Unfortunately concurrence in yet to be completed negotiations that will once again change the Tri-Party Agreement are somewhat or may be seen to be reversing the progress made in amendment four.

The Tri-Party Agreement changes that are being made in order to support the Phased Implementation alternatives are very disconcerting. The Tri-Party Agreement will go from a long list of interim and long-term enforceable milestones to only a handful of milestones, many of them not enforceable.

The changes will not increase meaningful public involvement or really involve site specific boards, the Hanford Advisory Board, in ongoing oversight of the TWRS program. And this is a step in the wrong direction.

Response The amendments referenced in the comment were based upon the privatization initiative. The Phased Implementation alternative merely bounds the technical approach of staged remediation of the tank waste and analyzes the potential impacts to support a comparison among alternatives. DOE and Ecology are cognizant of the Hanford Advisory Board's concerns regarding the remediation schedule and stakeholder and Tribal Nation participation in decision making. DOE is committed to meeting milestone commitments in the agreement and to effective and meaningful public and Tribal Nation involvement in the cleanup of the Hanford Site. Please refer to the response to Comment number 0012.19 (public involvement), 0072.149 (Tribal Nations consultation), and 0043.04 (privatization relationship to the Tri-Party Agreement).

Comment Number 0055.08

Martin, Todd

Comment Secondly, I think that the chart that Carolyn showed that had to do with the technical uncertainty of the various options was misleading on Phased Implementation. The rationale is that the technical uncertainty for this alternative is low because we are starting small and we are building. We will be able to employ learning. I think that is a very subjective call and I do not buy it. That option includes pretreatment processes have never been done before. Technetium removal. That is not low on the technical uncertainty scale.

Response The phased approach allows information to be collected and analyzed concerning retrieval, separations, and vitrification technologies before constructing full-scale plants. Lessons learned from the demonstration phase would be applied to the full-scale phase, which should improve the efficiency of operations of the second phase. This may reduce construction and operating costs during the second phase. The process of building demonstration plants to verify that technologies function effectively before building full-scale plants is a standard practice used in many industries where new technologies are being used. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0057.02

Garfield, John

Comment With respect to the summary slide, Todd made this same comment, the high-waste complex separations and treatment processes involved uncertainties that will be reduced by implementing the phased approach. I concur with the basic finding of the EIS in terms of the alternative chosen, however, instead of emphasizing the need to demonstrate technology, the emphasis should be on spreading early capital dollars and using a single facility to accomplish the mission. That should be the emphasis more than demonstration. There is no technical justification for demonstration philosophy with this process. The functions of sludge washing, cesium removal, and vitrification are not unknown technologies and any uncertainty with them can be demonstrated either radioactively hot at a laboratory scale or at large-scale cold with simulants much more efficiently than two low-level demos and one high-level demo. That will set the program back 5 to 10 years treated under 5 percent of the waste and cost something on the order of $3 billion dollars. That is a waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The demonstration process provides the opportunity to reduce overall program costs while completing remediation of the tank wastes within Tri-Party Agreement requirements, especially considering the uncertainty associated with the tank waste inventory. The lessons learned and process knowledge gained during Phase 1 would be incorporated into the design and operation of the full-scale treatment facilities during Phase 2. Please refer to the response to Comment number 0055.08.

Comment Number 0068.02

Martin, Todd

Comment Further, another one that is very easy for anybody to understand is you look at the EIS, and you see in Phase 1 they need to retrieve and vitrify the waste from about 36 tanks. How much would that cost? How much would it cost to pump the nuclear waste out of this auditorium if it were full? According to the EIS, zero dollars. Won't cost a penny. Surely there's a cost there. But the EIS doesn't reflect it. Again, the costs need to be fixed.

Response Please refer to the response to Comment number 0035.07 which addresses a similarly worded comment.

Comment Number 0072.121

CTUIR

Comment P 3-92: Sect. 3.4.10: This alternative is unacceptable if the implementation consists of decommissioning any process that produces waste acceptable to the HLW permanent repository, the added push of continuing to operate the test facility will reduce the time it take to finish the job.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Decommissioning of facilities for this alternative is addressed in Volume One, Section 3.4.

Comment Number 0072.122

CTUIR

Comment P 3-92: Phase 1: The selection of the SST waste is an integral component and effort has to be taken that this section include language reflecting that waste from all SSTs be test reacted as to ensure complete acceptability.

Response The waste processed during Phase 1 could include selected SST waste. As explained in Volume One, Section 3.4, the retrieval and treatment of the remaining DST and SST waste will be completed in the following stages of the alternative (Phase 2) following completion of the demonstration phase (Phase 1). Before any waste is retrieved it would be characterized and analyzed to ensure compatibility. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.193

CTUIR

Comment P B-132: Sect. B.3.9: This alternative, while good for a conservative industry approach does not take into account the uncertainties associated with the characterization program. Unless the demonstration phase proved beyond a doubt it could handle waste forms from all the tanks.

Response Considerable uncertainty associated with the tank waste inventory data remains, and additional tank characterization is required before final design of any alternative. Please refer to the response to Comment numbers 0012.14, and 0072.07 for discussions of characterization of tank inventory and characterization in programs. Phase 1 of the Phased Implementation alternative would include technical evaluation, demonstration, and detailed design for the separations and immobilization processes for various categories of waste feed. Following the successful implementation of Phase 1, Phase 2 would be implemented to complete the tank waste remediation according to the technical approach most appropriate to the tank waste categories. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0088.05

Porter, Lynn

Comment One of my concerns about the preferred alternative and privatization is who decides when it's a success or not. Is this strictly going to be the DOE deciding, or will the Tri-Parties together decide on this? And there need to be enough milestones in this, spaced closely enough together that the public interest groups can track this and know whether it's succeeding or failing, whether it's on track where it should be. Because otherwise this could go on for years, and all of a sudden, as it has before, all of a sudden we find out hey it's not working and we have to start over.

Response Privatization is a contracting mechanism that is not within the scope of the EIS. DOE and Ecology have agreed on a set of criteria that will be used in making a decision on whether privatization is achieving its intended goals or failing, which would cause a change from the primary path to the alternate path. Under this agreement, should Ecology determine that compliance with the primary path is unlikely, it will inform DOE of such an opinion. DOE will respond within 30 days whether a change from the primary to the alternate path is necessary. If DOE determines that a change is not necessary, it will provide Ecology with a written rational for continuing with the primary path. Ecology will have the authority at any time to require DOE to evaluate the viability of the primary path. These activities will be among the issues routinely statused, discussed, and reviewed by the Hanford Advisory Board and its Health Safety and Waste Management Committee. Additional review, input, and comment by Tribal Nation regulator and stakeholder representatives is encouraged. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

L.3.4.12 Ex Situ/In Situ Combination 2 Alternative

Comment Number 0005.05

Swanson, John L.

Comment As an example of some of my concerns related to (3) and (4), I cite the "last minute" addition of the "Variation of the Ex Situ/In Situ Combination alternative." I do not see that this is a bounding case at all, and I see no evidence that it is based on anything more than some assumed characterization data (perhaps on computer predictions based on a set of assumptions). Thus, I feel that you got carried away by even proposing this as a separate variation; wouldn't it be better to discuss it in the context of being in the "noise level" of the very uncertain characterization data on which I am assuming the original ex situ/in situ alternative was based? (I am assuming this because you do not tell me the source of the "currently available characterization data" that you are basing this on, and I am not aware of any sound data bank that would allow this alternative to be factually based). (See Comment 0005.09).

Response The variation of the Ex Situ/In Situ Combination alternative (known as the Ex Situ/ In Situ Combination 2 alternative in the Final EIS) referenced in the comment was added to provide a range of alternatives that includes a combination of the in situ and ex situ alternatives. Without this alternative, there would have been only one alternative to represent partial retrieval, and it is important to show the public and the decision makers the relationship between environmental impacts and the extent of retrieval. This alternative provides one more alternative on the continuum from no retrieval to minimal retrieval to partial retrieval to extensive retrieval.

The variation of the Ex Situ/In Situ Combination alternative presented in the TWRS Draft EIS was based on limited data analysis and was therefore included in a brief preface to the Draft EIS, which provided general information on the levels of impacts that would occur as a result of implementing the alternative. This alternative has been developed and analyzed to the same extent as the other alternatives in this Final EIS. The variation is known as Ex Situ/In Situ Combination 2 alternative in the Final EIS. The information is presented in Summary, Sections S.5, S.6, and S.7; in Volume One, Section 3.4, and throughout Section 5.0. More detailed information on the alternative may be found in Volume Two, Appendix B.

Comment Number 0012.08

ODOE

Comment The EIS includes an attachment which describes a variation of the Ex Situ/In Situ Combination alternative. This alternative was not analyzed in the EIS and should be excluded from consideration for that reason.

Response The variation of the Ex Situ/In Situ Combination alternative analyzed in the Draft EIS was identified very late in the process of preparing the Draft EIS. DOE and Ecology choose to include a brief summary of this alternative as an attachment to the EIS. This alternative has been fully developed and incorporated into the Final EIS. DOE and Ecology believe the Ex Situ/In Situ Combination 2 alternative provides another alternative between the no retrieval and extensive retrieval, and, as a result provides useful information to the public and decision makers. Please refer to the response to Comment number 0005.05 for more information.

Comment Number 0047.04

Ahouse, Lorretta

Comment I am very concerned that an "attachment variation of the Ex Situ/In Situ Combination alternative" was added at the last moment to the Draft EIS. As I understand, this alternative would only remove 26 percent of the total tank waste volume and would not meet the Tri-Party Agreement. This is not acceptable to me as a citizen of Washington State. Why was this alternative even added so late in the process if its does not meet the Tri-Party Agreement? Does the Department of Energy have any plans to seek an exemption from the Tri-Party Agreement? Why are we wasting taxpayers dollars to examine alternatives that are not legally acceptable? Please, just get on with the cleanup.

Response Please refer to the response to Comment numbers 0005.05 and 0012.08 which address similarity worded comments. Please refer to the response to Comment number 0072.80 for a discussion of the NEPA requirement to analyze reasonable alternatives, even when they do not comply with regulations. In the Final EIS the Summary, Section S.7 and Volume One, Section 6.2 address the ability of the alternative to comply with Federal and State regulations and the Tri-Party Agreement.

L.3.4.13 Miscellaneous

Comment Number 0005.11

Swanson, John L.

Comment I am quite sure that the alternatives involving in situ disposal will require more extensive/costly characterization activities than the other alternatives, but I do not see that reflected in the cost comparisons. Isn't that a bias in their favor? (I learned at the May 2 hearing that characterization is not included in this EIS, but my statement re biasing of comparisons stands. Also, shouldn't the omission of characterization from this EIS be highlighted, along with the omission of closure, so that it will be clear how limited in scope this EIS really is?)

Response Additional characterization requirements for in situ alternatives have been considered. Volume One, Section 3.4 acknowledges that additional characterization would be required for the in situ alternatives have been considered. The cost estimates completed in support of the Draft EIS included an additional $903 million for the in situ alternatives to cover additional characterization activities. These cost estimates are available for review in the TWRS EIS Administrative Record and DOE Reading Rooms and Information Repositories The relationship between closure and the alternative is presented in the Summary and Volume One, Section 3.3 and the impact in Section 5.0. For a discussion of the closure issues, please refer to response to Comment numbers 0072.08, 0101.06, and 0072.50.

Comment Number 0035.09

Martin, Todd

Comment Lastly, I would like to address the issue of mortgage reduction. This is something at Hanford that we have been dealing with for two years.

It has been a very high priority, and it has to do with putting money into old facilities for the purpose of closing them down in such a way that we could free that money up for real cleanup.

The tanks are the greatest mortgage reduction opportunity at Hanford we have. If we get the waste out of the tanks, we will reduce the budget by, as Dick said, about 300 million dollars. It is time to get on with it. It is time to do the job.

Response Cost associated with continued monitoring and maintenance activities at the tank farms would be reduced as the number of tanks containing waste was reduced. Remediation of Hanford tank waste is a needed investment to environmental well-being of the Hanford area and is required to protect human health and the environment.

L.3.5 CESIUM AND STRONTIUM CAPSULE ALTERNATIVES

L.3.5.1 Preferences for Capsule Alternatives

L.3.5.1.1 Specific Preferences

Comment Number 0006.01

Skyes, Megan

Comment As a scientist involved in biomedical research in the area of bone marrow transplantation, I am writing to express my support for the production of Cs-137 sources at the Hanford Reservation. It is my understanding that this is the only world producer of large Cs-137 sources other than the Russian laboratories at Mayak. In view of the high prices of Cs-137 sources that results from the existing monopoly, it will be nearly impossible to purchase sources in the future, as funding for biomedical research is becoming more and more limited. Therefore, the production of Cs-137 sources (at a lower cost) would be a major benefit to the biomedical research community. There are numerous other investigators, not only in the field of bone marrow transplantation, but in immunology who are dependent upon the availability of these irradiators in order to carry out their research. I hope that it will be possible for the Department of Energy to deal with the existing Cs-137 at Hanford in a cost-effective manner and in so doing to serve a vital need for the medical research community.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. For the Final EIS, DOE has identified the No Action alternative as the preferred alternative and has modified the Summary Volume One, Section 1.3 accordingly.

The TWRS EIS addresses alternatives for management and disposal of encapsulated cesium and strontium. The encapsulated cesium and strontium are included in the EIS primarily because they were originally extracted from the stored high-level tank waste to reduce the thermal heat generation in the tanks and would be considered HLW for purposes of disposal. DOE is actively seeking commercial interest in the beneficial applications for the encapsulated cesium and strontium, and DOE remains committed to pursuing any viable commercial or other beneficial uses; at this time, the preferred alternative is No Action. These uses would not be without substantial cost for reprocessing and repackaging since the current encapsulation was designed principally for storage purposes. If viable commercial or beneficial uses are not implemented, the capsules would be designated as waste at some point in the future and would be disposed of using methods consistent with one of the alternatives identified in the EIS or a new NEPA analysis would be completed. Under no action, the capsules will be stored and maintained under current operations at the WESF, which includes a comprehensive monitoring program. This program is described in Volume One, Section 3.2.

Comment Number 0008.03

Evett, Donald E.

Comment Secondly, S.5.2 Cesium and Strontium Capsule Alternatives: I personally would prefer to select alternative (4) physically mixing the capsule contents with the high-level tank waste, which would then be vitrified and disposed of at a potential geologic repository.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium waste and strontium capsules.

Comment Number 0029.02

Bartholomew, Dale C.

Comment I believe that cesium capsules should be left in a condition for possible future commercial irradiation. At the public hearing on May 2, 1996, we were advised that only one capsule leaked, but no one at the hearing was able to identify the mode of failure. If the mode of failure was a bad weld, I believe that it is premature to dispose of all capsules, because there still may still be some interest in commercial irradiation. It would be imprudent to waste all of the previous time, effort, and cost that went into the separation and concentration of the cesium-137 and strontium-90 isotopes.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. For the Final EIS, DOE has identified the No Action alternative as the preferred alternative and has modified the Summary and Volume One, Section 1.3 accordingly. Please refer to the response to Comment number 0006.01.

Comment Number 0032.07

Heacock, Harold

Comment A secondary issue addressed in the Draft EIS is the disposal of the cesium and strontium capsules currently stored in the WESF facility at the B Plant.

We believe that any action to dispose of the capsules should be deferred at this time, so long as an adequate degree of environmental protection is maintained in their storage.

These capsules represent a resource that may have significant future use in irradiation programs. Pending the determination of their potential future utilization, we believe this potential asset should be retained.

This position is consistent with the Draft EIS since the high-level waste ex situ vitrification plant operation is at least 10 years away.

Ultimate disposal of these capsules with the other high-level waste is the preferred solution to the disposal of the capsules.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0040.05

Rogers, Gordon J.

Comment The cesium and strontium capsules should be transferred into air-cooled storage in the facility now being built for the Spent Nuclear Fuel project. In the meantime serious efforts should be made to see if there is a market for commercial use as radiation sources. Permanent disposal plans can wait.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0043.05

Hanford Communities

Comment The Hanford Communities would also like to comment on the plans for disposition of the cesium and strontium capsules currently stored in the B Plant. We believe that any action to dispose of the capsules should be deferred at this time. These capsules represent a resource that may have significant value. Rather than pay to dispose of these materials, the Department should actively explore opportunities for commercial use and sale.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

L.3.5.1.2 General Preferences

Comment Number 0012.13

ODOE

Comment The second issue addressed by the EIS is what to do with the cesium and strontium capsules stored at Hanford. The cesium capsules contain cesium-135 and cesium-137. These two isotopes present different hazards. Cesium is very soluble in water. Cesium-135 has a long half-life. If it is disposed at Hanford, it presents an unacceptably large risk to public safety and health and the environment. Oregon supports disposal of the cesium and strontium from capsules in a suitable form to the national high-level nuclear waste repository. The waste form selected should ensure that cesium-135 will not endanger public health and safety or the environment.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0060.05

Davenport, Leslie C.

Comment I do not feel that a final choice can be made between the proposed alternatives yet. The No Action alternative of continued storage in WESF is acceptable during the next 10 years while DOE selects an alternate storage method for the capsules or determines if there is a use for them. I do not like the Onsite Disposal alternative because I feel that the capsules, if discarded, belong in the proposed geologic repository. Similarly, it makes little difference other than cost if the capsules are Overpacked and Shipped, or Vitrified with Tank Waste if a HLW vitrification facility is operational at Hanford.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

Comment Number 0089.02

Nez Perce Tribe ERWM

Comment ERWM endorses the Overpack and Ship alternative for the strontium and cesium capsules.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and

other public comments into consideration when making a final decision on the cesium and strontium capsules. Please refer to the response to Comment number 0006.01.

L.3.5.2 No Action Alternative (Capsules)

No comments were submitted for this topic.

L.3.5.3 Onsite Disposal Alternative

No comments were submitted for this topic.

L.3.5.4 Overpack and Ship Alternative

No comments were submitted for this topic.

L.3.5.5 Vitrify with Tank Waste Alternative

No comments were submitted for this topic.

L.3.6 BORROW SITE SUMMARY

Comment Number 0019.03

WDFW

Comment WDFW is concerned by stating specific (potential) borrow sites in this document future decisions will be steered by the mentioning of such locations now. Statements are made in this document without the word "potential" even mentioned. Example, section B.6.1, paragraph discussing first and second layers, last sentence, which states "The proposed topsoil would be obtained from the McGee Ranch quarry site of the Hanford Site." This document appears to be trying to steer future decisions prior to exploring alternatives for borrow sites.

Throughout the document, the author states "future NEPA documentation will specifically address in detail impacts and mitigation of post-remediation tank closure where, for example most impacts of borrow site activities would occur" (page 5-258). The summary states "The impacts of closure cannot be meaningfully evaluated at this time. U.S. Department of Energy (USDOE) will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future." Since a meaningful analysis of impacts to potential borrow sites for post-remediation activities is not being undertaken by this EIS, WDFW requests all references to potential post-remediation borrow sites be deleted from the document (i.e., figures, tables, and text).

Response The TWRS EIS frequently states that the final selection for the borrow sites must be evaluated in the document for waste site and tank farm closure. The Summary states that, "The impacts of closure cannot be meaningfully evaluated at this time. DOE will conduct an appropriate NEPA review, such as an EIS, to support tank closure in the future." This question was also contained within the Notice of Intent to prepare the TWRS EIS.

Volume One, Section 3.6, states that, "The final selection of borrow sites for earthen material has not been made; however, the locations indicated represent potential borrow sites that would support each of the alternatives in both volume and location. Future borrow site decisions will be made in the ROD for the Hanford Remedial Action EIS."

Volume One, Section 4.5, states that, "The potential Vernita Quarry and McGee Ranch borrow sites have potential for both historic and prehistoric materials. Surveys have identified prehistoric or historic sites at both Vernita and McGee Ranch. The McGee Ranch area has been determined to be eligible for nomination to the National Register of Historic Places as the McGee Ranch/Cold Creek District. No prehistoric sites are known at the potential Pit 30 borrow site, although one structure from the homestead era is located at Pit 30." These statements are reiterated in Section 5.5 where it is stated that, "Archaeological surveys of the three potential borrow sites have identified a variety of prehistoric or historic artifacts and sites at the Vernita Quarry and McGee Ranch. The likelihood of disturbing additional archaeological sites in these areas is considered high." In addition, the archaeological importance of historic and prehistoric sites is reiterated in Volume One, Sections 5.5.1, 5.5.2, and 5.5.3.

Volume One, Section 5.17 identifies the potential Vernita Quarry and McGee Ranch borrow sites as undeveloped areas on the Hanford Site Development Plan's Future Land-Use Map. Further, using the potential Vernita Quarry site would involve expanding an existing quarry, while using the potential McGee Ranch borrow site would essentially be a newly developed site (though a small, old borrow area does exist). It is further stated that, "Planning for possible borrow sites for the TWRS program is still in its early stages and the CLUP and Hanford Remedial Action EIS address future land uses for the Site as a whole." Section 5.5.3 explains that any disturbance of the land surface, such as would occur in borrow site activity, is not compatible with the relationship between the Native Americans and the land.

Volume One, Section 5.20.1 states that, "Although much of the area proposed for the remedial activities is in areas currently disturbed, activities in some areas [primarily the Vernita and McGee Ranch borrow sites] have the potential to impact historic, prehistoric, or cultural sites. These areas have not been fully surveyed because they are potential borrow sites subject to change during final design. The final selection of borrow sites would be made through the Site Comprehensive Land Use Plan."

The discussion of alternatives uses these borrow sites as example locations for the materials that may be required for closure. Certainly, gravel and sand sources are required for construction of the facilities required for the various alternatives. In WHC-SD-WM-EV-103 and WHC-SD-WM-EV-104, Tables 6-12 and 9-12, respectively, state the assumption that an onsite gravel plant would provide crushed aggregate for concrete construction at a location 5 kilometers (km) (3 miles [mi]) from the construction site, the potential borrow site known as Pit 30.

Considering the earlier discussion, which states that the decisions for the borrow sites will be made elsewhere, that the prehistoric, historic, and cultural significance must be thoroughly evaluated, and the undeveloped status given to portions of the area land relationship with the Native Americans, DOE and Ecology do not believe that including these potential borrow sites alternatives for borrow sites. Using these named potential borrow sites provides only a basis to more completely discuss the potential impact of each of the alternatives covered in the TWRS Final EIS in terms of potential for traffic accidents with distance traveled, construction and operation emissions to the environment, a comparison between the alternatives, and an interrelated closure discussion for each of the various alternatives.

Comment Number 0019.07

WDFW

Comment Page 3-116, Tables 3.6.1, 3.6.2, and 3.6.3 If I were to open this EIS to this page, I would conclude from the titles of thee tables that a decision has been made on borrow site locations when in fact this document does not perform adequate NEPA analysis, i.e., a range of alternatives, for sources of different material types needed. WDFW requests all references to borrow site locations be deleted from the document since the impacts to borrow sites will require NEPA review.

Response Please refer to the response to Comment numbers 0019.03, 0072.08, and 0101.06. The EIS has been reviewed and revised as appropriate to clarify the assumed borrow sites as "potential" sites.

Comment Number 0072.123

CTUIR

Comment P 3-116: Tables 3.6.2. and 3.6.3.: These tables present figures that are for closure options. Because this EIS is a RETRIEVAL EIS, the tables are inappropriate and should be removed, or all of the closure options be equally presented.

Response The tables identified in the comment represent borrow materials required for the assumed closure scenario presented in the EIS. For more information on the closure assumption, please refer to the response to Comment numbers 0072.08 and 0019.03. As identified in the Draft EIS in Volume One, Section 3.3 closure is not within the scope of this EIS because there is insufficient information concerning the amount of contamination to be remediated. The amount and type of waste that remains in the tanks after remediation also may affect closure decisions. Closure as a landfill was included in all of the alternatives except the No Action and Long-Term Management alternatives so the alternatives could be meaningfully compared. This does not mean that closure as a landfill has been proposed or would be selected for final tank closure. Because the information contained in the Draft EIS is correct, no change to the text was made.

L.3.7 COMPARISON OF ACTIVITIES ASSOCIATED WITH ALTERNATIVES

Comment Number 0005.15

Swanson, John L.

Comment I find it strange that system costs is the only metric included in the summary description of each alternative in Section 3.0 ("Description and Comparison of Alternatives"). People are certainly interested in the costs, but the major concern on the part of the public appears to me to be in the perceived risk to their health and well-being. Couldn't/shouldn't summary data of some sort in that area be included in this section along with the cost data? If this is not done, I feel that you should change the title of this section to "Description and COST Comparison of Alternatives."

Response Volume One, Section 3.0 provides a description and comparison of the alternatives based on the characteristics of the alternatives themselves. These characteristics include cost. However, the section also provides a comparison of the processes inherent to each alternative; construction, operations, and post-remediation features of each alternative; the schedule, sequence of activities, and costs of each alternative; the amount of waste to be retrieved from the tanks, treated, and disposed of onsite verses offsite for each alternative. The potential environmental impacts associated with each of the alternatives are presented in Volume One, Section 5.0. In Volume One, Section 5.14, a summary table is provided that lists each alternative and all of the associated impacts as presented in Section 5.0. Additionally, a summary of those impacts was presented in the TWRS EIS Summary, Section S.7, which was prepared to accompany the EIS or to be read separately by individuals who did not want to read the entire EIS. The level of data and summarization of the data, as well as the presentation of the data and summary information provided the public and decision makers with the appropriate level of information in a format that was accessible considering the complexity of the proposed action and associated impacts. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0005.55

Swanson, John L.

Comment Why is the number of HLW shipments required for the Extensive Separations alternative ~50 percent as large as that for the Intermediate Separations alternative (page 5-146), when the ratio of the number of canisters is only ~10 percent as large?

Response The average rail trips per year calculated and reported in Volume One, Section 5.10, Trail Traffic Volumes, for the number of canisters generated as result of the Ex Situ Extensive Separations alternative has been modified in the Final EIS.

L.3.8 ALTERNATIVE CONSIDERED BUT DISMISSED

No comments were submitted for this topic.

L.3.9 MISCELLANEOUS

Comment Number 0005.59

Swanson, John L.

Comment Page vii of Volume Two contains incorrect definitions/descriptions of B Plant and T Plant.

Response According to two references, Hanford Tank Clean Up: A Guide to Understanding the Technical Issues (Gephart-Lundgren 1996), The Hanford Site: An Anthology of Early Histories (Gerber 1993), and T Plant (DOE 1994l), T Plant and B Plant were both constructed as plutonium removal facilities. Both facilities used the bismuth phosphate separation process. In later years, B Plant was used to remove cesium and strontium from acid waste pumped from the Plutonium-Uranium Extraction (PUREX) Plant. T Plant is currently used as a decontamination and repair facility. According to DOE 1994l, these plants, along with Z and U plants, for example, were given alphanumeric names due to 1940's wartime secrecy. These descriptions are provided in the Volume One Glossary. B Plant and T Plant were deleted from the Acronyms and Abbreviations list in Volume Two, Appendix B.

Comment Number 0005.60

Swanson, John L.

Comment On page B-9, an incorrect date is given for the start of the PUREX plant.

Response According to two references, Hanford Tank Clean up: A Guide to Understanding the Technical Issues (PNL 1996) and The Hanford Site: An Anthology of Early Histories (WHC 1992), the correct date for the PUREX Plant hot start up was January 1956. All applicable, incorrect references have been revised.

Comment Number 0022.04

Sims, Lynn

Comment There is no argument that Cold War Clean Up is extremely expensive. But inadequate clean up will be more expensive. Choosing less expensive options now will probably result in contaminated soils and water, serious loss of quality of life and health and perhaps loss of land use, trade, and commerce. Our costs now are a result of military production. Perhaps military clean up should be built in up front in the military budget since that is the department which seems to receive more funds than requested while DOE monitoring and clean up funds are slashed.

Finally, it must always be of paramount importance to remember that bomb production was implemented to protect this nation and that to skimp on efforts to clean up puts our homeland at serous risk forever.

Response Comment noted.

Comment Number 0025.01

Heart of America

Comment *A public interest group distributed a questionnaire at the Spokane and Seattle, Washington public meetings. Listed below are the questions and a tally of the totals from the 33 individuals who submitted surveys. The agency responses follow after the summary of the questionnaire. Below each question in bold is the ranking system contained in the questionnaire (using a scale of 1 to 10). In parenthesis following the rank are the number of individuals who circled the number on this questionnaire.*

Please tell us the degree to which you agree or disagree with the following proposals for Hanford's high-level nuclear wastes on a scale from one to ten with #1 being Strongly Disagree; #5 No Opinion; and #10 being Strongly Agree.

1. The current Tri-Party Agreement calls for retrieving 99 percent of the wastes from all of Hanford's high-level nuclear waste tanks by the year 2028 and turning it into some form of glass (vitrification). To what degree do you

agree/disagree with the Tri-Party Agreement?

Rank: 1 (3) **2** (1) **3** (1) **4 5 6** (1) **7** (1) **8** (8) **9** (3) **10** (14) . **N**/A (2)

2. Leaving 75 percent of the high-level nuclear waste in the tanks forever, and filling them with cement or gravel after removing the most radioactive 25 percent would cost less than retrieving and vitrifying 99 percent of the waste. This is the Ex Situ/In Situ Combination alternative.

a. The cost savings claimed by USDOE for this option justify leaving most of the high-level nuclear waste in the tanks:

Rank: 1 (23) **2** (1) **3** (3) **4** (1) **5 6 7** (1) **8** (2) **9** (1) **10** (2)

b. USDOE has fully considered in the EIS the evidence that waste from tank leaks is moving towards groundwater and the risks this may pose to the Columbia River and future exposed populations from this alternative:

Rank: 1 (18) **2** (1) **3 4 5** (2) **6 7** (4) **8** (2) **9** (2) **10** (1) **N**/A (4)

c. Any alternative that leaves high-level nuclear waste in the tanks and in the soil beneath the tanks poses an unacceptable risk to the Columbia River and future generations.

Rank: 1 (1) **2 3** (1) **4 5 6 7 8** (2) **9** (3) **10** (27)

d. For the same reasons that the public voted in 1986 against Hanford being an underground high-level nuclear waste dump, leaving high-level nuclear waste in tanks or threatening groundwater is NOT acceptable:

Rank: 1 (2) **2 3** (1) **4 5 6 7 8** (4) **9** (2) **10** (25)

3. USDOE's Tank Waste Task Force (public interest groups, local governments, Tribes,...) urged USDOE to base decisions assuming that the wastes, after being vitrified, will stay at Hanford for a very long time, and not to assume USDOE will move the waste to its proposed Yucca Mountain repository. Do you agree/disagree with the advice:

Rank: 1 (6) **2** (1) **3** (2) **4 5** (5) **6 7 8** (1) **9** (7) **10** (11) **N**/A (1)

4. a. USDOE should use conservative assumptions that tank leaks move down to groundwater in less than 40 years, instead of claiming that leaks will stay close to the tanks and not reach groundwater for over 100 years:

Rank: 1 (1) **2** (1) **3** (1) **4** (1) **5** (1) **6** (1) **7 8** (3) **9** (2) **10** (23)

b. Because this EIS assumes tank leaks do not move quickly to groundwater, the EIS wrongly creates a bias in favor of delaying retrieval of all wastes from leaking single-shell tanks:

Rank: 1 (3) **2** (1) **3 4 5** (2) **6 7** (3) **8** (3) **9 10** (22)

5. a. Should the EIS drop (not include) the "repository fee" in its presentation of costs and as a basis for decision making?

Rank: Yes (22) **No** (12)

b. Does the inclusion of the repository costs appear to have biased the consideration of alternatives, including how one would weigh each alternative's risk versus costs?

Rank: Yes (26) **No** (4) **N**/A (3)

c. If the cost of the No Separations alternative (make all the waste into glass logs) were in the same price range as other alternatives when the hypothetical repository fee was not added onto it, would you urge that it be considered as a reasonable alternative to building multiple vitrification and separations plants:

Rank: Yes (19) **No** (10) **N**/A (5)

Response

Comment item number 1: Please refer to the response to Comment numbers 0047.03 and 0009.01.

Comment item number 2a: Please refer to the response to Comment number 0072.05.

Comment item number 2b: Please refer to the response to Comment number 0012.15.

Comment item number 2c: Please refer to the response to Comment number 0072.08.

Comment item number 2d: Please refer to the response to Comment numbers 0072.08, 0072.100, and 0072.111.

Comment item number 3: Please refer to the response to Comment numbers 0081.02.

Comment item number 4a: Please refer to the response to Comment numbers 0012.15 and 0030.02.

Comment item number 4b: Please refer to the response to Comment numbers 0012.15 and 0030.02.

Comment item number 5a: Please refer to the response to Comment numbers 0081.02 and 0004.01.

Comment item number 5b: Please refer to the response to Comment numbers 0081.02 and 0004.01.

Comment item number 5c: DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment numbers 0081.01 and 0004.01.

Comment Number 0027.03

Roecker, John H.

Comment Systems Engineering

In 1993 DOE proudly and loudly stated that it was going to use systems engineering to establish the requirements for both TWRS and also the Hanford Site. To my knowledge that has not been done in either case, yet here we are reviewing the EIS for implementing a very specific TWRS action. Looks to me as if the systems engineering commitment lasted about as long as the January 1994 Tri-Party Agreement. Two fundamental systems engineering actions are required to correct this situation. First, a top down requirements allocation from the site level to the program level is needed. Secondly, the TWRS Functions and Requirements Document, along with an integrated alternatives systems analysis, must be finalized and issued. I would request that issuance of the Final TWRS EIS be deferred until such systems engineering and analysis has been completed. Without such one cannot be sure that the right work is being performed or that the best alternative has been selected.

Response Since 1993, two systems engineering documents, TWRS Functions and Requirements (DOE/RL-92-60) and TWRS Systems Engineering Management Plan (DOE/RL-93-106) have been prepared. DOE conducted an independent Systems Requirements Review (SRR), submitted in November 1994, to validate the TWRS Functional Requirements Baseline. The SRR evaluated selected representative TWRS activities and identified the need for improvement in the implementation of systems engineering, quality of supporting documentation, and timeliness of testing assumed solutions and competitive alternatives. In response to the SRR, the TWRS System Requirements Review Action Plan (DOE/RL-95-74) was prepared, which addressed the findings presented in the SRR and presented the methodology for revising the Functional Requirements Baseline and developing the infrastructure required to support the functional requirements. Because the EIS and the TWRS Functions and Requirements have been developed concurrently, the conclusions of the TWRS Functional Requirements are anticipated to be consistent with the recommended alternative presented in the Final EIS. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives. Please refer to the response to Comment number 0101.07 for further discussion of systems engineering.

Comment Number 0027.04

Roecker, John H.

Comment Technical Balance

I wish I was more interested in the projected cost of housing in the Tri-Cities in the year 2040 because there sure is plenty of computer printout data on that and other similar items, but I am just not. Instead, I would like to see more of the technical data that supports such items as operating efficiency, number of canisters, process design, alternative costs, etc. I would like to request that the reams of computer printout data and modeling contained in the appendices be restrained a little and more of the basic technical data that really establishes how an alternative is going to perform be put into the EIS.

Response The technical data that support the areas of interest indicated (i.e., operating efficiency, number of canisters, process design, and alternative costs) are contained in the TWRS Administrative Record and are available for review. The data to support the performance capability of the recommended alternative will be contained in the detailed design document for that alternative, which will be prepared following the Final EIS. The evaluation criteria used in the EIS are defined by NEPA and are confined to impacts to the environment only. As such, the requested evaluation of alternative performance data is beyond the scope of this EIS, but will be contained in future documents.

Comment Number 0027.06

Roecker, John H.

Comment Use of Non-Optimized Alternatives

The alternatives described in the EIS represent first cut approaches and do not represent optimized alternatives that have been tuned utilizing good engineering principles. More recent optimized process design flowsheet and facility design data is available and should be used in the Final EIS. This optimized design will significantly reduce the estimated cost.

Response The purpose of the EIS is to examine bounding alternatives, including a No Action alternative. It is anticipated that the optimized process design flowsheet will be used during the detailed design of the waste retrieval, transfer, treatment, and storage facilities conducted during the demonstration phase of the preferred alternative. The TWRS baseline flowsheet is continually updated and optimized. In order to support the EIS schedule, the baseline data used for development of the Draft EIS was frozen in May 1995. NEPA requires the alternatives be compared on an equitable basis. The Draft EIS presents conceptual alternatives that were developed using common bases that allow equitable comparison. Please refer to the response to Comment number 0072.05.

Comment Number 0027.08

Roecker, John H.

Comment Cost Estimates

In this day of tight budgets the cost estimate for an alternative is a very critical item. It is impossible to understand the basis for any of the cost estimates with the information contained within the EIS itself. It is necessary to look up several reference documents. This is not the easiest task if you do not live in the Tri-Cities. It would be helpful if the backup information for the life cycle cost estimates could be included in an appendix. There are several of the existing appendices that could be greatly reduced to make room for this information. As an example, the over 50 pages devoted to socioeconomic impact could be reduced to approximately 10 pages. The endless tables representing computer modeling printout could be put in a reference document.

Response As stated in Volume One, Section 1.0, the EIS fulfills the requirement for an analysis of potential environmental impacts in the decision-making process. NEPA and The Washington State Environmental Policy Act (SEPA) provide decision makers with an analysis of environmental impacts (both positive and negative) of proposed actions for consideration during decision making. This EIS presents the impacts of the proposed action and its reasonable alternatives for review and comment by the public and interested parties. Because of the magnitude of the cost required to implement any of the alternatives, it was determined that cost estimates would be included in the EIS. The development and presentation of alternative cost estimates is not the primary purpose or major focus of an EIS. The development of bounding alternatives for the EIS would indicate the need to develop additional cost data for the decision-making process.

The technical data used to develop the alternatives presented in the EIS are contained in the TWRS EIS Administrative Record and DOE Reading Rooms and Information Repositories. The Administrative Record contains additional cost estimate detail. As indicated in the front of Volume One, EIS technical reports, background data, materials incorporated by reference, and other related documents are available at Seattle, Spokane, and Richland, Washington; Portland, Oregon; and Washington, D.C.

The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0027.09

Roecker, John H.

Comment My understanding of the capital cost estimates for the down sized facilities in the combination and Phased Implementation alternatives is that the sixth-tenths power rule was used. That is an absolute error. The sixth-tenth power rule does not work for these types of facilities. These facilities have a significant portion of their capital cost attributable to basic facility systems which are essentially independent of facility size. The sixth-tenth power rule works for facilities in which processing equipment makes up most of the capital cost. That is not the case with these waste processing facilities. That is something that must be fixed in the Final EIS. Conceptual cost estimates for the size facilities included in the EIS have been made. Why not use the available existing data which has backup rather than include erroneous data?

Response The cost estimating methodology has been reviewed for the Final EIS and revised cost estimates were completed for the Phased Implementation and combination alternatives. These revised costs are shown in Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to the response to Comment numbers 0055.06, 0057.06, and 0035.06.

Comment Number 0030.01

Krieg, Ronald K.

Comment I am also disappointed in the limited scope that the inclusion of subsurface barrier technology in this Draft EIS was only as a potentially viable component to remediation alternatives, and am dissatisfied in Appendix B's level of analysis and conclusions of subsurface barrier technology. My other areas of concern involve the focus being on future impacts and conditions of alternatives alone with no regard to current or past practices. If the DOE is to develop a systematic approach to actually solving some problems in a truly cost effective manner with the least environmental impact, all aspects and pertinent details of all alternatives should be included in this EIS.

Response Subsurface barrier technology is discussed in Volume Two, Appendix B. Subsurface barriers are a potentially viable technology available to the decision makers. The EIS incorporates by reference (Treat et al. 1995) a detailed engineering feasibility study on subsurface barriers. Subsurface barriers were added as a potential mitigation measure in Volume One, Section 5.20 in the Final EIS. Please refer to the response to Comment number 0001.01.

All of the alternatives' future potential impacts are based upon an analysis of the potential impact of the alternatives themselves, without consideration of past or current practices, as appropriate. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0030.04

Krieg, Ronald K.

Comment The Hanford Federal Facility Agreement and Consent Order set a goal for the SSTs that no more than 1 percent of the tank inventory would remain as a residual following waste retrieval activities (3-31, Vol. 1). Many times it is stated that this retrieval criteria of 99 percent may not be achieved (3-101, Vol. 1). Residuals left in tanks would not meet the water protection requirements if additional closure action is not taken (6-30, Vol. 1), with these residuals having low solubility because substantial quantities of liquid was used in the attempt to dissolve or suspend wastes during retrieval (3-31, Vol. 1). Furthermore, performance of key alternative processes have been assumed in absence of substantive data. Cost estimates may have a high degree of uncertainty because some of the processes are unproven (3-100, Vol. 1).

The Tri-Party Agreement calls for total waste removal from Hanford's single- and double-shell tanks for processing and storage offsite, unless technically unfeasible. Throughout the EIS the word "uncertainties" is used regarding costs, COC inventories and volumes, technology performance, actual risks, and SST leakage quantities. It would be a shame to see uncertainty translate to unfeasibility. The time has come to eliminate uncertainty through a systematic, cost and risk effective remedial approach with the least long-term impacts to our future populace's health and environment.

Response As required by the CEQ, the TWRS Draft EIS identifies and analyzes the range of reasonable alternatives for the proposed action, which also includes a No Action alternative. All data that support the cost and impact analysis of each alternative are presented in an objective format for comparison by the decision makers and by the public during the comment period. However, the EIS is limited to the TWRS and evaluation of reasonable tank waste remedies. Under the Tri-Party Agreement, DOE and Ecology are bound to complete specific milestones related to tank waste remediation, and given the uncertainties listed in the comment, the Agencies have selected the Phased Implementation as the preferred alternative.

Identification and presentation of the many existing uncertainties was the method chosen by DOE and Ecology to complete the evaluations and publish the EIS. To consider and resolve all uncertainties before publication of the EIS would result in inordinate delay and failure to comply with the Tri-Party Agreement. Please refer to the response to Comment numbers 0005.03, 0072.05, and 0072.80 for discussions regarding regulatory requirements for bounding alternative analyses.

Comment Number 0030.05

Krieg, Ronald K.

Comment A recent report prepared by the National Research Council regarding containment-in-place technologies acknowledges subsurface barriers as an imperative use during remediation efforts and as a feasible interim solution to hazardous substance migration at Hanford and other Department of Energy sites. The committee's comparison of costs found retrieving and processing wastes costs $15 billion more (17.5 vs. $2.4 billion) than the alternative of in situ stabilization and isolation. I do not believe the Feasibility Study of Tank Leakage Mitigation Using Subsurface Barriers (WHC-SD-WM-ES-300) fully analyzed subsurface barrier technology and recommend what the National Research Council has; that containment-in-place technology be re-evaluated on its technical, fiscal, environmental, and public health merits as a possible short- or long-term alternative for radioactive waste management and inclusion as such in this EIS.

Another problematic issue is in Appendix B's level of analysis and conclusions of subsurface barrier technology, which failed to include information from the Feasibility Study of Tank Leakage Mitigation Using Subsurface Barriers regarding subsurface barriers' cost effectiveness when supporting clean closure activities. Although closure decision are not a part of this EIS, they are stated to be interrelated with the decisions made concerning remediation of tank wastes.

The conclusion I am referring to is stated: "The most cost effective individual action is adding a close-coupled subsurface barrier to support clean-closure. This result is lowering both risk and HI and the overall cost of the alternative. This apparent anomaly arises from the substantial reduction in contaminated soil and recovered contaminants requiring treatment when a subsurface barrier is used. The resulting cost savings more than offset the cost of installing the barrier (WHC-SD-WM-ES-300 Rev. 0, pg. 8-3). Information such as this must not be overlooked, forgotten, or excluded from this EIS.

A reduction in the financial risk involved with contaminant migration and the technical uncertainties of the ex situ technologies is possible and available now. The potential cost savings to TWRS could be in the $5-7 billion range if a 10-year delay in remediation costs could be attained through effective deployment of subsurface barrier technology. This principle would carry over to many other situations throughout the DOE complex. Mitigated through the use of effective subsurface barriers under the tanks a delay in start up could save money in two ways: 1) identical real budgets have lesser present value as they are postponed farther into the future, and 2) technology productivity improvements occur as time passes, further reducing real costs. This approach would allow the DOE to improve the design, construction, and operations of initial and full scale remedial operations to the SSTs.

Barriers for confinement-in-place of buried waste have been effectively used in many environmental remediation activities. Subsurface barriers provide a cost effective option for resolving the 200 Areas' management and remediation problems either as a short or long-term approach. With their continued development, cost efficient subsurface barrier technology providing the highest containment performance standards must be retained and given serious consideration on its technical fiscal, environmental, and public health merits for inclusion in this Draft EIS.

Response The subject report by the National Research Council, titled The Potential Role of Containment-in-Place an Integrated Approach to the Hanford Reservation Site Environmental Remediation, recommended that containment-in-place technology be considered and evaluated on its technical, fiscal, environmental, and public health merits as a possible short- or long-term alternative for radioactive waste management. Such analysis should be conducted on a site-specific basis.

For analysis in the EIS, alternatives that bound the full range of reasonable alternatives were developed. In order to bound the impacts associated with in situ disposal of the tank waste or tank leakage during waste retrieval activities, subsurface barriers were not assumed to be used. This does not preclude the use of subsurface barriers during remediation activities but provides an upper bound on the expected environmental impacts. Subsurface barriers would be beneficial for retrieval of wastes from known or suspected leaking tanks. This technology would be evaluated for tank-specific application. Subsurface barriers were added as a potential mitigation measure in Volume One, Section 5.20 in the Final EIS. Please refer to the response to Comment numbers 0001.01 and 0030.01.

Comment Number 0046.03

DiGirolamo, Linda Raye

Comment We ought to convert the WHOLE NUCLEAR INDUSTRY by forming a commission name NEW AGE ENERGY - touched upon by Mr. Browning - This NAE would begin research and development at Hanford while the DOE cleans up its awful mess...beginning immediately!

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0054.01

Belsey, Richard

Comment Grout did not work because we had so many processes going on. At Savannah River, they are today using grout because they were able with relatively simple separations to clean out 99.99 percent of the high activity fraction. But Hanford kept on, the Hanford's performance assessment kept on bouncing back over, over, strung out over time saying give us more information, your I-129 releases from the grout are still rising at 10,000 years. You at least have to model it out to know where it is going to turn the corner. I raise this question because we have re-opened all of those issues almost like re-opening a wound and looking at an infection again and saying why are we doing this and I would council that in fact you all list other stabilization forms (grout and ceramics) in this Draft EIS. How did we come to glass. There has been both a rich scientific literature about stabilizing radionuclides in glass going back 20 or 30 years and whereas with other substances there is spotty science and particularly with ceramics and grout there are highly variable reactivity. You go down to Savannah River it is almost like a witches brew. They stir it up and they have to use this particular kind of stone or else the whole thing does not gel and same thing with ceramic. So from my perspective, science wise we have to be careful about changing the stabilized waste form and we also now have about a 20-year, nearly a 20-year experience, not our own, but with other people using glass particularly for the high-level wastes. So I think that we should clearly not make any change in the waste form because of the inherent delay that will come about and the one thing we can not afford to do is to delay. The delays have cost nearly a billion dollars now and every year we delay costs that much more with by and large no real value so we got to get on with it. So state clearly that you are not going to consider anything except glass and glass from whoever gets to do the job of cleaning this up. I will leave that for now. Thank you very much.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. NEPA requires that a full range of alternatives be examined in the EIS. This range of alternatives must include a No Action alternative, and may include other reasonable alternatives to allow analysis of a full range of alternatives. Some alternatives do not produce a glass waste form. Consequently, the EIS cannot omit glass from analysis as the waste form for a given alternative. It should be emphasized that for the ex situ alternatives, glass was the primary waste form to be produced. Similarly, the EIS also discusses alternate immobilization technologies to allow their analysis. These technologies were not included in the alternatives developed for impact analysis, but may serve as potential components of a remediation alternative. The discussion of alternate technologies, including grout, will be found in Volume Two, Section B.9.0. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the response to Comment numbers 0005.40, 0005.18, 0072.179, and 0009.08 for a discussion of issues related to grout.

Comment Number 0058.01

Swanson, John L.

Comment I have heard tonight different people give their biases. They blame somebody else for subjective judgement while they are drawing their own. In recent years have used a saying many times that I will repeat here. It applies to these costs analyses and comparisons of alternatives and that is the assumptions drive the conclusions.

Response When assumptions were made in the EIS, every effort was taken to ensure that these assumptions were applied equitably among the alternatives to ensure comparability. Please refer to the response to Comment number 0005.03.

Comment Number 0059.02

James Jordan Associates

Comment A brief white paper entitled, A Comparison of BNL's Small Modular HLW Treatment System with a Large Central Melter System is attached in support of JJA's request to include the BNL concept in the EIS analysis. Finally, an economic analysis of the estimated costs of producing high-level radioactive glass using the Small Module Inductively Loaded Energy concept invented by BNL is attached to this request. JJA has formally requested that the BNL concept be developed for possible use at Hanford and other DOE sites.

Response Alternatives were developed that bound the full range of reasonable alternatives and reflect the results of the public scoping process for the EIS and discussed in Volume One, Section 1.2. Representative alternatives that incorporate the range of cost, human and ecological health risk, and technologies have been developed for analysis in the EIS. The alternatives in the EIS have been developed to bound the applicable alternative technologies, including the one proposed by the commentor. Because the EIS contains bounding alternatives that will be presented to the decision makers, no change has been made to the EIS. Please refer to the response to Comment numbers 0072.05 and 0072.79.

Comment Number 0062.02

Longmeyer, Richard

Comment My second comment is with regard to the privatization. I have some concerns with regard to safety issues, as well as issues such as water quality issues. Both groundwater, and the Columbia River. The question is will the private contractors treat groundwater and the Columbia River with the same care that the government has been mandated to treat it, under the Tri-Party Agreement? Will they hold to the same safety guidelines, or perhaps better guidelines, that would be something that I would be interested to know.

Response Privatization is not within the scope of the EIS, as discussed in Volume One, Section 3.3 on page 3-13 of the Draft EIS, because it is a contracting mechanism. Under this concept, DOE would competitively bid a portion of the remediation work instead of having the Site Management and Operations contractor perform the work. Equivalent requirements for retrieval, treatment, and disposal of the waste, as well as quality and performance verification, would apply regardless of how DOE contracts to perform the remediation. Please refer to the response to Comment numbers 0009.19, 0060.02, and 0076.03.

Comment Number 0072.15

CTUIR

Comment It is difficult to follow the constituents through the various processes and into the environment. A mass balance showing distribution of the constituents for the tanks into various waste forms, effluents, and the environment would be helpful.

Response The detailed technical data developed to assess the environmental impacts of the alternatives addressed in the EIS are contained in referenced technical documents and calculations. The technical data are available for public review as a part of the TWRS EIS Administrative Record and in DOE Reading Rooms and Information Repositories. A mass balance for each of the waste treatment alternatives was completed in order to estimate the off-gas and liquid effluents. These off-gas and effluents streams then were used as sources in the risk assessment analysis. The human and ecological health effects from these off-gas and effluent streams are addressed in Volume One, Section 5.11. The TWRS EIS is a lengthy document and the inclusion of the detailed conceptual engineering information into the EIS would greatly lengthen the document. DOE and Ecology must balance the need to present relevant supporting data against the need to have a manageable and understandable document. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.196

CTUIR

Comment P B-166: Sect. B.7.1: It is noted that the evaluation for potential sites does not indicate that the affected Tribes were not notified or consulted with. If they were, please produce references, if they were not, please contact technical representatives of the affected Tribes.

Response The Draft EIS identifies in Volume Two, Section B.7 that the final site selection for the facilities associated with the ex situ alternatives has not been made. The potential site locations indicated in the EIS were taken from Hanford Site studies that examined potential site locations for the treatment facilities required for tank waste remediation and are included as examples for calculation of environmental impacts. The identification of these sites, within the 200 Area Waste Operations areas, is consistent with the Hanford Site Development Plan and the recommendations of the Hanford Tank Waste Task Force. As indicated in Volume One, Section 5.20, before to any ground disturbance activities, consultations would be conducted with the DOE Richland Operations Office Historic Preservation Officer, the Hanford Cultural Resource Laboratory, Washington State Historic Preservation Officer, and concerned Native American Tribal groups and governments. Consultation with Tribal Nations groups and governments would be performed early in the planning process to determine areas or topics of importance to these groups such as religious areas and potential resources of medicinal plants. Please refer to the response to Comment number 0072.149 for a discussion of the Tribal Nation consultation process for the TWRS EIS. Please refer to the response to Comment numbers 0019.03, 0072.235, 0072.50, and 0101.06 for related borrow site and closure information.

Comment Number 0072.236

CTUIR

Comment P E-202: Sect. E.10.2: Although not clearly stated, this appears to be the preferred alternative. Please confirm. Additionally, it appears that the only alternative for MUSTs involves filling them with grout (sand, gravel and cement). As we have stated on several prior occasions, the selection of an alternative that results in irretrievable waste forms may be unacceptable.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. There has been no attempt in the accident analyses or at the location referenced in the comment to identify any alternative as the preferred alternative. The preferred alternative is identified in the Summary, Section S.7 and Volume One, Section 3.4. For the ex situ alternatives, the MUST waste would be retrieved and only the residual left in the tanks would be grouted. Grouting of the MUST was included in the analysis to facilitate a balanced comparison of the alternatives. Closure of the MUSTS, like closure of the tank farms, will be the subject of future NEPA analysis. For each of the alternatives presented in Volume One, Section 3.4 and Volume Two, Appendix B, remedial actions for MUST waste are described. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0083.01

Pollet, Gerald

Comment Hanford's Dangerous Nuclear Waste Tanks

They can explode! They do leak! Leaked waste will poison the Columbia River! So why does the U.S. Department of Energy want to consider leaving 75 percent of the waste in the tanks forever? Is this your idea of clean-up?

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The EIS includes an analysis of potential accidents, including explosions, in Volume One, Section 5.12 and Volume Four, Appendix E. Past tank leaks are discussed in Volume One, Section 5.4.2. A discussion of the potential cumulative impacts of past tank leaks and the TWRS alternatives is provided in Volume One, Section 5.13 and Volume Four, Appendix F. The regulations (40 CFR 1500 to 1508) that implement NEPA requirements that an EIS address the full range of reasonable alternatives. For the TWRS EIS, the full range of reasonable alternatives was determined to range from leaving all of the waste in the tanks to retrieving as much of the waste as practicable (assumed to be 99 percent) and alternatives that fall between these two extremes. The DOE and Ecology preferred alternative is to retrieve 99 percent of the waste to the extent technically practicable. Please refer to the response to Comment numbers 0072.05 and 0009.01.

Comment Number 0085.03

Klein, Robin

Comment In the mean time we're calling for funding to develop real solutions. Not just for Hanford tank wastes, but to address soundly the global problem of disposing of dangerous radioactive materials worldwide. At the same time we're being asked to comment on TWRS. I'm going on a slight tangent here on purpose. We're also being asked to comment on the PEIS for disposition of weapons usable fissile materials nation wide. There we are faced with the ominous alternative, possibility of processing the worlds stores and reactors, with the likelihood that this could occur at Hanford. I hope that in parallel, with comments on what to do with the tank wastes, we don't lose sight of the pressure mounting to fire up reactors once again along the Columbia River. This is a non-solution to a problem, for which there is no good solution. Maybe if just a fraction of the dollars that were spent on developing those horrific weapons were spent on coming up with a permanent real solution, funding those great minds at the labs in Los Alamos Sandia, we'd probably stand a chance, and I believe we would. After all, that stuff's going to be around a while one way or another. But don't revive a failing nuclear industry at the price of health and safety of our futures.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. Congressional funding issues are not included in the scope of this EIS. However, Volume One, Section 5.13 (Cumulative Impacts) addresses actions at other DOE sites and programmatic actions that could impact the Hanford Site, actions adjacent to the Hanford Site, and planned or reasonably foreseeable DOE actions at the Hanford Site.

L.4.0 AFFECTED ENVIRONMENT

L.4.1 GEOLOGY

Comment Number 0072.124

CTUIR

Comment P 4-3: Sect. 4.1 Geology: This section is missing a table depicting the Ringold formation.

Response The Ringold Formation is shown in Figures 4.1.3 and 4.1.4 and described in Section 4.1.3. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.125

CTUIR

Comment P 4-4: Fig. 4.1.1: Depressions are typically mapped by a closed end line with comb-like tooth projections pointing towards the depression, not as shown in this figure.

Response The closed line comb-tooth symbol is considered standard nomenclature for depicting a depression. The nomenclature used in the figure was adopted from a report on the geology of the Hanford Site (Lindsey 1992) and communicates the feature accurately. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.126

CTUIR

Comment P 4-7: PP 1: S 3: What direction are the fluvial sediments deposited, where is the figure depicting the direction of these sediments?

Response The direction of deposition of the fluvial sediments is not germane to the analysis of impacts and was therefore not included in the discussion. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.127

CTUIR

Comment P 4-9: PP4: S 5: What contamination exceeds which levels?

Response Radiological control areas are those areas where contaminants exceed natural background levels. Generally, the contaminants that exceed background levels are discussed in the sentences that proceed the referenced text in Volume One, Section 4.1 and in Appendix I. More detailed discussions are available in the source documents for this information, which are referenced in the EIS and available for public review in the DOE Reading Rooms and

Information Repositories.

Comment Number 0072.128

CTUIR

Comment P 4-10: Sect. 4.1.5: Where are the references for these potential borrow sites?

Response The information concerning the potential borrow sites was obtained from the Site Evaluation Report for Candidate Basalt Quarry Sites, Bechtel Hanford Incorporated, February 1995. This reference was added to Volume One, Section 4.1.5.

Comment Number 0072.129

CTUIR

Comment P 4-10: Sect. 4.1.6: Please explain the stress regime for the fold belts indicated here in relation to the Cascadia subduction zone.

Response The stress regime of the Yakima Fold Belt is discussed in Volume Five, Section I.1.6.2. Because the geotechnical data presented in Volume Five, Appendix I is sufficient to support the EIS analysis of the seismicity, no further discussion is warranted.

Comment Number 0072.130

CTUIR

Comment P 4-10: Sect 4.1.6: PP2: Where is the diagram indicating the epicenters of these quake swarms? Please indicate a possible cause. Figures showing historical and recent seismicity of the Columbia Plateau are provided in Volume Five, Appendix I.

Response Earthquake swarms can occur at any location and their cause is not understood. They are not associated with known faults. Figures showing historical and recent seismicity of the Columbia Plateau are provided in Volume Five, Section I.1.6.

Comment Number 0089.20

Nez Perce Tribe ERWM

Comment Page 4-10, Paragraph 4

Not all earthquake sources are mentioned in this EIS, and Probabilistic Seismic Hazard Analysis DOE Hanford Site, Washington, WHC-SD-W236A-TI-002, Revision 0, by Geomatrix Consultants should be referenced. Large earthquakes occurring on the Cascadia Subduction Zone pose a threat to the tanks and should have been considered in this EIS. Also, there is more than one earthquake swarm area located within the boundaries of the Hanford Site.

Response As stated in Volume Four, Section E.1.4, seismic scenarios were being studied by DOE and Ecology when the Draft EIS was published. The scenarios have been incorporated into the Final EIS in Volume Four, Appendix E. The hazard curves referenced in WHC-SD-W236A-TI-002, Rev. 1, were incorporated into the analysis. Please also refer to the response to Comment number 0072.130.

L.4.2 WATER RESOURCES

Comment Number 0072.131

CTUIR

Comment P 4-11: Sect. 4.2: Which contaminants that are not within the scope of this EIS.

Response The contaminants in the vadose zone, groundwater, and surface water due to past releases are not within the scope of this EIS. The EIS does present data regarding these contaminants in Volume One, Section 4.2. This information has been modified in the Final EIS to include data regarding vadose zone contamination that was unavailable when the Draft EIS was published. These new data are also addressed in Volume Six, Appendix K. Cumulative impacts are discussed in Volume One, Section 5.13 and Volume Four, Appendix F.4.5. Please also refer to the response to Comment numbers 0072.08, 0012.01, and 0012.15 for issues related to vadose zone contamination and closure.

Comment Number 0072.132

CTUIR

Comment 4-12: Sect. 4.2.2: It is indicated that the confined aquifers are not likely to be impacted, please justify this statement.

Response Interconnection between the unconfined and lower confined aquifer is possible across the Central Plateau. However, except for the area near the erosional windows that occurs in the basalt several kilometers north of the 200 East Area and B Pond vicinity in the 200 East Area, there is no indication of aquifer interconnection. Groundwater mounding from discharges from B Pond have resulted in a substantial downward hydraulic gradient in this area. Groundwater mounding associated with B Pond are anticipated to greatly diminish by the time there are any releases from the TWRS facilities. The assertion that the confined aquifer is likely not impacted by TWRS alternatives is based on the TWRS facilities being separated from the confined aquifers by the vadose zone, unconfined aquifer, and confining layer(s) that are generally present in the lower portion of the unconfined aquifer, in addition to the reduction of downward hydraulic gradient in the vicinity of B Pond as discharges to the pond are reduced and eliminated. Please refer to the response to Comment number 0045.04 for a discussion of the text related to this issue that has been added to the Final EIS.

Comment Number 0072.133

CTUIR

Comment P 4-12: Sect. 4.2.2: Bullet 3: an overbank deposit is not necessarily laterally continuous; please indicate how these overbank deposits act as confining layers.

Response Overbank deposits are not necessarily laterally continuous; however, their presence, in conjunction with other relatively low-permeability sediments, combine to form a confining layer at the base of the unconfined aquifer, except as noted in the vicinity of an erosional window several kilometers north of the 200 East Area. Please refer to the response to Comment numbers 0072.132 and 0045.04.

Comment Number 0072.134

CTUIR

Comment P 4-14: PP 1: Please indicate how the groundwater flux influences the local groundwater north of the 200 West area.

Response The potential influences to the local groundwater north of the 200 West area due to waste water from the Effluent Treatment Facility will cease before tank waste releases addressed in this EIS reach groundwater for any of the alternatives. Please refer to the response to Comment number 0012.16. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.135

CTUIR

Comment P 4-15: Sect 4.2.2.4: In this section its indicated that the NW corner of the 200 West area that groundwater flows northward. Please indicate how the treated waste water from the affluent treatment facility impacts the ground water movement in this area.

Response Please refer to the response to Comment number 0072.134, which addresses the same issue, and the response to Comment number 0012.16 for a related discussion of groundwater flow modeling.

Comment Number 0072.136

CTUIR

Comment P 4-18: PP2: Please indicate more clearly how the downward hydraulic gradients affect the local groundwater movement.

Response The potential effects of downward hydraulic gradients in the unconfined aquifer in the vicinity of B Pond will cease or be greatly reduced before tank waste releases occur for any of the alternatives. Consequently, these potential impacts are not germane to the analysis of impacts and are not included in the discussion. Please refer to the response to Comment numbers 0072.13, 0072.138, 0072.259, 0045.04, and 0089.23 for related discussions regarding B Pond.

Comment Number 0072.137

CTUIR

Comment P 4-18: Sect. 4.2.3: PP 3: Can you supply a figure indicating the relative levels that are consistently detected that are of Hanford origin?

Response Provided in this section are the current water quality and supply information. Relative levels of contaminants in the affected environment between Hanford and non-Hanford sources are not germane to the analysis of impacts and are therefore not included in the discussion. The two must be assessed together to provide a meaningful analysis. Any concentrations of radionuclides above background levels are assumed to come from the Hanford Site.

Comment Number 0072.138

CTUIR

Comment P 4-18: PP 4: Although the B pond is not used for human consumption today, it is still open to access from animals in the environment. Do the samples exceed chronic aquatic levels?

Response There is no indication that the TWRS alternatives would affect or be affected by B Pond. Thus, chronic aquatic (contaminant) levels in B Pond are not within the scope of this EIS.

Comment Number 0072.139

CTUIR

Comment P 4-21, 4-22, 4-23: The distributions of tritium, iodine-129, and nitrate are drawn with lines indicating a high level of certainty. Is there a figure indicating the depth of these distributions?

Response Typical monitoring well construction on the Site requires that the monitoring wells be screened from about 10 feet above the water table to 20 feet below the water table. The distributions of tritium, iodine-129, and nitrate are based on data from these wells and are assumed to represent concentration levels in the upper 20 feet of the unconfined aquifer. There are no known references that contain figures indicating the depth or vertical distribution of contaminants.

L.4.2.1 Surface Water

No comments were submitted or this topic.

L.4.2.2 Groundwater

Comment Number 0045.01

DiGiromlamo, Linda Raye

Comment Page 4-12. Section 4.2.2, third bullet: Vertical gradients in some parts of the 200 Areas are downward from the unconfined aquifer to the confined aquifer. Therefore, assuming the mud and overbank materials are not completed impermeable, some movement of water from the unconfined to the confined aquifers is probable. Also, there have been some indications of "contaminants" in wells tapping the confined aquifer. This should be discussed in the Final EIS.

Response Please refer to the response to Comment number 0045.04.

Comment Number 0045.04

USDOI

Comment Page 4-15. Section 4.2.2.3, last paragraph, fourth sentence: The Draft EIS states that erosional windows "allow some interconnection" between the unconfined and confined aquifer. It would be more accurate to state in the Final EIS that some interconnection is possible everywhere and that the erosional windows enhance the degree of connection.

Response The following statements were added to the text of the EIS in Volume One, Section 4.2 and Volume Five, Appendix I. Interconnection between the unconfined and lower confined aquifer is possible across the Central Plateau; however, except for the area near the erosional windows that occur in the basalt several kilometers north of the 200 East Area and B Pond vicinity in the 200 East Area, there is no indication of aquifer interconnection. In the vicinity of B Pond, groundwater mounding from discharges from B Pond have resulted in a downward hydraulic gradient. Several kilometers north of the 200 East Area, there is an absence of confining layer(s) associated with an erosional window which has results in enhanced interconnection of the aquifers in this area. Please also refer to the response to Comment numbers 0072.132 and 0072.133.

Comment Number 0053.03

Carpenter, Tom

Comment More recently, we hear that cesium could possibly be heading toward the ground water that is in the vadose zone underneath the tanks. This is an interesting finding because five years ago, John Brodeur, who is a geophysicist out there, was trying to get the attention of the Hanford officials saying you need to do better in monitoring the vadose zone and the soil underneath the tanks and eventually he lost his job but managed to be put back into Hanford under the auspices of another contractor, Rust Geotech, which ended up doing the type of state-of-the-art modeling that, in fact, showed in December of 1995 that there could be a problem with cesium 125 feet down in the vadose zone, which is a lot further than led to be believe the cesium would ever travel. It is a very significant environmental finding and yet the public was not told about the cesium possibilities until mid February and then only reluctantly and I wonder why that is.

Response In the Draft EIS in Volume One, Section 4.2 and Appendix I, vadose zone contamination beneath the tank farms was described, and in Volume One, Section 3.3 the emerging data on the extent of migration in the vadose zone were discussed. Appendix K includes a discussion of potential transport mechanisms that may result in the contaminant migration. Please refer to the response to Comment numbers 0030.02, 0012.15 and 0009.01 for discussion regarding the emerging data and how that data are addressed in the Final EIS.

Comment Number 0072.258

CTUIR

Comment P I-23: Sect. I.2.2.2.2: Indicating that perched water may occur in the West Area, is an indicator of the large amount of uncertainty involved with predicting subsurface structures. This section should also include the language that calcite layers may also occur under the East Area as well.

Response DOE and Ecology acknowledge the uncertainty involved with predicting subsurface structures. Caliche layers, which are often associated with perched water in the vadose zone, could occur in other areas including the 200 East Area. Based on limited information from boreholes in both the 200 East and 200 West Areas, it is likely that caliche layer(s) would be encountered in the 200 West Area and much less likely that they would be encountered in the 200 East Area. Volume Five, Appendix I has been modified to indicate perched water is possible in the 200 East Area, but not as likely as the occurrence in the 200 West Area. A discussion regarding the emerging data on vadose zone contamination is provided in Volume Five, Appendix K.

Comment Number 0072.259

CTUIR

Comment P I -23: Sect. I.2.2.2.3: Areas where substantial amounts of liquid may affect vadose zone saturation characteristics, such as near the B Pond should be part of the uncertainty analysis. This does not seem to be the case. Please indicate why this fact was seemingly overlooked.

Response The liquids from B Pond were not overlooked in the EIS. This issue goes beyond those expressed in the comment and includes other potential effects on the saturated zone. The 1979 groundwater levels on which the impact analysis is based represents a point in time where the B Pond groundwater mound was at a high level, higher than would be expected for the future given the decrease in waste-water discharges to the pond and its ultimate closure. This results in a conservative vadose zone impact assessment (i.e., faster contaminant transport in the vadose zone) because the vadose zone saturations are high and vadose zone thickness is less than would be expected without the mound. Another major concern relating to B Pond is the effect of the groundwater mound on groundwater gradient direction and magnitude. As pointed out in the Draft EIS, Volume Four, Section F.4.3.5, Site predevelopment water levels, as represented by a hindcast (estimates of water levels and flow directions that existed before the Hanford Site was constructed) and predicted future water levels for the year 2040, compare favorably with the groundwater levels from the year 1979 on which the impact analyses are based. Volume Four, Appendix K of the Final EIS contains predictions of the future groundwater flow directions after all of the groundwater mounds caused by past practice activities are gone. This analysis validates the flow direction calculated for the EIS impacts. Discussions of uncertainties have been expanded in the Final EIS and are now presented in Volume Five, Appendix K. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.261

CTUIR

Comment P I-34: Sect. I.2.3.2: Existing groundwater contamination should also be part of the EIS evaluation, since the tank leaching will add to what is already there, and both of these contribute to risk.

Response Existing groundwater contamination is discussed in Volume Five, Appendix I and Volume One, Section 4.2. Potential cumulative impacts are discussed in Volume One, Section 5.13 and Volume Four, Section F.4.5. Existing groundwater and soil contamination is not within the scope of this EIS, but will be addressed in a future NEPA analysis on tank closure. Please refer to the response to Comment numbers 0012.15, 0030.02, and 0072.08 for more information related to this issue.

L.4.2.3 Water Quality and Supply

Comment Number 0072.260

CTUIR

Comment P I-23: Sect. I.2.2.2.4: Contaminants are listed, but concentrations and total mass are not listed. Why was this information included at all if existing contamination is not used in the EIS? Even though TWRS does not claim ownership of the contaminated soil, it should be part of the analysis since all of the tank leaching will be pushing this contamination into the groundwater.

Response Records on the inventory of past practice waste disposal are sparse. The list of contaminants in Volume Five, Table I.2.2.1 was provided to give an indication of waste disposal. Volume Four, Section F.4.5 and Volume One, Section 5.13 address potential cumulative impacts associated with past practice waste disposal and past leaks from the tanks. Included in this section is information on the quantity of the high-risk contaminants carbon-14, iodine-129, technetium-99, and uranium. The contaminants in the vadose zone from past tank leaks are not within the scope of this EIS, and will be addressed in future NEPA analysis for tank closure. The remediation plan will address vadose zone and groundwater contamination within the context of tank farm closure alternatives. Emerging information indicates that some contaminants such as cesium, potentially from past tank leaks, are 100 feet or more below the tanks. The potential mechanisms for this transport are discussed in the EIS in Volume Five, Appendix K.

For most of the TWRS remediation alternatives, the liquid fluxes (the driving force that could push existing contaminants deeper), either from infiltrating precipitation or combined with releases from the tanks, would be at or far less than current liquid fluxes due to infiltration and the fluxes associated with past leaks. It is only for ex situ alternatives, during the waste retrieval sluicing period, that the liquid flux would increase. During the retrieval period, the liquid flux would increase from 1.4E-5 m/day to a total of 2.1E-5 m/day. Following retrieval, there is a 14-year cap construction period where the infiltration would be approximately 1.4E-5 m/day. The cap is calculated to reduce total infiltration to 1.4E-6 m/day for a nominal 1,000-year period. Please refer to the response to Comment numbers 0012.15, and 0030.02 for additional information concerning existing contamination in the vadose zone and 0005.17 and 0072.08 for a discussion of the reasons for not including closure in the EIS.

L.4.3 METEOROLOGY AND AIR QUALITY

Comment Number 0072.140

CTUIR

Comment P4-26: PP 2: Because the Hanford Site is classified as a major source of hazardous air pollutants, what portion of these pollutants is expected to be produced by TWRS activities?

Response The cumulative impacts of ongoing and reasonably foreseeable new Hanford activities, including TWRS, are presented in Volume One, Section 5.13. Ongoing Hanford operations would include the current impact of tank farm emissions, and the TWRS alternative would include new or increased tank farm emissions postulated to result from implementation of the alternative. Please refer to the response to Comment number 0072.243. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.262

CTUIR

Comment P I-41: Sect. I.3.2.2: The statement is made that DOE has applied for a Sitewide Air Operating Permit for the Hanford Site; we expect to see the Vitrification Plants, EMSL, LIGO, and all other sources included.

Response The Hanford Sitewide Air Operating Permit will include all Hanford facilities within DOE oversight that have a stack or vent point, unless determined to be insignificant emission units, as defined in WAC 173-401. Volume One, Section 6.0 indicates that air emission permits are among the permits DOE will need to have modified or initiated depending on the alternative selected in the ROD.

L.4.4 BIOLOGICAL AND ECOLOGICAL RESOURCES

Comment Number 0012.18

ODOE

Comment Figure I.7.2.1 on page I-90 of Volume Five is flawed. It claims areas outside the 200 Areas for waste operations. The Future Site Uses Working Group recommended use of the 200 Areas as needed for waste operations and only such additional areas between the 200 Areas as was required. The working group included a buffer around this area for protection of the public. The figure also fails to identify the mature shrub-steppe habitat as sensitive areas south of the 200 Areas. This habitat is identified by the State of Washington as needing special protection.

Figure I.7.2.2 on page I-92 of Volume Five claims a large section of the center of the Site for waste operations. This proposed area contains the bulk of the mature shrub-steppe habitat remaining on the Site. The area indicated is far larger than indicated by the working group. There is no approved future land use map of the Hanford Site. This figure and references to it need to be removed from the document.

Response Volume Five, Figure I.7.2.1 shows existing Hanford Site land uses and is adapted from the Hanford Site Development Plan issued by DOE in 1993. The figure is not intended to show biological information such as sensitive habitats. Vegetation types in the TWRS areas are shown in Volume Five, Figure I.4.2.1.

Volume Five, Figure I.7.2.2 is also adapted from DOE's 1993 Hanford Site Development Plan. The area shown for waste operations in the figure represent DOE's 1993 vision of future Site land uses based on existing and future Hanford Site missions. As stated in the comment, and noted in Volume Five, Figure I.7.2.1 and in Section I.7.2, there currently is no official approved land use map for the Site. The Hanford Site CLUP, currently in preparation, will provide an official DOE vision of future Site land uses. The Hanford Site Development Plan material is included in the EIS to provide an indication of the DOE vision of future land uses in the absence of an official land use plan. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0019.05

WDFW

Comment Significant adverse affects to wildlife will occur if the McGee Ranch is impacted from projects such as the Environmental Restoration Disposal Facility and TWRS. These projects are citing the McGee Ranch as a borrow site for silt loam soil. Cumulative demands for this silt loam soil exceed the resource. The existing Priority Habitat and value as a wildlife corridor will be lost. WDFW has requested USDOE to protect and preserve this parcel of land as a wildlife corridor between the two largest contiguous tracts of shrub-steppe in the State of Washington (letter dated April 5, 1996 from Martin Baker, Assistant Director, Washington Department of Fish and Wildlife to John Wagoner, Manager, U.S. Department of Energy-Richland Operations, see enclosure).

Response The potential borrow sites identified in the EIS would not be selected to support borrow needs of the EIS alternatives based on the analysis in this EIS. These sites were identified to inform the decision maker of potential impacts associated with each of the alternatives should the representative closure option presented in the EIS be implemented. However, just as the EIS will not support selection of borrow sites, it will not support decisions associated with closure. The Draft EIS states in Volume One, Section 5.4 that use of the McGee Ranch borrow site would adversely affect an important wildlife corridor. The EIS was modified to note the Washington Department of Wildlife April 5, 1996 request to DOE to preserve this land as a wildlife corridor. Please refer to the response to Comment numbers 0072.08, 0101.05, and 0019.03 for discussion related to closure and borrow sites.

Comment Number 0019.08

WDFW

Comment Page 4-28, second paragraph. The Nature Conservancy has discovered 20 new species on the Hanford Site. Two plants and eighteen insects. Please revise your statement and elsewhere (e.g., I.4.1, I.4.3.4, etc.).

Response The EIS was updated in Volume One, Section 4.4 and Volume Five, Appendix I to note the Nature Conservancy's discovery of 20 new species on the Hanford Site.

Comment Number 0019.09

WDFW

Comment Page 4-28, section 4.4.2, second paragraph. The National Biological Service has listed native shrub and grassland steppe in Washington and Oregon as an endangered ecosystem (referenced earlier in this document). Please include this statement within the description of vegetation of the site, and elsewhere in the document (e.g., summary I.4.0, I.4.2., etc.).

Response The EIS was modified in Volume One, Section 4.4 and Volume Five, Appendix I to include the statement that the National Biological Service has listed native shrub and grassland steppe as an endangered ecosystem in Washington and Oregon.

Comment Number 0019.10

WDFW

Comment Page 4-52, 4.7.1.2. Washington Department of Fish and Wildlife administers the Wahluke Wildlife Recreation Area. Please correct statement.

Response The EIS was modified in Volume One, Section 4.7 and Volume Five, Appendix I to indicate that the WDWF administers the Wahluke Wildlife Recreation Area.

Comment Number 0019.11

WDFW

Comment Page 4-54, Section 4.7.3, first bullet. WDFW is not aware of any State natural resource agency which has submitted a proposal for the Arid Land Ecology Reserve. Please delete the words "Washington State."

Response The words "Washington State" were deleted from the referenced text in Volume One, Section 4.7.

Comment Number 0019.21

WDFW

Comment Page R-11, Fitzner 1992. The letter written by L. Fitzner appears on Washington Department of Wildlife letterhead. Please correct the name of the agency.

Response The EIS was modified to identify the referenced document.

Comment Number 0019.22

WDFW

Comment Page I-1, section I.1.0, first paragraph, last sentence. Duranceau's report does not adequately evaluate potential borrow sites for soil or gravel nor does it adequately evaluate the impacts to wildlife at basalt sites. Thus, adequate NEPA documentation has not occurred.

Response The Duranceau report (Duranceau 1995) was not intended to represent NEPA documentation for TWRS borrow site use decisions. The report was prepared as part of the process of evaluating potential borrow sites for eventual TWRS program use. The TWRS EIS also does not provide NEPA documentation with respect to borrow site use because decisions regarding closure activities, during which most TWRS borrow site impacts would occur, cannot yet be made. Closure is not included in the scope of the TWRS EIS. Additional NEPA evaluations of the environmental impacts associated with closure and borrow site issues, such as potential habitat destruction, cultural resources, site-wide planning, and cumulative impacts, will be evaluated in future NEPA documents. The selection of borrow sites will be made after extensive evaluation of prehistoric, historic, and cultural significance. Please refer to the response to Comment numbers 0072.08, 0019.03, 0101.05, and 0072.263 for discussions related to closure and borrow sites. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0019.23

WDFW

Comment Page I-44, section I.4.2, second paragraph, fourth sentence. WDFW disagrees with this statement. Cheatgrass provides less than fifty percent cover when woody and native herbaceous species are combined.

Response The EIS was modified in Volume Five, Appendix I to delete the statement that cheatgrass provides more than 50 percent of the vegetative cover in the Central Plateau vicinity.

Comment Number 0072.141

CTUIR

Comment P 4-27: Sect. 4.4.1: Biodiversity is also the buffer which keeps the ecosystems from upheaval.

Response Volume One, Section 4.4.1 has been modified to indicate that biodiversity provides a moderating effect on wide fluctuations in environmental conditions. Different plant and animal species respond differently to changes in environmental conditions. Ecosystems with higher levels of biodiversity are likely to experience less overall disruption as a result of events such as climatic changes, floods, or fires.

Comment Number 0072.142

CTUIR

Comment P 4-28: PP3: The recently discovered nine new plant/insect species on the Hanford Site is actually an indication of the amount of unrecorded biodiversity.

Response The EIS acknowledges in Volume One, Section 4.4 and in Volume Five, Appendix I that the discovery of new plant and insect species on the Hanford Site indicates the biodiversity of the Site. The ecological resources of the Hanford Site have been studied extensively. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the response to Comment number 0072.143.

Comment Number 0072.143

CTUIR

Comment P 4-30: PP 1: What was the amount of error associated with the biological surveys in relation to survey coverage, mis-identification, and were any of the nine newly recorded species found in these areas?

Response The Nature Conservancy study was a multi-year effort that focused only on the North Slope, the Fitzner Eberhardt Arid Lands Ecology Reserve, and along the Columbia River. Although the study was intensive, the possibility remains that additional species could be discovered in the same areas in the future.

The Nature Conservancy did not study any of the potential TWRS areas. None of the new species were found in potential TWRS areas. Pacific Northwest National Laboratory (PNL) and the WDFW are beginning studies that might identify additional previously unknown species in areas of the Site not studied by the Nature Conservancy. PNL biological specialists indicate that, while new species conceivably could be found anywhere, the potential Vernita Quarry borrow site is the most likely location for new species of the various potential TWRS sites. This is because Vernita Quarry is part of the Umtanum Ridge area where new species have been recorded in the past. The McGee Ranch area is less likely to contain newly discovered species than Vernita because McGee Ranch is partly disturbed by past agricultural use. The Central Plateau, where all other potential TWRS sites are located, is the least likely area for new species (Brandt 1996).

Comment Number 0072.144

CTUIR

Comment P 4-30: PP 4: Elk have also been sighted on islands and along the Columbia river.

Response The EIS has been modified in Volume One, Section 4.4 and Volume Five, Appendix I to indicate that elk reportedly also have been sighted on the islands and along the Columbia River. The presence of elk along the Columbia River and on the islands would not affect the analysis of TWRS alternatives' impacts because potential TWRS sites are 11 km (7 mi) or more from the river.

Comment Number 0072.145

CTUIR

Comment P 4-30: PP 5: S 2: The subjective use of the word 'near' is confusing, how far away is 'near'?

Response In this context, "near" is considered to be habitats occurring within 1 km (0.6 mi) of any TWRS site.

Comment Number 0072.146

CTUIR

Comment P 4-31: S 4.4.4: Sensitive habitats also occur in the undisturbed shrub steppe.

Response The term "sensitive habitats" in Volume One, Section 4.4 refers only to wetlands and riparian habitats. There is no intention to imply that undisturbed shrub-steppe does not include habitat areas that can be considered "sensitive" to disturbance.

Comment Number 0072.147

CTUIR

Comment P 4-31: S 4.4.5: If the Pipers Daisy, a Washington State sensitive species has been found at the potential Pit-30 Borrow Site, What plans are there for mitigation and for increased surveys regarding this, also, this plant and potentially many other sensitive species were not mentioned in the Eco-Risk section.

Response Future NEPA documentation for TWRS closure activities, the phase of the TWRS program during which most borrow site activities would occur, would require additional site-specific biological surveys. While specific mitigation measures have not yet been determined for impacts associated with decisions that will be supported by the TWRS EIS, these measures will be addressed in the Mitigation Action Plan to be prepared after the TWRS Final EIS is completed. In general, as discussed in Volume One, Section 5.20 of the EIS, the principle of siting, configuring, and laying out facilities to avoid sensitive natural resources as much as possible would be a key element of a mitigation strategy. Additional potential mitigation measures that could be applied by DOE also are identified in Section 5.20. For additional information on closure and borrow site issues, please refer to the response to Comment numbers 0019.03, 0072.08, and 0101.05.

The analysis of chemical and radiological impacts presented in Volume One, Section 5.4 and Volume Three, Appendix D to biological and ecological resources considered a generic plant, as well as a number of wildlife species. Possible impacts considered to specific "sensitive" plant species were no greater than the low impacts expected on the generic plant analyzed.

Comment Number 0072.148

CTUIR

Comment P 4-32: PP 4: Please site where the reference is for the activities for the Native Americans written about here. Were the three affected tribes consulted regarding their activities, if so, please provide the references.

Response Hunn (Hunn 1990) was a primary reference for the material concerning Native American activities. Other references include Aiken (Aiken 1993), Devoto (Devoto 1953), and Irving (Irving 1976). Additional references are provided in Volume Five, Appendix I, Section I.4.6. Consultation with the affected Tribes occurred before publication of the Draft EIS. Additional consultation with these Tribes occurred subsequent to publication of the Draft EIS. The description of the affected environment (Volume One, Section 4.0 and Volume Five, Appendix I) and the environmental justice impact analysis (Volume One, Section 5.19) has been modified to reflect additional information (i.e., Native American natural and cultural resources, values, and perspectives) obtained through the consultation process. Please refer to the response to Comment numbers 0072.252, 0072.149, and 0012.19 for additional information on related topics.

Comment Number 0072.149

CTUIR

Comment P 4-32: PP5: Big game including elk and antelope were abundant on the Columbia Plateau, Bird species were an additional source of food. If the authors had followed the E.J. 12898 and consulted with the affected tribes instead of referencing HUNN, 1990, they would have been provided with appropriate information.

Response The EIS has been modified in Volume One, Section 4.5 and Volume Five, Appendix I to include additional information provided by affected Tribal Nations regarding big game on the Hanford Site. Affected Tribal Nations were consulted throughout the NEPA process as required by NEPA and the environmental justice Executive Order. This consultation process began in January 1994 with the publication of the Notice of Intent (FR 4250). In the Notice, DOE requested that "all interested parties submit written comments or suggestions concerning the scope of the issues to be addressed, alternatives to be analyzed, and environmental impacts to be addressed in the TWRS EIS." During the 45-day comment period from January 28, 1994 through March 15, 1994, comments were received from the public, agencies, and Tribal Nations. These comments were considered when preparing the Draft EIS. DOE's response to the comments and plan for preparation of the EIS in a manner responsive to the comments are documented in the Implementation Plan for the TWRS EIS (DOE 1995b).

During the preparation of the Draft EIS, DOE and Ecology initiated several meetings with representatives of Tribal Nations to inform them of progress on the preparation of the EIS and to solicit input regarding issues being addressed in the EIS. Meetings were held with representatives of one or more of the affected Tribal Nations in July, August, and September 1994; May, June, November, and December 1995; and May and June 1996. On four of these occasions, requests were made to the affected Tribal Nations to meet individually with DOE and Ecology representatives of the TWRS EIS project. Several of the meetings were follow-up meetings with individual Tribal Nation representatives to exchange technical information or to clarify requests for inclusion of data or analysis in the EIS.

In December 1995, DOE and Ecology issued formal consultation letters to all local, and Federal agencies and Tribal Nations with an interest in the Hanford Site. These consultation letters stated that "DOE requests formal consultation ... so that the Tribe can identify and comment on specific issues and concerns that it feels should be addressed in the TWRS EIS" (Draft EIS Volume Five, Appendix J).

On April 5, 1996, in advance of the April 12, 1996 start of the public comment period, DOE issued the TWRS Draft EIS to the affected Tribal Nations as part of the consultation process. DOE requested that the Tribal Nations review and comment on the Draft EIS and committed to consider those comments while preparing the Final EIS. Further, DOE and Ecology held one or more meetings with each of the affected Tribal Nations during and following the 45-day comment period on the Draft EIS to facilitate Tribal Nation review and comment on the Draft EIS and to exchange technical information.

Throughout the NEPA process, DOE and Ecology have been proactive in consulting with the affected Tribal Nations regarding the content of the TWRS EIS. Many substantive portions of the Draft EIS were the result of consultation with affected Tribes from scoping to the publication of the Draft EIS; a similar number of changes in the Final EIS reflect consultation following issuance of the Draft EIS for comment. Consultation is a valuable part of the NEPA process. As with any intergovernmental relationship, DOE and Ecology understand that the consultation process requires improvement and will continue to work with the affected Tribal Nations to that end. A proactive consultation process results in the meaningful exchange of technical information between both parties and a shared understanding of the challenges, issues, and concerns that the agencies and Tribal Nations face as they work to improve the environment of the Hanford Site. Please refer to the response to Comment numbers 0072.53 and 0072.252 for more information on this topic.

Comment Number 0072.150

CTUIR

Comment P 4-32: PP6: Once again, citing from HUNN, 1990 and Fortner 1994, is unacceptable for describing Native Activities on the Hanford Site. Please consult with the affected tribes regarding these issues.

Response The EIS has been modified in Volume One, Section 4.5 and Volume Five, Appendix I to include information provided by affected Tribal Nations concerning Native American activities on the Hanford Site. This information was secured following consultation with the affected Tribal Nations. Please refer to the response to Comment numbers 0072.53, 0072.149 and 0072.252 for more information on this topic.

Comment Number 0072.263

CTUIR

Comment P I-44: Sect. I.4.2: The potential borrow sites are not described as being very important ecologically; the descriptions are understated to such a degree that one would suspect that this is intentional. They are each located in important undisturbed or recovering shrub-steppe or corridor areas. The acknowledged Site value "Do no more harm during future actions" would clearly be violated if any of these locations is used.

Response Volume Five, Appendix I and Volume One, Section 4.0 of the EIS describe the affected environment that could potentially be impacted by TWRS alternatives. These sections also indicate that the potential borrow sites are in shrub-steppe areas, McGee Ranch is an important wildlife corridor, and shrub-steppe is classified as a priority habitat by Washington State because of the importance of this community-type to sensitive wildlife species. Volume One, Section 5.4 contains the analysis of the impacts of TWRS alternatives on the Hanford Site's shrub-steppe habitat and on McGee Ranch as a wildlife corridor. Volume One, Section 5.20 indicates measures that could be taken by DOE to mitigate these impacts. The information contained in the TWRS EIS will not support a decision on closure alternatives selected. Closure, and its associated borrow sites, will be evaluated in future NEPA documents. Please refer to the response to Comment numbers 0019.03, 0101.05, and 0072.08 for more information on closure and borrow sites.

Comment Number 0072.264

CTUIR

Comment P I-48: PP 1: There is no mention of mitigation of these treasured resources.

Response Volume Five, Appendix I and Volume One, Section 4.0 of the EIS describe existing conditions in the environment that potentially could be affected by the TWRS alternatives. Impacts to biological and ecological resources are discussed in Volume One, Section 5.4 of the EIS, and potential mitigation measures for these impacts are discussed in Volume One, Section 5.20.

Potential mitigation measures include siting and configuring TWRS facilities to minimize the amount of currently undisturbed land that would be affected by TWRS and revegetation with locally-derived native plant species. For areas of biological importance (i.e., shrub-steppe habitat) that cannot be avoided, compensatory mitigation could be implemented, which would focus on planting new sagebrush to replace mature plants that were unavoidably impacted. Specific mitigation sites, planting strategies (e.g., number, location, and plant density) and performance standards would be defined in the TWRS EIS Mitigation Action Plan that will be developed in coordination with various government agencies (e.g., WDFW and U.S. Fish and Wildlife Service) and with input from the Hanford Site Natural Resources Trustees Council. These mitigation measures may be most effective as part of the Sitewide Biological Resources Mitigation Plan that is planned for the Hanford Site. Please refer to the response to Comment numbers 0019.06 for more information on this topic.

Comment Number 0072.265

CTUIR

Comment P I-49: Sect. I.4.3.1: Insert 'Elk' after mule deer.

Response Volume Five, Section I.4.3.1 and Volume One, Section 4.4, have been modified to indicate that elk reportedly have been sighted elsewhere on the Hanford Site, although they occur primarily on the Fitzner Eberhardt Arid Lands Ecology Reserve.

Comment Number 0072.266

CTUIR

Comment P I-54: Sect. I4.6: PP 5: Ethnobiological resources (based on one published reference, one unavailable report, and one set of unpublished field notes, without *any* consultation with the affected tribes) also seem considerably understated. These references are *not* in the reading room, and should have been forwarded to the affected Tribes for consideration. Please provide us with a copy of the Fortner reference.

Response The requested materials were provided to the CTUIR on receipt of the request. Reports regarding cultural and natural resource surveys relative to Tribal Nation resources are not provided to the general public. However, Tribal Nation officials are provided access to these reports.

L.4.5 CULTURAL RESOURCES

Comment Number 0072.37

CTUIR

Comment Cultural resources were not described with any real understanding of Native American heritage, rights or concerns. The sparse description does not reflect the intended breadth of DOE and federal policy with respect to traditional cultural properties, and does not demonstrate an understanding of DOE responsibilities for natural and cultural trusteeship.

Response DOE and Ecology acknowledge the concern that the Draft EIS may not adequately reflect Native American views concerning their heritage, cultural and natural resources, values, and perspectives. Additional consultation has occurred with the affected Tribal Nations. The EIS has been modified in Volume One, Sections 4.4, 4.5, 4.8, and 4.9; Volume Five, Appendix I; and Volume One, Sections 5.4, 5.5, 5.8, 5.9, and 5.19 to provide additional material that more fully reflects Tribal concerns and perspectives. Please also refer to the response to Comment numbers, 0072.149, 0072.53, and 0072.252.

Comment Number 0072.38

CTUIR

Comment The basis for identifying natural resources of cultural importance was a single set of unpublished notes that were not forwarded to the CTUIR technical staff. No consultation whatsoever with CTUIR staff occurred during the preparation of this EIS.

Response The unpublished material referred to in the comment concerning natural resources of cultural importance has been provided to the CTUIR. Cultural surveys are not published to protect any cultural resources that may be present. Consultation with the affected Tribes that occurred during preparation of the Draft EIS is identified in Volume One, Section 7.0. Additional consultation with the affected Tribes occurred during preparation of the Final EIS. The Affected Environment section of the EIS (Volume One, Section 4.0 and Volume Five, Appendix I) and the Environmental Consequences (Volume One, Section 5.0) have been modified to reflect additional material obtained during the consultation process. Please also refer to the response to Comment numbers 0072.37, 0072.53, 0072.149, and 0072.252 for information related to consultation with the Tribal Nations within the EIS process.

Comment Number 0072.39

CTUIR

Comment The Environmental Justice Executive Order is ignored completely in this section.

Response Volume One, Section 4.5 describes the affected environments' cultural resources, which include prehistoric, historic, and ethnographic sites. Potential impacts on the affected environment are described in Volume One, Section 5.5. The assessment of whether the impacts identified represent an environmental justice impact (e.g., adverse and disproportionate impact to minority, Native American, or low-income populations) is presented in Volume One, Section 5.19, which complies with the environmental justice Executive Order 12898. For additional information on Tribal Nations consultations regarding TWRS EIS, please refer to the response to Comment numbers 0072.37, 0072.53, 0072.252, and 0072.149.

Comment Number 0072.40

CTUIR

Comment Sacred sites are clearly within the TWRS impact zone, as are cultural resources and natural resources of cultural importance. If any consultation at all had occurred, this error could have been avoided.

Response In Volume One, Sections 5.5 and 5.19 the EIS has been modified in response to this and other comments to indicate that specific cultural and natural resources of cultural importance to Tribal Nations would potentially be impacted by TWRS alternatives. Volume One, Section 5.8 (visual impacts) and Section 5.9 (noise impacts) have been modified to address concerns expressed by Tribal Nations that construction and operation of facilities in the 200 Areas under some TWRS alternatives would adversely impact Gable Mountain. Please refer to the response to Comment numbers 0072.154, 0072.252, and 0072.53 for information regarding changes to the EIS based on consultation with Tribal Nations. These modifications were made in response to Tribal Nation comments submitted on the Draft EIS, an important step in the consultation process. Please refer to the response to Comment number 0072.149 for information regarding Tribal Nation consultations. Extensive consultation was performed with the Tribal Nations during the preparation of the EIS. Please refer to the response to Comment numbers 0072.37, 0072.53, 0072.154, 0072.225, and 0072.252 for information regarding changes to the EIS based on consultations with the Tribal Nations.

Comment Number 0072.151

CTUIR

Comment P 4-34: PP1: Although the White Bluffs road has been fragmented by past contemporary activities it remains just as important to the affected tribes as any other cultural site within the Pasco Basin.

Response The EIS was modified in Volume One, Sections 4.5 and 5.5 and Volume Five, Appendix I to note that the White Bluffs Road is considered an important cultural site by the affected Tribes even though it has been fragmented by recent activities.

Comment Number 0072.152

CTUIR

Comment P 4-34: PP5: Please indicate how much Plutonium, and other hazardous materials were deposited to the environment from this "monument." A careful presentation of the historical facts would be appropriate here.

Response This section describes historical resources only. Information on environmental releases and impacts from the 105-B Reactor are outside the scope of the TWRS EIS and are not discussed in this EIS. No TWRS activities are proposed at or near the 105-B Reactor, nor would any activities at the reactor site have any impacts on the TWRS alternatives analyzed as part of this EIS.

Comment Number 0072.153

CTUIR

Comment P 4-35: Sect. 4.5.3: The first paragraph of this section must be deleted in its entirety. The information contained within this paragraph is not necessary as a component of the EIS. The sole justification for this paragraph appears to be to inject DOEs unsubstantiated legal opinions into the record for this document. This is not a legitimate reason to include a statement in an EIS. In addition, the CTUIR considers the core DOE opinion contained in this paragraph to be fallacious. In the CTUIRs opinion, federal law indicates that the U.S. Department of Energys Hanford Nuclear Reservation is, indeed, "open and unclaimed land" upon which, under the terms of the CTUIRs and the Yakama Indian Nations treaties of 1855, these Tribes have the right to hunt, gather plants and pasture livestock, should they so choose. Moreover, by appearing to make a distinction between the terms "right" and "privilege" as they appear in these Tribes' treaties, this paragraph promotes a legal position that has been rejected by the Washington Supreme Court and others.

It is inappropriate for this EIS to contain a paragraph that: 1) contributes nothing to the analysis and decisions being made in the EIS, 2) on its face is nothing more than a statement of legal opinion by a party that would have a great deal to gain from the adoption of that opinion, 3) is based upon debatable, misleading and/or inaccurate legal statements, and 4) which statements and opinions, if uncritically accepted, would severely injure the interests of sovereign tribal governments which the Department of Energy, as an agency of the federal government, has a fiduciary trust duty to protect. Paragraph one of Section 4.5.3. must be deleted in its entirety. Please contact CTUIR/SSRP staff directly concerning your response to this comment before completing the text of the final EIS.

Response The cited paragraph has been deleted from Volume One, Section 4.5, and a similar paragraph has been deleted from Volume Five, Appendix I, based on consultation with affected Tribal Nations.

Comment Number 0072.154

CTUIR

Comment P 4-35: Sect. 4.5.3: Although no *specific* religious Native American sites have been identified in the TWRS area of influence, it must be recognized that construction activities occurring during the cold war did not have cultural monitors. Also Gable Mountain is within the emergency reaction zones of the TWRS activities and this is a culturally significant religious site.

Response Many construction activities that occurred on the Hanford Site during the Cold War era did not have cultural monitors. Volume One, Section 5.8 indicates that activities conducted during implementation of all alternatives evaluated in this EIS would be visible from elevated locations (i.e., Gable Mountain, Gable Butte, and Rattlesnake Mountain). These locations are acknowledged as culturally important sites to Native Americans. Volume One, Section 5.19 has been modified based on additional consultation with the affected Tribes to indicate potential environmental justice impacts based on Tribal Nation cultural and natural resources values. Please refer to the response to Comment number 0072.37.

The direction from Recommendation for the Preparation of Environmental Assessments and Environmental Impact Statements, Office of NEPA Oversight, U.S. Department of Energy, Washington D.C., May 1993 (DOE 1993d) is to calculate the potential risk from accidents (e.g., the number of latent cancer fatalities [LCFs] from exposure to radiological constituents). The risk is not to be measured against risk acceptance guidelines, but against potential risks calculated in the other proposed alternatives.

Risk is measured against risk acceptance guidelines in safety analysis reports for operation and facility design. It helps provide guidance in establishing administrative and mechanical barriers to mitigate or prevent unacceptable accidents from occurring during final design activities. A discussion of potential accident and mitigation impacts on land use and access to sacred sites has been added to Volume Four, Appendix E. Please refer to the response to Comment number 0072.225 for a discussion of potential accident impacts on significant religious sites and other cultural resources.

Comment Number 0072.267

CTUIR

Comment P I-58: PP 4: The fish consumption rate of 59 g/d is not the correct number to use, nor is it 9 times the average rate for non-Native Americans (this statement also appeared in the original CRITFC report; the discrepancy is due to political disagreements between the EPA Water Quality and EPA CERCLA offices). Please consult with the CTUIR technical staff regarding this matter.

Response Additional consultation has occurred with the affected Tribes to obtain data for a Native American subsistence risk assessment scenario that has been added to the Final EIS in Volume One, Section 5.11 and Volume Three, Appendix D. This scenario includes information from the Tribes concerning Native American fish consumption. The Native American subsistence risk assessment scenario is discussed in the response to Comment number 0072.198. Volume Five, Appendix I has been revised to delete the fish consumption data.

Comment Number 0072.268

CTUIR

Comment P I-58: Sect. I.5.0: This section, like the others, is taken largely from other documents. The sentence: "The Hanford Site is *considered to be* a traditional homeland by many Native Americans" needs to read: "The Hanford Site is part of the original homeland of several Hanford Site Nations." The previous sentence ("The Hanford Site is of particular importance...") needs to be revised as follows: "The Hanford Site is of particular importance to Native Americans. Although no specific religious sites have been identified in the immediate vicinity of the tank farms, Gable Mountain is a traditional cultural property among many on the site that is only a short distance away, is within the visual disturbance range of the vitrification plant, and would be one of the highest impact areas due to airborne releases from the 200 Areas. Additionally, the groundwater itself as well as the Columbia River are also cultural resources that have been and will continue to be adversely impacted by past TWRS activities and all of the proposed alternatives. All natural resources are also cultural resources to indigenous peoples."

Response Volume Five, Section I.5.0, and Volume One, Section 4.5 have been modified to include information relating to Tribal Nation perspectives on cultural and ethnic resources. The Final EIS indicates that the Hanford Site is part of the original homeland of several Hanford Site Nations. The second sentence cited has been modified to add that all natural resources also are cultural resources to indigenous peoples and potential visual and air quality impacts may occur on Gable Mountain, and that groundwater and the Columbia River are also considered cultural resources by the affected Tribal Nations. Volume One, Sections 5.5 and 5.19 also have been modified to indicate potential environmental impacts based on Tribal Nations' cultural and natural resource values. Please also refer to the response to Comment numbers 0072.37, 0072.40, and 0072.140.

Comment Number 0072.269

CTUIR

Comment P I-62: Sect. I.5.3: The following sentence: "DOE has maintained the position that, for safety and security reasons, Hanford Site land uses are not compatible with exercising the privileges of hunting and gathering and pasturing and thus these lands are not considered open and unclaimed" does not reflect reality. It merely reflects the opinion of a few well-known DOE persons who consistently take such a minimalist approach to compliance as to be non-credible. Other DOE programs do, in fact, assume that Native American can and will exercise their treaty-reserved rights on Site, and are taking active measures to ensure that this can be done safely. The sentence quoted above must be omitted.

Response Please refer to the response to Comment number 0072.153 for information regarding the response to the treaty issue in the comment. For the purposes of analysis, the EIS assumes that institutional control would be maintained for 100 years. At the end of institutional control and for purposes of providing a baseline comparison for evaluating the alternatives contained in this document, the EIS assumes a variety of alternative land uses would be potential for the Hanford Site. This analysis, presented in Volume One, Section 5.11 and Volume Three, Appendix D, includes potential impacts associated with the land uses, such as Native American residential subsistence uses, residential farming, industrial worker uses, recreational shoreline users, and intruders. Please refer to the response to Comment numbers 0040.02 and 0101.01 for issues related to the 100-year administrative control period and to the response to Comment numbers 0072.154, 0072.37, 0072.225, and 0072.198 for issues related to remediation and post-remediation Site conditions and health risks.

Comment Number 0072.270

CTUIR

Comment P I-62: Sect. I.5.3: PP 4: While there may be no specifically identified sacred sites within 200E or 200W, there are most definitely sacred sites and traditional cultural properties within the TWRS impact area (i.e., downgradient in the groundwater and the River, and down-plume for airborne releases). There are many culturally important biota within this larger impact zone.

Response The EIS has been modified in Volume One, Section 4.5 and Volume Five, Appendix I to note that there are sacred sites, traditional cultural properties, and culturally important biota located in areas that potentially could be impacted by TWRS EIS alternatives. Potential impacts to these sites, when feasible, have been addressed in the Final EIS. For example, in Volume One, sections on noise (Section 5.9) and visual (Section 5.8) impacts associated with construction and operation of TWRS facilities in the 200 Areas, which could impact Gable Mountain, have been modified. Please refer to the response to Comment numbers 0072.37, 0072.154, and 0072.225 for more information.

Comment Number 0089.17

Nez Perce Tribe ERWM

Comment Nez Perce treaty rights and interest in the region are not mentioned at all in this section. Please correct this oversight in the Final EIS.

Response Volume One, Sections 4.4 and 4.5 and Appendix I, Section I.5 of the EIS have been modified to note that the Nez Perce Tribe has retained rights on the Columbia River under a treaty between the Tribe and the U.S. Government.

Comment Number 0089.21

Nez Perce Tribe ERWM

Comment Page 4-35, Paragraph 3

The Nez Perce Tribe's presence is there and retained rights to the Columbia River should be mentioned.

Response Please refer to the response to Comment number 0089.17, which addresses this issue.

Comment Number 0089.22

Nez Perce Tribe ERWM

Comment Page 4-35, Paragraph 4

Same as previous comment. (Comment number 0089.21)

Response Please refer to the response to Comment number 0089.17, which addresses this issue.

L.4.6 SOCIOECONOMICS

Comment Number 0072.155

CTUIR

Comment P 4-38: Table 4.6.2: The category White + the category Minority Group should add up to 100 percent. The statement that the category, group, consists of all races other than White + Whites of Hispanic origin is very confusing, please explain.

Response The categories "White," "African American," "Native American," "Asian and Pacific Islanders," and "Other" in Volume One, Section 4.6, Table 4.6.2 add up to 100 percent of the total population. The additional data in the table on "Hispanic Origin" and "Minority Group" have been deleted to avoid presenting confusing information.

Comment Number 0072.156

CTUIR

Comment P 4-38: Sect. 4.6.1.2: Drawing an artificial line to separate potentially impacted people from potentially non-impacted people is misleading in the case of the three affected Tribes. Please list them as three separate affected populations within this section. It is apparent that within this section that executive order 12898 has not been fulfilled, simply listing statistics of demographics and presenting them as fulfilling.

Federal actions to address environmental justice in minority populations and low income populations is incorrect and misleading. Consultation with the affected Tribes would have resulted in the net benefit of demographic information that would have been appropriate for this section.

Response An important distinction exists between the area of potential impacts, which is depicted in the EIS as an 80-km (50-mi) radius surrounding the Hanford Site, and the populations residing within this area and the affected Tribes (i.e., CTUIR, Yakama, and Nez Perce). Both are important aspects of the environmental justice initiative and were addressed as such in the Draft EIS. Where impacts were to populations based on location of residence, the EIS addressed those impacts in terms of the geographic location of the minority, Native American, or low-income population as expressed in Volume One, Section 4.6. Where a potential impact would diminish potential treaty rights and privileges of Tribal Nations or cultural resources, regardless of whether or not the population of that nation resided in the area of potential impacts, the EIS addressed these situations in terms of impacts to the Tribal Nations. An example of this is expressed in Volume One, Section 5.19, regarding potential continued restrictions on access to portions of the 200 Areas.

In Volume One, Section 4.6, the Draft EIS presented the demographics of the potentially affected area. The Draft EIS also indicated that Tribal Nations with interest in the Hanford Site were located outside of the area of potential impacts. The Final EIS has been modified to clarify the delineation between potentially impacted populations residing within the area of potential impacts and the Tribal Nation populations. Further, the Final EIS has been modified in other sections to respond to comments and consultation with the affected Tribes regarding potential impacts to the CTUIR, Yakama, and Nez Perce. Please refer to the response to Comment numbers 0072.252, 072.271 and 0072.37. For example, the following sections were revised:

- A Native American scenario in Volume One, Section 5.11 and Volume Three, Appendix D (please refer to the response to Comment number 0072.153).
- Environmental justice analysis in Volume One, Section 5.19 to more fully present Tribal perspectives on potential impacts (please refer to the response to Comment number 0072.40).
- Volume One, Section 4.5 to communicate the perspective of Tribal Nations regarding cultural and natural resource values (please refer to the response to Comment number 0072.37).

Comment Number 0072.157

CTUIR

Comment P 4-43: Sect. 4.6.1.3: Where is the household income and educational attainment for Yakima County within this paragraph? Where also is the information for Oregons Morrow and Umatilla counties?

Response As stated in Volume One, in the introductions to both, Sections 4.6 and 5.6 (Existing Socioeconomic Environment and Socioeconomic Impacts), detailed socioeconomic information and impact analysis are provided only for Benton and Franklin counties because impacts outside these two counties would be insufficient to require detailed analysis. Demographic data on the 80-km (50-mi) radius around the Hanford Site, including Yakima and Morrow counties, are included to provide the basis for the environmental justice analysis in Volume One, Section 5.19. Please refer to the response to Comment numbers 0072.53, 072.252 and 0072.271.

Comment Number 0072.271

CTUIR

Comment P I-62: Sect. I.6.0: Each of these sections mentions the Environmental Justice Executive Order (EO 12898), and claims to satisfy it by estimating the number of Native Americans living within the 3 counties closest to Hanford. This demonstrates a complete misunderstanding of the Order, which clearly states that the evaluation must cover human health and the environment of minority populations, differential patterns of consumption, economic and social impacts, and an evaluation of whether there is a disproportionate burden placed on these populations. Counting the number of Native Americans (and Hispanics) who live within 50 miles of Hanford does *not* satisfy this Order. Other information, such as educational attainment, public safety, schools, and so on, is interesting, but does not seem to be used for anything, and is not related to the rest of the EIS. Information that would be more directly relevant to local tribes would be the number of Native Americans actually employed at Hanford relative to local populations within 50 miles, and the trends in their employment over the years.

Response Volume One, Section 5.19, was specific to environmental justice issues. Mitigation measures associated with environmental justice are located in Volume One, Section 5.20. The demographic information in this section provides the basis for the environmental justice analysis provided in Volume One, Section 5.19. Volume Five, Appendix I does not purport to contain the environmental justice analysis. The appendix is intended to describe the potentially affected human and natural environment. The impacts of the alternatives on that environment are presented in Volume One, Section 5.0.

For the description of the affected environment, the EIS presents demographic data relative to Native American populations within an 80-km (50-mi) radius of the Hanford Site, which consist of the area of potential environmental impacts from TWRS EIS alternatives. This area includes all or portions of 10 counties by census tract (eight in Washington and two in Oregon). The EIS also describes the labor force within Benton and Franklin counties, an area that comprises the region of economic impact of the Hanford Site and hence the TWRS EIS alternatives. This description includes a breakout of the labor force by category by race and sex. Finally, the data presented provide a breakout of the Hanford Site contractor workforce representation by gender and race. The data presented indicate that the Native American population in the two-county area was approximately 0.8 percent, the Native American percent of the two-county labor force was approximately 0.8 percent, and the Native American percentage of the Hanford Site labor force was approximately 1 percent.

The data presented in Volume One, Section 4.6 and Volume Five, Appendix I were prepared to support the environmental justice analysis. Executive Order 12898 requires Federal agencies to identify minority and low-income populations that may be impacted by the proposed action. The above referenced data were provided to support that requirement.

Other information presented in the socioeconomic section, such as public schools, public safety, and infrastructure, is provided to support the NEPA-required assessment of each EIS alternative's potential impact on public services. This analysis is presented in Volume One, Section 5.6.

The second NEPA requirement is to determine the potential impact of the EIS alternatives on the affected environment. The analysis of potential impact to the affected environment is presented in Volume One, Section 5.0. Socioeconomic impacts are presented in Section 5.6. Several modifications to the impact analysis have been made in response to consultation from Tribal Nations. For example, in Volume One, noise impacts (Section 5.9) and visual impacts (Section 5.8) address potential impacts to sacred sites that are within sight or sound of the proposed TWRS activities. The long-term human health impacts have been expanded to include a Native American Subsistence user in Volume One, Section 5.11 and Volume Three, Appendix D. Please also refer to the response to Comment number 0072.37 for a discussion of additional changes to the Final EIS in response to this issue.

Based on the analysis of potential impacts to the human and natural environment, the environmental justice initiative requires the agency to determine if any of the impacts would pose a disproportionate and adverse impact on minority and low-income populations. This analysis is presented in Volume One, Section 5.19. For each area of potential impact (e.g., land use, human health, air quality, water quality, etc.), impacts presented in Section 5.0 were reviewed to determine if there were any potential disproportionate and adverse impacts to the surrounding populations. If an adverse impact was identified, a determination was made whether minority or low-income populations would be disproportionately affected. In the Draft EIS, two potential impacts were identified that would present a concern based on the requirements of the environmental justice initiative. The analysis of the impacts for the Final EIS has been reviewed based on comments and consultation with Tribal Nations. The result of this review has been a modification to the text of Volume One, Section 5.19 to indicate that under all of the alternatives except No Action and Long-Term Management, certain adverse impacts to scared sites would occur.

The final requirement of the environmental justice initiative is to mitigate any disproportionate and adverse impacts. In the EIS, mitigation measures that address the environmental justice impacts are addressed in Volume One, Section 5.20. Based on the decision documented in the ROD, DOE will prepare a Mitigation Action Plan, which will document mitigation measures to be implemented. Please refer to the response to Comment numbers 0072.53, 0072.225, 0072.157, and 0072.252 for discussions related to this topic.

Comment Number 0072.272

CTUIR

Comment P I-66: PP 1: The first step in identifying Native American communities is to contact the Affected Tribes. Those Tribes are: The CTUIR, YAKAMA, and NEZ PERCE.

Response Consultations with the affected Tribes have been conducted and the identification of Native American communities has been modified in Volume Five, Appendix I and in Volume One, Section 4.6, to specifically identify the CTUIR, Yakama, and Nez Perce Tribes. Please refer to the response to Comment numbers 0072.53, 0072.271, 0072.149, and 0072.157 for discussions of changes to the EIS based on Tribal Nation consultations.

L.4.7 LAND USE

Comment Number 0072.158

CTUIR

Comment P 4-48: Sect. 4.7.1: The invitation to the CTUIR for participation in the Comprehensive Land Use Plan was not on a Government to Government basis. This misunderstanding is in the process of being rectified. Additionally, where are the values brought forward from the Hanford from the Hanford Site Future Uses working Group?

Response The values of the Hanford Future Site Uses Working Group (HFSUWG) were one input to the 1993 Hanford Site Development Plan. The relationship between the values of the HFSUWG and the Site Development Plan is addressed in the EIS in Volume One, Section 4.7 and Volume Five, Appendix I.

Participation of the CTUIR in the CLUP is outside of the scope of the TWRS EIS. DOE and Ecology acknowledge the important role all affected Tribes have had in the NEPA process for the TWRS EIS. Consultation with the affected Tribes has resulted in many improvements to the EIS and has strengthened the decision-making process associated with the proposed action. Please refer to the response to Comment numbers 0072.37, 0072.149, and 0072.251 for more information. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.159

CTUIR

Comment P-4-51: PP 4: The Hanford Site Development Plan is not the "Official Land Use Plan." Please provide an explanation for what a 'passive agricultural use' is. Most agricultural uses involve the ripping or tearing of the land and injection of chemicals and the control of insects and water. This is not passive in any sense of the word. In addition, the FITZNER EBERHARDT Arid Lands Ecology Reserve and the proposed National Wildlife Refuge and Wild and Scenic River north of/and along the Columbia River consists of large tracts of the remaining undisturbed habitat of this type in America. The loss of these lands and their uncounted biodiversity should be considered priceless.

Response Volume One, page 4-49 of the Draft EIS states that the Hanford Site Development Plan, "is not a comprehensive formal land-use plan." The paragraph in Volume One, page 4-51 referenced in this comment has been modified to discuss the relationship between the TWRS EIS and the 1996 CLUP. None of the TWRS alternatives would adversely affect either the Fitzner Eberhardt Arid Lands Ecology Reserve or the proposed Wildlife Refuge/Wild and Scenic River area along and north of the Columbia River. DOE and Ecology remain committed to preserving the environmental quality of all protected lands and areas designated for protection. The word "passive" has been deleted from the phrase "passive agricultural uses." Please refer to the response to Comment number 0012.18 for a related discussion on this topic.

Comment Number 0072.273

CTUIR

Comment P I-88: Sect. I.7.0: The Future Site Uses Working Group Report is conspicuously absent from the document citation list. The Hanford Site Development Plan should not be used as a reference since it has not been endorsed by the tribes or the Natural Resource Trustee Council, and is contrary to identified Site values and Energy Secretary OLearys commitment to manage Hanford as a national natural resource.

Response The HFSUWG Report is cited in the TWRS EIS in Volume One, Section 4.7 and in Volume Five, Appendix I. This report is cited and included in the EIS reference lists for Volumes 1 and 5 as HFSUWG 1992. The recommendations contained in the HFSUWG Report were an input to the development by DOE of the Hanford Site Development Plan. Neither the Hanford Site Development Plan nor the HFSUWG Report represent an official land use plan for the Hanford Site. The CLUP, currently in preparation, will provide an official vision of future Site land uses. Please refer to the response to Comment numbers 0012.18 and 0072.159. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.274

CTUIR

Comment P I-88: Sect. I.7.2.1: This section should be omitted altogether, since it is inaccurate and not current.

Response One of the areas of analysis CEQ recommends for an EIS is examination of potential conflicts between the proposed action and local, State, Federal, and Tribal Nation current land uses and future land use plans (40 CFR 1502.16). Please refer to the response to Comment numbers 0012.18, 0072.159, and 0072.273. If the TWRS EIS alternative selected in the ROD were to include land uses that would be incompatible with land use policies adopted in the CLUP, additional NEPA analysis may be required.

Comment Number 0072.275

CTUIR

Comment P I-90: Fig. I.7.2.1: This figure woefully understates the ecologically and culturally significant areas on Site. Simply indicating areas as undeveloped does not do justice to a national treasure.

Response This figure presents existing land uses, as presented in the DOE 1993 Hanford Site Development Plan to support Volume One, Section 1.7.2, Existing Land-Use Types and Land-Use Plans. The ecological and cultural resources of the Hanford Site are discussed in Volume One, Sections 4.4 and 4.5 and Volume Five, Sections I.4 and I.5. A figure presenting the vegetation communities of the Site is provided in Volume One, Section 4.4 and Volume Five, Section I.4. No graphics have been included for cultural resources to preserve the confidentiality of specific cultural resources sites.

The cultural resources and biological resources impact analysis included the most recent available information from surveys conducted for this EIS and from other available previous research. The EIS then evaluated the impact of the various TWRS alternatives on the cultural and biological resources of specific locations used for each TWRS alternative.

Comment Number 0072.276

CTUIR

Comment P I-92: Fig. I.7.2.2: This figure similarly overstates the areas designated for waste management and R&D development. This map (from the Development Plan, which is not current) did not consider the various Threatened and Endangered species located on Site, and has no relation to current thinking. Additionally the non-surveyed areas which comprise 90 percent of the site are inadequately portrayed.

Response Volume Five, Figure I.7.2.2 presents information from the 1993 DOE Hanford Site Development Plan. This plan will be superseded by the information contained in the CLUP for the Hanford Site, which was released for public comment in August 1996 (DOE 1996c). The CLUP will be an official land use plan and will contain DOE's land use planning decisions. The CLUP and the related DOE land use decisions are expected to reflect the most current available information on plant and animal species of concern (threatened and endangered, as well as candidates for inclusion in both categories). The CLUP also will present DOE's land use decisions concerning areas of the Site that remain unsurveyed in terms of biological resources.

Following identification of the Final TWRS remedy and approval of the ROD, DOE will evaluate the land use impacts of the selected remedy for consistency with the final CLUP. The potential land use impacts considered with the alternatives evaluated in the EIS were coordinated with the expected requirements of the CLUP. Because these two documents have been prepared concurrently, it is unlikely that any inconsistencies will have major impacts (i.e., to the extent that the selected alternative would be withdrawn). Please refer to the response to Comment numbers 0012.18, 0072.159, and 0072.273 for more information on this topic.

Comment Number 0072.277

CTUIR

Comment P I-94: Sect. I.7.2.3: It is correct that Hanford is located on ceded lands. However, the statement that "Tribal Nations have often expressed their desire to exercise the rights and privileges at the Hanford Site that were reserved in the 1855 treaties" is, to put it mildly, an understatement. To limit the description of tribal land uses to this meager paragraph demonstrates how little input the tribes have actually had into the EIS. The tribes have worked long and hard to educate DOE about tribal rights, responsibilities, interests and concerns, and to educate DOE about federal responsibilities as a trustee of natural resources on behalf of the tribes. This section should be rewritten to show a little more understanding of tribal rights and concerns and DOEs trusteeship responsibilities. Please contact the CTUIR technical staff regarding this section.

Response The EIS has been modified following additional consultation with the CTUIR, Yakama, and Nez Perce Tribes. Additional text describing Tribal perspectives on Native American land uses and natural and cultural resources values is located in Volume One, Section 4.5 and Volume Five, Section I.5.4. Tribal land use descriptions also were discussed in Volume Five, Section I.5.3 in the Draft EIS. Both the Draft and Final EIS reference added discussion of Tribal land uses in this section. Please refer to response to Comment numbers 0072.37, 0072.153, 0072.154, 0072.268, 0072.225, and 0072.198, which discuss modifications to the EIS based on Tribal Nation consultation.

Comment Number 0072.278

CTUIR

Comment P I-96: Sect. I.7.3: Where within this section have the Natural Resource Trustee Council been mentioned? Please provide an explanation discussing the NRTC absence.

Response Consultation with the Natural Resources Trustee Council was addressed in Volume One, Section 7.0 of the

Draft EIS. The EIS has been revised in Volume One, Section 4.7 and Volume Five, Appendix I to discuss the composition, roles, and responsibilities of the Hanford Site Natural Resources Trustee Council. The Hanford Site Natural Resources Trustees Council is composed of Federal agencies (DOE and the Department of the Interior), States (Washington and Oregon) and the affected Tribes (the Yakama Indian Nation, the CTUIR, and the Nez Perce Tribe). The primary purpose of the Council is to facilitate the coordination and cooperation of the Trustees in restoring and minimizing impacts to natural resources injured as a result of cleanup of releases associated with activities at the Hanford Site. DOE will coordinate with the Council in developing the Mitigation Action Plan for impacts to natural resources identified in the TWRS EIS. Please refer to the response to Comment number 0072.264 for a related discussion on mitigation.

Comment Number 0072.279

CTUIR

Comment P I-98: Sect. I.7.3.5: This section slants the EIS in favor of development; it is mentioned that the local counties (actually a few county commissioners, not the entire counties) opposed designating the Hanford Reach as a Wild & Scenic River. There is no mention of the many groups and individuals (and indeed the vast majority of residents in those three counties) who support the Wild & Scenic designation. Again, the wording of the EIS implies some specific goal of developing as much of the Site as possible in order to avoid the cleanup goals agreed to in the Tri-Party Agreement.

Response DOE and Ecology acknowledge the concern expressed in the comment that local support exists for designating the Hanford Reach as a Wild and Scenic River. The agencies also are aware that local support exists for legislation. The EIS has been revised in Volume One, Section 4.7 to clarify that a number of county commissioners for Benton, Franklin, and Grant Counties are on record as opposing the designation of the Hanford Reach as a Wild and Scenic River, but that other residents and organizations of the Tri-Cities area support the wild and Scenic River designation.

The EIS assumes that DOE will retain administrative control for 100 years following approval of the TWRS ROD. During this administrative control period, the 200 Areas will be waste management and disposal areas with restricted access and use consistent with requirements described in the Tri-Party Agreement, the CLUP currently being drafted, and the HFSUWG recommendations. After the 100-year administrative control period, the EIS assumes no administrative control as the bounding condition for land use impacts by the Native American, residential farmer, shoreline, and industrial user. The EIS evaluates the land use impact of each alternative for these four types of users after the 100-year period has expired and there are no land use restrictions. DOE and Ecology consider the four users identified to represent reasonable potential future uses following administrative control, and do not consider these land impacts uses and users to represent a bias toward development, but rather baseline impact analysis prepared to support public and decision maker consideration of potential impacts to future generations from the alternatives analyzed in the EIS.

L.4.8 VISUAL RESOURCES

Comment Number 0072.160

CTUIR

Comment P 4-57: Sect 4.8.2: Because the TWRS area can be seen from Gable Mountain, this will impact the religious practices of the affected Tribes.

Response Volume One, Section 5.8, Visual Resources Impacts, acknowledges that TWRS areas would be visible from elevated locations such as Gable Mountain, Gable Butte, and Rattlesnake Mountain. However, the TWRS facilities generally would be similar in type and location to existing Site facilities and thus TWRS would represent a continuation of past visual impacts rather than new and additional visual impacts. Volume One, Section 5.8 has been modified to make explicit that these elevated locations (i.e., Gable Mountain, Gable Butte, Rattlesnake Mountain) are used by Native Americans in their religious practices. Based on additional consultation with the affected Tribal Nations (e.g., the CTUIR), Volume One, Sections 5.5 and 5.19 of the EIS (Cultural Resource and Environmental Justice, respectively) have been modified to more fully place in context potential impacts to Tribal cultural values and lifestyle. Volume One, Section 5.20, Mitigation Measures, describes measures that could be taken by DOE to minimize the visual impacts of TWRS facilities (e.g., recontouring newly disturbed land areas to conform with the existing terrain and constructing TWRS facilities using colors that conform with the surrounding environment). Please also refer to the response to Comment numbers 0072.37, 0072.40, and 0072.140 for discussion related to this subject.

L.4.9 NOISE

Comment Number 0072.161

CTUIR

Comment P 4-59: Sect. 4.9: Noise conditions from the TWRS activities may impact the religious practices of the affected Tribes, Please indicate how this subject has been addressed under Executive Order 12898.

Response The EIS has been modified in Volume One, Sections 5.9 and 5.19 (i.e., Noise and Environmental Justice, respectively), to state that noise emissions from TWRS activities might adversely affect activities conducted at Native American religious sites. Noise emissions would be greatest during construction. As noted in Volume One, Section 5.9, at distances greater than 600 m (2,000 ft) from TWRS construction sites, noise levels would approach existing background levels. Thus, it is considered likely that minimal noise impacts would occur at religious sites (e.g., Gable Mountain), which are approximately 3 km (2 mi) from potential TWRS areas. Please refer to the response to Comment numbers 0072.40, 0072.270 and 0072.271.

Comment Number 0072.280

CTUIR

Comment P I-103: Sect. I.9.0: These sections may satisfy the minimal requirements, but do not really show aesthetic sensitivity, especially with respect to tribal spiritual concerns and aesthetic buffer zones around sacred sites.

Response The EIS has been modified in Volume One, Sections 5.9 and 5.19 (Noise and Environmental Justice, respectively) to indicate the Native American concerns about potential impacts of noise emissions from TWRS alternatives' activities on Native American cultural and aesthetic values.

Volume One, Section 5.19 has been modified to reflect information obtained in additional consultation with the affected Tribes (i.e., the Yakama Indian Nation, Nez Perce, and CTUIR) that more fully places in context potential impacts to Tribal culture and lifestyle. Please also refer to the response to Comment numbers 0072.37, 0072.40, 0072.140, and 0072.268.

L.5.0 ENVIRONMENTAL CONSEQUENCES

L.5.1 GEOLOGY

No comments were submitted for this section.

L.5.2 WATER RESOURCES

Comment Number 0089.23

Nez Perce Tribe ERWM

Comment Page 5-15, Paragraph 2

The use of 1979 sitewide groundwater level measurements may not be a conservative approach to risk assessment as the groundwater mound at B pond forms a hydraulic barrier which delays and deflects tank wastes in the groundwater from traveling directly towards the Columbia River.

Response Please refer to the response to Comment numbers 0012.16 and 0072.259.

Comment Number 0091.01

Dyson, Jessica

Comment This new data showing contamination dangerously close to our groundwater would not even been told to us at this point if it was left up to the Department of Energy. This is vital information for the public to have and it does have significant impacts on the public. Almost all of our agriculture in Washington comes from eastern Washington and most of the land surrounding the Columbia River is irrigated with the rivers water. Any radiation in the groundwater will make it to the river and possibly to our dinner tables. It is your responsibility to account for all the risks to the public and be as conservative in your assumptions as possible to protect our communities.

Response DOE and Ecology are equally concerned about protecting the groundwater resources. The Draft EIS, in Volume One, Section 4.2 and Volume Five, Appendix I, documented that contaminants were present in the vadose zone beneath the tank farms and that one source of the contamination was past tank leaks. In Volume One, Section 3.3 the Draft EIS stated that new data were emerging that indicated contamination at lower levels than previously estimated. The new and emerging data are, in many cases, preliminary in that they indicate the presence of contamination beneath the tanks but do not provide any explanation on how they were transported. Potential contaminant transport mechanisms including chemically enhanced mobility of contaminants, preferential pathways (natural and man-made), and the effect of large liquid loss (as compared to the predicted losses for the TWRS remediation) were evaluated as part of the uncertainty analysis in Volume Five, Appendix K. This emerging information as well as future information that are being collected will be addressed by NEPA analysis for tank closure to ensure that the groundwater and Columbia River are adequately protected. The alternatives presented represent a full range of potential actions. The EIS incorporates "bounding" assumptions designed to result in conservative calculations of impacts. DOE and Ecology remain committed to selecting an alternative that will protect the valuable resources, which include the Columbia River, the groundwater beneath the tank farms and food sources produced in Eastern Washington. The preferred alternative would be protective of the groundwater and limit future contaminants from TWRS sources to well below drinking water standards in the Columbia River. An evaluation of potential Columbia River impact due to release of all tank waste is provided in Volume One, Section 5.2 and indicates that even for a large release, drinking water standards would not be exceeded. The preferred alternatives would release only about 1/100th of the waste and the rate of release would be slowed due to the infiltration-limiting cap over the tanks. Please refer to the response to Comment number 0030.02.

L.5.3 AIR QUALITY

Comment Number 0072.28

CTUIR

Comment The emission estimates were not documented.

Response Emission estimates were provided in the Engineering Data Packages for the various alternatives, which are available for public review in DOE Reading Rooms and Information Repositories. Emission rates were calculated from these emission estimates using the construction and operating schedules presented in the packages. The resulting emission rates are presented in Volume Five, Appendix G. Emission calculations in tons emitted for each constituent are contained in the references shown in Volume Five, Appendix G. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.29

CTUIR

Comment No onsite receptors were evaluated and no risks were calculated.

Response Onsite receptors were evaluated and risks were calculated in Volume One, Section 5.11 and Volume Three, Sections D.4, D.5, and D.6 of the Draft EIS in Volume Three, Appendix D. A rectangular grid of 834 receptors, which encompasses the entire Hanford Site, was used to evaluate potential air impacts onsite. The risk associated with potential air impacts, along with those from other media evaluated (groundwater and soil), was calculated for each exposure scenario evaluated and presented in Volume Three, Appendix D. Risk contour maps are presented in Volume Three, Section D.5 of the Final EIS.

Comment Number 0072.30

CTUIR

Comment Only a small subset of released constituents were modeled.

Response The pollutants presented in Volume One, Section 5.13 represent a small subset of the pollutants modeled. The results presented were for the pollutants that contributed to impacts. The complete list of pollutants and the modeling results are located in Volume Five, Appendix G. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.31

CTUIR

Comment There was no recognition that tank farms are only part of the annual Hanford dose; some apportionment is needed.

Response In Volume One, Section 2.0, Purpose and Need for Action, it is stipulated that this EIS addresses Hanford Site tank waste and encapsulated cesium and strontium to reduce existing and potential future risk to the public, Site workers, and the environment. An assessment of the contamination at the entire Hanford facility (Sitewide assessment) would facilitate apportionment of the contribution of TWRS. The Sitewide assessment is not within the scope of this document; consequently, no apportionment is presented. However, Volume One, Section 5.13 does address potential cumulative impacts of TWRS alternative emissions with emissions from ongoing and reasonably foreseeable activities. Please refer to the response to Comment number 0072.243. Because the information requested in the comment was included in the Draft EIS to the extent appropriate for the TWRS analysis, no modification to the document is warranted.

Comment Number 0072.32

CTUIR

Comment Particulate deposition should be included, since this is part of the annual NESHAPs reporting requirement.

Response The inclusion of particulate deposition in air emission modeling would reduce airborne concentrations and thus minimize offsite impacts. Ignoring the effect of particulate deposition results in a conservative estimate of air emission impacts. Particulate deposition was accounted for in the determination of anticipated risks to the general public due to ingestion of vegetation, meat, and milk contaminated by airborne deposition, as discussed in Volume Three, Appendix D. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.239

CTUIR

Comment P G-2: Sect. G.2.1: It is not clear whether fugitive emissions are included in the Area Sources. The relation between Stack/Fugitive-Area and Normal/Unplanned releases (per NESHAPs) should be made clearer. Are the stack numbers the same as those reported in the annual NESHAPs report? Is there a 1:1 correspondence between all the sources in the EIS and the NESHAPs reports? Please clarify the regulatory framework. For each source, please add the anticipated duration of operation or emission for the various alternatives (also add columns to the tables after the emission rate columns).

Response This comment contains six sections, each with its separate explanations. For clarity, each explanation has been given a number.

1. When fugitive emissions are included in the Area Sources, the text of the EIS points this fact out. In the Draft EIS, Volume Five, Section G.2.1, the following area sources associated with fugitive emissions are specifically called out: Waste Retrieval Annexes Areas, page G-3; and Process Facilities and Tank Farm Construction, page G-5.
2. All emissions are considered under National Emissions Standards for Hazardous Pollutants (NESHAPs) regardless of their source. There is no relation between Stack/Fugitive-Area and Normal/Unplanned releases, because all contribute to the emissions from the Hanford Site.
3. Because the stack designations used in the EIS are for air modeling and environmental planning purposes and have therefore not been constructed, they will not be found in the annual NESHAPs report.
4. The sources in the EIS are of a conceptual nature. The exact sources that will be active during construction and operation would be determined during final design. Consequently, there is no correspondence between the sources in the EIS and the NESHAPs reports.
5. The regulatory framework of the EIS is explained in detail in Volume One, Section 6.0. In particular, the relevant environmental requirements are detailed in Volume One, Section 6.1.
6. The anticipated durations of the construction and operating phases for each alternative are shown by alternative in Volume Five, Section G.2.2, Model Scenarios.

Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.240

CTUIR

Comment P G-13: Sect. G.3.1.2: Please forward information regarding particle sizes, Ranges, densities, and deposition rates for this section. This information was not in the tables referenced. Additionally filter failure rates should also be included.

Response A study conducted on cooling towers (Wistrom and Ovard 1973) shows the size of particulate matter (PM) emitted from cooling towers to range from 20 µm to 2,400 µm. Particles larger than 450 µm settle out within 400 feet from the tower. Approximately 30 percent of tower emissions are less than 450 µm and may drift offsite. These particulates will decrease in size as the water drop evaporates.

Particulate matter nominally 10 micrometers (µm) or less (PM-10) emissions associated with construction mainly are due to engine exhaust and fugitive dust. AP-42 Table C.2-2 (Wistrom and Ovand 1973) shows that 95 percent of PM due to engine combustion is smaller than 10 µm and 90 percent is smaller than 2.5 µm. Fugitive dust emissions tend to be smaller than 30 µm with 20 to 40 percent less than 10 µm, depending on source.

Radiological PM emissions emitted from HEPA air filters will be much smaller than 10 µm. The term HEPA was designated by the U.S. Atomic Energy Commission for filters that are at least 99.97 percent efficient by volume on 0.3 µm particles (Austin and Timmermann 1965). A control efficiency of 99.95 percent per filter was assumed in the Engineering Design Packages, which are cited in the EIS and available for reviews in DOE Reading Rooms and Information Repositories. Particle size data, densities, and deposition rates from the various emission sources are currently not available.

Comment Number 0072.241

CTUIR

Comment P G-13: PP 3: What are the filter failure rates for the tank farms and the WESF?

Response WSRC-TR-93-262 gives a recommended value of 5.0E-07 per hour for failure from rupture under regular operating conditions (4.4E-03 per year). The HEPA filtration systems have monitoring and alarm systems. If the filter plugs or blow out, the differential pressure gives indication. HEPA filter failure accidents are not covered in Volume Five, Appendix G but in Volume Four, Appendix E, Accident Analysis.

Comment Number 0072.242

CTUIR

Comment P G-15: Sect. G.3.1.4: No onsite receptor locations were evaluated. Since parts of the Hanford Site will be accessible to the public well before the 100 year assumed duration of Site-wide institutional controls is up, some on-site receptors should be added. Public dose limits apply to Site visitors as well as to the offsite boundary receptor. The only points of compliance indicated in this section were the Site boundary and the nearest residence. Although this is conventional for NESHAPs reporting, it is unacceptable for this EIS.

Response Sitewide institutional controls are designed to protect the public and restrict public access to areas of the Site that may pose a risk. In deciding which areas may be open to the public, a detailed assessment of potential exposure must be made and compared to the public dose limits then in effect. A discussion of anticipated health effects both during and after remediation may be found in Volume One, Section 5.11. Contour maps of potential health effects from air released during remediation are presented in Volume Four, Appendix E and Volume One, Section 5.11. Please refer to the response Comment number 0072.29.

Comment Number 0072.243

CTUIR

Comment P G-18: PP 2: The NESHAPs citation (40 CFR 61, Subpart H0 applies to *the entire Hanford Site as a single source*, not to a single program, activity or Area. Therefore, the proper comparison of air modeling results is not to the upper limit of allowed dose, but to a fraction of that limit. NRC uses the term "apportionment" (see, for instance, the WIPP permit) to set limits for individual activities within a larger unit; in the case of WIPP, the storage facility is not allowed to exceed 25 percent of the overall source term. The federal total dose limit for offsite receptors is 100 mrem (all pathways) and 10 mrem (inhalation only). This limits applies to the entire Hanford Site, and the ROD must specify what portion of this limit can be "filled" by TWRS activities. The 1 mrem contour (Phase 2, for instance) occurs in locations where non-rad workers work, and that are outside the bounds of the 200 Area. There is a second impact zone offsite (Ringold area, on the other side of the Columbia River) that will be of concern during actual operations.

Response The 40 CFR 61 Subpart H exposure limit is applied to the Site as a whole. As part of the Hanford Site Air Operating Permit, the annual potential emission from each discharge point has been identified. NESHAPs compliance is based on exposure at the nearest actual residence. Inhalation pathway exposure for the nearest resident for the TWRS alternatives ranges from 0.019 to 2.4 mrem/yr as shown in Volume Four, Tables G.4.0.20 to G.4.0.30. For 1994, the nearest resident received 0.01 mrem by the inhalation pathway from all Hanford Site emissions (PNL 1995). Assuming the other Site facilities emissions continued at the 0.01-mrem/yr rate, the inhalation pathway exposures for the Site, including the TWRS alternatives, would range from 0.029 to 2.41 mrem/yr (0.019 plus 0.01 mrem/yr to 2.4 plus 0.01 mrem/yr). To be conservative, the TWRS EIS analysis also was performed for hypothetical residences at currently unoccupied locations along the Columbia River and Highway 240. All of these hypothetical residence locations were calculated to be below 1 mrem/yr (10 percent of the 10-mrem/yr NESHAPs) except for the In Situ Vitrification alternative, which was 18.8 mrem/yr at the maximum location. The potential for this exposure could be mitigated by including such measures as continued restriction on location of residences in the subject area.

However, because there are no residences at these hypothetical residence locations, the NESHAPs of 10-mrem/yr would not apply and there would be no exceedance. Volume One, Section 5.13 contains an analysis of the cumulative air quality impacts of the TWRS alternatives and other Site activities. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.244

CTUIR

Comment P G-36: Table G.3.1.2: No rationale is given for the selection of non-radiological constituents. Please do not refer us to endless other documents - the TWRS EIS is a stand-alone product that will be the sole basis of the ROD. It must provide complete information for evaluation. In particular, the document "Jacobs 1996" that is cited as the basis for the emission estimates is not publicly available, and may not have received any peer review at all. Presenting table after table of emission rates without any explanation is meaningless, and CTUIR cannot accept any results based on such unsupported data.

Response Incorporation of technical data and information by reference is used as a means to limit the volume of the EIS. Referenced supporting technical data, including Jacobs 1996, are publicly available in the Administrative Record and were provided to DOE Reading Rooms and Information Repositories during the Public Comment Period. An independent technical review of the Draft EIS was completed and a copy of this report is available in the TWRS EIS Administrative Record. This independent technical review found that data used in the analyses were derived from valid and fully documented sources that were traceable, and models used to predict impact analyses either were EPA-approved or accepted by experts as fundamentally sound.

Non-radiological constituents and emission rates for current operations (including the No Action alternative) at the tank farm were derived from the Hanford Site Air Operating Permit Application, which covers existing tank farms and evaporator operation. The selection of non-radiological constituents was based on measured emissions from monitoring instrumentation or tank vapor space sampling results. Constituents and emission rates for waste treatment operations addressed in other alternatives were derived from material balance calculations developed for each alternative.

Comment Number 0072.245

CTUIR

Comment P G-57: Table G.3.1.20: Only 5 radionuclides were used for some of the air modeling. 10 nuclides were used for other alternatives, without any explanation. Various sets of hazardous air pollutants were also used. Since the tank contents do not change between the various alternatives, this is illogical. This entire section must be improved.

Response The tables cited in Volume five, Appendix G provided radionuclide emission rates for the alternatives presented in the EIS. The tables showing five radionuclides were based on radionuclides presently reported by the tank farm operations groups. Because no additional information is available, these radionuclides form the basis for emission rates for alternatives where no activities are performed on the tank contents, (i.e., No Action, Long-Term Management, In Situ Fill and Cap). For the remaining alternatives, there is additional information on radionuclide emissions in the flowsheets contained in the engineering data packages. Where additional information is available, additional radionuclides are shown in the tables for a particular alternative, along with the source (e.g., process plant stack). The hazardous air pollutants referred to in the comment are shown in the preceding tables. The tables for No Action, Long-Term Management, and In Situ Fill and Cap alternatives show the emissions presently reported by the tank farm operations groups. The tables for the remaining alternatives show emissions during construction and operation, which are both taken from the engineering data packages. Construction emissions are those anticipated from use of heavy equipment on the Hanford Site. Operating emissions are those given in the flowsheets in the engineering data packages, which are available for review in DOE Reading Rooms and Information Repositories. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.246

CTUIR

Comment P G-21: Sect. G.5.3: No description of the presumed filter efficiency (and failure rates), particulate size range and deposition rates were given. Additionally, no consideration whatsoever of the long-term impacts of deposited material (either radiological or nonradiological) was given. If deposition rates had been evaluated, there would have been high impact areas identified (Gable Mountain and White Bluffs). Since federal NESHAPs reporting requires deposition and incorporation into agricultural products as part of the annual dose evaluation, corresponding calculation should be presented in the EIS. If they are not, it will be impossible to demonstrate that any of the alternatives will, in fact, be able to meet compliance limits.

Response Routine emissions are discussed in Volume One, Section G.3.1. HEPA filter efficiency was factored into the emission rates provided in the engineering data packages that support routine emissions. HEPA filter failure accidents are discussed in Volume Four, Appendix E, Accident Analysis. Please refer to the response to Comment number 0072.241.

Dose evaluations from routine emissions are not covered in Volume Five, Appendix G, but are discussed in Volume Three, Appendix D. The intent of Appendix G is to access whether or not the air emissions are in conformance with air quality standards. Please refer to the response to Comment numbers 0072.32, 0072.239, and 0072.240 for related information. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.247

CTUIR

Comment P G-33: Fig. G.4.0.12: Even without any deposition being included, it is apparent that there are high concentrations at the high elevations on Gable Mountain and Rattlesnake Ridge. This means that tribal members visiting those sites will receive a greater exposure than the general public. Further, more deposition will naturally occur at these higher elevations, thus placing these culturally important areas and the people who visit them at increased risk. This section must be revised and linked to socio-cultural impacts.

Response DOE and Ecology acknowledge the concern regarding potential concentrations of radionuclides on Gable Mountain and Rattlesnake Ridge. Further information on the short-term impacts of air emissions during operation of TWRS facilities is contained in Volume Five, Figures G.4.0.1 through G.4.0.12. At higher elevations, predicted concentrations and dose values could be somewhat greater than in the lower elevations, in the immediate area. For areas near Gable Mountain and Rattlesnake Ridge, predicted radionuclide doses are well below the Washington State Acceptable Source Impact Levels (ASILs) and radionuclide dose limits established by State and Federal standards. It would be reasonable to conclude that, even if the predicted doses are somewhat greater at higher elevations, these doses would not be expected to exceed State or Federal standards. The long-term impacts of remediation on Tribal members are addressed in a separate Native American scenario presented in Volume One, Section 5.11 and Volume Three, Appendix D. For information on this scenario, please refer to the response to Comment numbers 0072.198 and 0072.225 for post-remediation accident impacts.

Comment Number 0072.248

CTUIR

Comment P G-20: Sect. G.5.2.2: No description of the actual vitrification operations was given including temperatures, feed materials, emissions, air pollution control device efficiency, effects of startup, trial melts, upsets, and maximum rated capacity. The recent vitrification event at Savannah River should serve as an indication of anticipated variances in emissions.

Response A description of the vitrification operations is provided in Volume Two, Appendix B and was based on information in the referenced Engineering Data Package, which is available for review in the DOE Reading Rooms and Information Repositories. Please refer to the specific data package for vitrification to obtain the most detailed information available. Emissions are based on design rates for the equipment, which should represent peak emissions. Average operating rates (and emissions) are estimated to be approximately 40 percent of the design rates. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.249

CTUIR

Comment P G-83: Tables G.4.0.1-19: these Tables seem to have been prepared solely for reporting purposes and have no identifiable relation to dose and risk. Each individual contaminant is compared to a regulatory level, but no other information is presented. The concentrations vary from 1 hour to annual averages, again without explanation as to whether this assumes maximum continuous operation, or something else.

Response As is stipulated in Volume Five, Section G.5.3 (page G-21), these tables were used to screen the potential impacts associated with air contaminants at the Site versus applicable regulatory (State and Federal) levels. The tables compare the modeling results to the Federal and State standards. The maximum 1-hour average concentration that resulted from the modeling was converted to 3-, 8-, and 24-hour average concentrations to compare to applicable standards when appropriate. The 1-hour average concentration was multiplied by 0.9 to obtain the 3-hour average, 0.7 for the 8-hour average, and 0.4 for the 24-hour average (EPA 1992b).

Predicted maximum emissions for hazardous air pollutants and pollutants for which a Washington State ASIL exists are provided along with the applicable level in Tables G.4.0.1 through G.4.0.19. Some of the pollutants evaluated have Washington State ASIL of Federal Standards reported for 1-hour, 3-hour, 8-hour, or 24-hour concentrations. For instance, PM-10 has a Federal and State 1-, and 8-hour standard. Consequently, for carbon monoxide, the 1-hour model predicted concentration was adjusted by multiplying it by 0.7 to obtain an 8-hour concentration. Because the 1-

hour concentration can be altered by multiplying it by the appropriate conversion factor; a conservative estimate of the contaminant concentration is available for comparison to the applicable standards. The modeling results for all alternatives show no exceedances of Federal or State air quality standards for criteria pollutants, hazardous air pollutants, or radionuclides. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.250

CTUIR

Comment P G-83: Tables G.4.0.19: Groundshine must be included in the evaluation, with and without an assumption of intervention, and with varying degrees of intervention success.

Response Table G.4.0.19 is not in Volume Five, Appendix G on page G-83 as indicated; it is on page G-105. It is assumed the commentor is to referring to Tables G.4.0.1 to G.4.0.19. Because the constituents presented in Tables G.4.0.1 to G.4.0.19 are not radioactive, these constituents would not contribute to a groundshine pathway. However, Tables G.4.0.20 to G.4.0.30 compare the maximum dose per year from radiological constituents with State air quality standards (the purpose of Volume Five, Appendix G is to measure air emissions against air quality standards). The radiological releases do not exceed the air quality standards so intervention would not be required. The groundshine pathway was included in the evaluation of remediation risk to onsite and offsite receptors. Results of the remediation risk evaluation are presented in Volume Three, Appendix D. These results indicate that the impacts from groundshine are orders of magnitude less than from inhalation. The additive impact from groundshine, therefore, would not change the maximum dose shown in Volume Five, Tables G.4.0.20 to G.4.0.30 and no change to the document is warranted.

Comment Number 0072.251

CTUIR

Comment P G-12 - P G-19: Sects. G.3.0 and G.5.1: This section provides insufficient detail about modeling methods. Exposure assumptions must be presented, as well as assumptions about the particulate size range and respirable fraction used in the dose estimation.

Response The model used for this investigation is the Industrial Source Complex Model (ISC2). The model is a Gaussian dispersion model, which can be used for estimating the concentration of pollutants at a receptor. The model is a guideline air quality model accepted by the EPA for regulatory applications. The assumptions in Gaussian dispersion modeling are as follows.

- Pollutant emissions are continuous.
- Mass of pollutants released remains in the atmosphere during transfer from the source to the receptor.
- Meteorological conditions do not change.
- Diffusion in the downwind direction is negligible in comparison to transfer by the wind. Thus diffusion occurs in only the vertical and crosswind directions.
- Time averaged concentrations in the crosswind and vertical direction are assumed to be distributed normally.

ISC2 was run using the standard rural dispersion coefficients. Standard EPA procedures were followed and the regulatory default option was used. The options implemented included the following:

- Final plume rise that accounts for the effective height of the source of emission;
- Buoyancy-induced dispersion that allows for the plume size to increase at the stack exit point;
- Default wind profile exponents;
- Default potential temperature gradients; and
- Upper bound values for building downwash.

The respirable fraction of particulates is assumed to be those with diameter less than or equal to 10 µm (PM-10). Respirable particulates that are greater than 5 µm typically are trapped by hair follicles in the trachea and never reach the lungs.

The risk calculations for each exposure scenario are calculated in Volume Three, Appendix D. For the residential farmer exposure scenario, the exposure parameters for inhalation are as follows:

Inhalation rate - 20 $\frac{m^3}{day}$

Exposure frequency - 365 $\frac{day}{yr}$

Exposure duration = 6 yrs (child)
24 yrs (adult)

Body weight = 16 kg (child)
70 kg (adult)

Averaging time = 365 $\frac{day}{yr}$ * 30 yr

The exposure parameters for each scenario evaluated are presented in Volume Three, Appendix D. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0100.01

WDOH

Comment First, Washington's standard for radioactive air emissions is CAP-88. CAP-88 should be used for the modeling in the EIS.

Response There were several reasons why EPA's preferred radionuclide dose model was not used in this analysis. While portions of the dose calculation methodology of the Clean Air Assessment Package-1988 (CAP-88), as well as other site-specific models such as GENII, may have been incorporated in the risk assessment, the air dispersion algorithms of those models were not. The ISC2 was selected as the general air dispersion model for the following reasons:

- ISC2 is a sophisticated model with capabilities comparable to CAP-88, such as the ability to account for a wide spatial separation of many varied source types;
- ISC2 is an EPA guideline model, and was the choice for assessing traditional pollutants (e.g., dust and combustion products) and air toxic emissions;
- Use of ISC2 for all air dispersion modeling provided for consistency in the EIS; and
- A sitewide compliance demonstration with the radiological standards was not the goal of this EIS.

Volume Five, Appendix G contains a comparison of the ISC2 and CAP-88 modeling results and shows that these results compare closely.

Comment Number 0100.02

WDOH

Comment Second, the state standard for total radionuclides is misstated at 25 mrem/yr.

Response The text in Volume Five, Appendix G has been modified to state that the Ambient Air Quality Standard (WAC 173-480) for the maximum accumulated dose equivalent at any offsite receptor from a commercial nuclear facility is 25 mrem/yr. As a Federal facility, the Hanford Site could be expected to comply with the EPA regulation (40 CFR 61), which limits the maximum predicted dose at the nearest residence to 10 mrem/yr dose equivalent.

L.5.4 BIOLOGICAL AND ECOLOGICAL RESOURCES

Comment Number 0019.12

WDFW

Comment Page 5-64, third paragraph, third bullet. Should include "candidate" category as well.

Response The EIS text presents this key issue of the biological and ecological resources impact analysis in the following sentence: "... potential impacts on plant and animal species of concern (those listed or candidates for listing by the Federal government or Washington State as threatened, endangered and sensitive)."

Comment Number 0019.13

WDFW

Comment Page 5-65, section 5.4.1, first paragraph. WDFW believes it is more appropriate to discuss the percent loss of shrub-steppe within the waste management zone (WMA) to emphasize the impacts to shrub-steppe there. Currently, there is approximately 5,800 acres of undisturbed shrub-steppe within the WMA. Impacts to undisturbed shrub-steppe would range up to 6 percent in the WMA from the TWRS alternatives.

Response The EIS was modified in Volume One, Section 5.4 to add the percentage of undisturbed shrub-steppe that potentially would be affected by TWRS EIS alternatives within the waste management area.

Comment Number 0019.14

WDFW

Comment Page 5-67, Table 5.4.1, Phased Implementation (Total). Impacts do not match what is stated elsewhere in the text. 470 acres is stated here. 540 acres (pg. 5-230) and 690 acres (pg. 5-123) are mentioned elsewhere. Please clarify.

Response The EIS was modified to clarify and correct the potentially affected acreages for the Phased Implementation (Total alternative), based on revisions to the Phased Implementation alternative that occurred since publication of the Draft EIS. Volume One, Table 5.4.1 identifies the total amount of shrub-steppe that would be affected. Volume One, Section 5.4 identifies the total amount of land that would be affected, not only the amount of shrub-steppe. Table 5.14.1 has been revised to indicate that shrub-steppe impacts for the Phased Implementation (Total alternative) would be 94 hectares (240 acres) in the 200 Areas and 140 hectares (350 acres) at the potential borrow sites for a total impact of 240 hectares (590 acres). Volume One, Section 5.7 (page 5-123) indicates that approximately 320 hectares (790 acres) would be the total temporary construction-related land use, including both shrub-steppe and non shrub-steppe areas.

Comment Number 0019.15

WDFW

Comment Page 5-71, section 5.4.2, first paragraph. The nesting period should also include a discussion on passerines (sage sparrow, etc.) and that site clearing would avoid the breeding season for these species. These species also receive protection under the Migratory Bird Treaty Act.

Response The EIS has been modified in Volume One, Section 5.4 to include potential impacts on nesting passerine (songbird) species. Mitigation of potential impacts to these species would be described in the Mitigation Action Plan.

Comment Number 0019.16

WDFW

Comment Page 5-75, section 5.4.5, first paragraph. WDFW concurs with the importance of the McGee Ranch as a wildlife corridor for species migration, proliferation, and genetic diversity. Impacts to the McGee Ranch would have a significant adverse affect on wildlife.

Response DOE and Ecology acknowledge the position of the WDFW on McGee Ranch and addressed the wildlife corridor in the Affected Environment discussion in Volume One, Section 4.4 and Volume Five, Appendix I, and potential impacts to the wildlife corridor under each of the alternatives in Volume One, Section 5.4. It is important to note that the TWRS EIS will not support decisions associated with closure of the tanks and it is only under the hypothetical closure option analyzed in the EIS that adverse impacts to McGee Ranch would occur. Thus, no action taken as a result of this EIS would affect species migrations proliferation, or genetic diversity associated with the corridor. Please refer to the response to Comment numbers 0019.03 and 0072.08 for related information on how closure is addressed in the EIS and related impacts on potential borrow sites.

L.5.5 CULTURAL RESOURCES

Comment Number 0089.16

Nez Perce Tribe ERWM

Comment Page I-60, Paragraph 2

It needs to be emphasized that disturbed areas still have potential to contain cultural resources.

Response The EIS has been modified in Volume One, Section 5.5 to indicate that disturbed areas may contain cultural resources that were not identified during the cultural resources survey. This fact is acknowledged by DOE and Ecology and is the reason why the mitigation measures identified in

Volume One, Section 5.20 of the Draft and Final EIS include a commitment to conduct cultural resource surveys, consult with affected Tribal Nations, and mitigate through avoidance whenever feasible.

Comment Number 0101.03

Yakama Indian Nation

Comment In addition we consider that the actions should assure that cultural values of the Yakama Nation, not directly related to public health and safety or the ecological aspects of the environment, should be protected. These other cultural values stem from what could be termed religious beliefs and are associated with the sanctity of the land forms and other natural resources at Hanford.

To accomplish objective establishment of performance bases, i.e., a valid suite of scenarios to be used in the performance assessments, we consider experts knowledgeable in predicting future possible demographic conditions and societal land use patterns, including intruder scenarios, should be utilized. Delphi methods for polling expert opinions on such subjective topics should be employed. YIN representatives should be involved with this activity to assure the demographers, anthropologists, archaeologists, geologists and other experts having the knowledge to anticipate future conditions adequately incorporate scenarios involving Indian usage of the land, the water and the other natural resources, reflecting historical data as warranted. Without the valid determination of such conditions, including those which may occur and would be limiting with respect to the design confidence level, any of the actions described in the subject EIS may be unfounded and not protective of the public health and safety and the environment. In addition, actions justified as a result of the impact assessments may not meet requirements stemming from cultural values discussed above.

Response Please refer to the response to Comment number 0072.149 for a discussion of consultation with Tribal Nations on the TWRS EIS, and Comment numbers 0072.37, 0072.40, 0072.268, 0072.251, and 0072.53 for discussions of changes to the EIS based on Tribal comments on cultural values, cultural sites, and land uses. The discussion of Treaty rights and privileges has been modified in the Final EIS, based on consultation with the affected Tribal Nations, in Volume One, Section 4.4 and Volume Five, Appendix I. The EIS used reference cases, including the Native American subsistence scenario, for comparative purposes to predict unrestricted future land uses beyond the 100-year administrative control period to 10,000 years. These are incorporated into the Native American User Scenario, which is addressed in Volume One, Section 5.11 and Volume Three, Appendix D. For a complete discussion of this issue, refer to the response to Comment number 0072.149. For discussion of how the EIS addresses environmental justice analysis relative to the Tribal Nations, please refer to the response to Comment numbers 0072.271, and 0072.252.

In response to this and other comments by affected Tribal Nations, the risk assessment for the EIS was revised to include an evaluation of anticipated post-remediation risk to a Native American subsistence user of the Hanford Site. Inclusion of a Native American scenario in the Draft EIS was not feasible because a methodology for the assessment had not been developed sufficiently to be incorporated into the Draft EIS. The scenario used for the analysis was developed through consultation with representatives of the affected Tribes and included discussions regarding societal land use patterns, the intruder scenarios, and demographic conditions. Please refer to the response to Comment number 0072.198, which contains a complete discussion of the information included plus a document reference list regarding the addition of a Native American scenario. Please refer to the response to Comment number 0072.225 for a discussion of post-remediation accident impacts to Tribal Nation sacred sites and cultural values.

L.5.6 SOCIOECONOMICS

Comment Number 0072.33

CTUIR

Comment Counting the number of Native Americans living in the 3 nearest counties does not satisfy the Environmental Justice Executive Order or DOE policy.

Response As discussed in the response to Comment number 0072.53, the EIS environmental justice analysis provides demographic data in Volume One, Section 4.6 on Native Americans, as well as low-income and minority populations within an 80-km (50-mi) radius of the Hanford Site Central Plateau. This area includes portions of 10 counties in Washington and Oregon. Volume One, Section 5.19, Environmental Justice, presents a review of all TWRS alternatives' impacts on the natural and human environment that were addressed throughout Volume One, Section 5.0 to determine whether any potentially disproportionate and adverse impacts would occur to the identified minority or low-income populations, including Native American populations. Volume One, Section 5.20 identifies potential mitigation measures that DOE could adopt to address potential environmental justice impacts identified in Section 5.19. Please also refer to the response to Comment numbers 0072.252 and 0072.149.

Comment Number 0072.34

CTUIR

Comment Economic impacts of accidents were not included.

Response The model used to analyze economic impacts incorporates historical data on Tri-Cities socioeconomic conditions to test its results (e.g., the accuracy with which the model, using historical data yields output for past employment that agrees with known past employment levels). The model was then applied to future Hanford Site employment under each alternative to estimate area employment, housing prices, and taxable retail sales. Total area employment estimates were used to estimate impacts on public services. This analysis was presented in Volume One, Section 5.6.

DOE's Recommendations for the Preparation of Environmental Assessments and EISs (DOE 1993d) directs that impacts from low-probability events be analyzed with the amount of detail commensurate with their likelihood of concurrence and potential consequence. The likelihood of an accident under the TWRS alternatives that could affect the local economy is low. Further, there are no historical data for the Tri-Cities that could be used to provide a basis for analyzing potential economic impacts of accidents at the Hanford Site. Volume One, Section 5.6 and Volume Five, Appendix H have been modified to explicitly state that economic impacts of accidents have not been analyzed for post-remediation accident impacts. Please refer to the response to Comment number 0072.225 for a discussion of post-remediation accident impacts on Tribal Nation sacred sites and cultural resources and modifications to Volume Four, Appendix E regarding this issue.

Comment Number 0072.35

CTUIR

Comment No costs for storage, mitigation or disposal were included

Response An econometrics model was used for the economic impact analysis in the EIS to assess the impacts of TWRS alternatives. Hanford Site employment is used in the model as the key independent variable, and then equations based on historical data for the Tri-Cities area, are used to forecast the impacts of changes in future Site employment on socioeconomic conditions (e.g., total nonfarm employment, housing prices). Employment associated with TWRS activities such as waste storage and disposal is included in the analysis; thus, the costs of storage and disposal are included indirectly in the socioeconomic analysis. The direct costs of storage and disposal under each alternative are provided in Volume One, Section 3.0 and Volume Two, Appendix B. Please refer to the response Comment number 0072.225 for a discussion of the impact of mitigation of post-remediation accidents. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.36

CTUIR

Comment Jobs and housing as the only socioeconomic measures is unsatisfactory.

Response In addition to jobs and housing, the EIS socioeconomic impact analysis includes impacts on taxable retail sales, population, and a wide range of public facilities and services, including schools, police and fire services, medical services, solid and sanitary waste disposal systems and electricity and natural gas energy services in Volume One, Section 5.6 and Volume Five, Appendix H. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.252

CTUIR

Comment P H-1: Sect H.1.0: The topics covered in this section include the impact on local jobs, impact on the Tri-Party Agreement Milestone schedule, and impacts on demographics, housing prices and similar items. Therefore, we would expect to also see a full treatment of community and tribal quality of life, and intra- and intergenerational equity. This is, in fact, the intent of NEPA and is required under Executive Order 12898. We are aware that scoping discussions pertaining to this type of analysis were held with contractors and Headquarters personnel, yet it is entirely omitted from the Draft EIS.

Executive Order 12898 and DOE Environmental Justice Policy. The Executive Order states that the human health and environment of minority populations must be evaluated, including differential patterns of consumption, social and economic impacts, and whether there is a disproportionate burden of exposures and/or risks on these populations.

DOEs Environmental Justice Strategy includes provisions for identifying high risk populations (including subsistence consumption patterns), and for identifying DOE activities that might have a disproportionately high human health or environmental effects on minority populations. This goes far beyond merely counting the number of Native Americans in the three Hanford counties. ***CTUIR expects DOE to consult with technical staff in order to ensure that adverse impacts on a traditional subsistence lifestyle and characterization of populations at highest risk are adequately evaluated for the baseline conditions and for each alternative for as long into the future as the contamination or post-remediation conditions persist..*** The DOE Strategy also directs programs to "encourage ... participation [of American Indian Tribes] in the development of NEPA documents." Since a typical simple "scoping" briefing does not satisfy this directive, and since many of the deficiencies of this EIS could have been anticipated and corrected before publication of the Draft EIS, ***CTUIR further expects DOE to proceed with the revision of the EIS and negotiation of the Record of Decision to genuinely include CTUIR as an equal participant in the decision-negotiation process and in the development of mitigation action plans.***

Response Volume One, Section 5.19 was devoted to a summary of the environmental justice analysis included in the EIS. Volume Five, Appendix H is intended describe the analysis of the socioeconomic impacts of the TWRS EIS alternatives. A summary of this impact analysis is presented in Volume One, Section 5.6. The impacts of the alternatives on other aspects of the human and natural environment are presented in Volume One, Section 5.0 (e.g., air, water, human health, and land use).

The environmental justice requirement states that the environmental justice analysis should be completed to the "extent practicable and appropriate" (EO 12898). In developing the data to support the analysis, the Executive Order instructs agencies to "collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have substantial environmental, human health, or economic effect on the surrounding populations." This information is to be used to determine if "programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations."

The Executive Order mandate to collect data that are readily available on the area surrounding the site likely to be impacted by a proposed action and to analyze impacts that may have disproportionately high and adverse effects on minority and low-income populations is consistent with NEPA requirements. NEPA requires that a sliding scale be applied to analysis of potential impacts on the human and natural environment. "The sliding scale approach to NEPA analysis recognizes that agency proposals can be characterized as falling somewhere on a continuum with respect to environmental impacts. This approach embodies instruction that CEQ has provided (40 CFR 1502.1 and 1502.2, for example) with respect to preparation of EISs. The term 'scale' refers to the spectrum of significance of environmental impact. Do not attempt to quantify impacts on environmental resources when it is clear form the context that any impacts would be virtually absent" (DOE 1993d).

For the purposes of complying with the environmental justice and NEPA requirements, the TWRS EIS adopted the following approach to analysis of potential impacts to minority and low-income populations. The data presented in Volume One, Section 4.0 and Volume Five, Appendix I support the environmental justice analysis by describing the affected environment, including potentially affected populations. Consistent with Executive Order 12898 requirements, Section 4.6 and Appendix I identify minority and low-income populations that may be impacted by the proposed action. The second NEPA requirement is to determine the potential impacts of the EIS alternatives on the affected environment. The analysis of potential impacts to the affected environment is presented in Volume One, Section 5.0. This analysis considers the potential impacts on all populations and if an impact would adversely and disproportionately impact minority or low-income populations, the impact was identified.

Based on the analysis of potential impacts to the human and natural environment, the environmental justice initiative requires the agency to determine if any of the impacts would pose a disproportionately high and adverse impact on minority and low-income populations. This analysis is presented in Volume One, Section 5.19. For each area of potential impact (e.g., land use, human health, air quality, water quality) impacts presented in Volume One, Section 5.0 were reviewed to determine if there were any potential disproportionate and adverse impacts to the surrounding populations. If an adverse impact was identified, a determination was made as to whether minority or low-income populations would be disproportionately affected. In the Draft EIS, two potential impacts were identified that would present a concern based on the requirements of the environmental justice initiative. The analysis of the impacts for the Final EIS have been reviewed based on comments and consultation with Tribal Nations. The result of this review has been a modification to the text of Volume One, Section 5.19 to indicate that under all of the alternatives, except No Action and Long-Term Management, certain adverse impacts to sacred sites would occur.

The final requirement of the environmental justice initiative is to mitigate any disproportionate and adverse impacts. In the EIS, mitigation measures that address the environmental justice impacts are addressed in Volume One, Section 5.20. Based on the decision documented in the ROD, DOE will prepare a Mitigation Action Plan, which will document mitigation measures to be implemented

For the Draft EIS, the analysis of human health impacts determined that minority and low-income populations would not be disproportionately and adversely impacted by TWRS actions compared to non-minority and non-low-income populations. However, one area of potential differential impacts could not be fully analyzed in the Draft EIS. This area of potential impacts, long-term risks to human health under a Native American Subsistence scenario, could not be incorporated into the Draft EIS because a methodology for the analysis had not been developed to a level sufficient to support incorporation into the EIS. Subsequent to publication of the Draft EIS, a Native American subsistence scenario has been developed for use on the Hanford Site. Following consultation with affected Tribal Nations, this scenario has been incorporated into the Final EIS. This analysis is presented in Volume Three, Appendix D and summarized in Volume One, Section 5.11. For discussion of consultations with Tribal Nations, please refer to the response to Comment number 0072.149.

Throughout the NEPA process, DOE and Ecology have been proactive in consulting with the affected Tribal Nations regarding the content of the TWRS EIS. Many substantive portions of the Draft EIS were the result of consultation with affected tribes from scoping to the publication of the Draft EIS; just as many of the changes in the Final EIS reflect consultation that has occurred since the Draft EIS was issued for comment. Consultation is a valuable part of the NEPA process. As with any intergovernmental relationship, DOE and Ecology understand that the consultation process requires improvement and will continue to work with the affected Tribal Nations to that end. A proactive consultation process results in the meaningful exchange of technical information between both parties and a shared understanding of the challenges, issues, and concerns that the agencies and Tribal Nations face as they work to improve the environment of the Hanford Site. Please also refer to the response to Comment numbers 0072.53 and 0072.271 for related discussions. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.253

CTUIR

Comment P H-2: Sect H.1.1: This section deals solely with Hanford employment numbers. We would also expect to see baseline information about local services (for example, school attendance and student-teacher ratios; number of emergency and enforcement personnel per capita, and so on). Various economic impact analysis methods, such as economic base models, econometrics analysis, or input/output models, would require some of this data.

Response Baseline data about local services (e.g., schools, police, and fire services) are provided in Volume Five, Appendix I (Affected Environment), rather than Volume Five, Appendix H (Socioeconomic Impact Modeling). The model used in the EIS uses the historical statistical relationship between Hanford Site employment and other socioeconomic factors (i.e., total nonfarm employment, population, and housing prices) to predict the effects of the TWRS alternatives employment on total nonfarm employment, population, and housing prices. Changes in Hanford Site employment drive the changes in these other socioeconomic aspects of the Tri-Cities area. The model outputs, in terms of future population changes, then were used to assess the TWRS alternatives potential impacts on school enrollments, police and fire services, and other local services. The assessment of impacts on these services was performed by evaluating how the additional TWRS demands on the service systems would affect their ability to meet the total demand (non-TWRS related demands plus TWRS-related demands). This element of the assessment did not involve using the socioeconomic impact model. Please refer to the response to Comment number 0072.36.

Comment Number 0072.254

CTUIR

Comment P H-4: Sect. H.2.0: No documentation for the 2.4 multiplier (2.4. non-Hanford jobs created/lost for each Hanford job) is provided. Various estimates have been used by local civic planners.

Response The socioeconomic impact assessment model uses the historical statistical relationship between Hanford Site employment and total Tri-Cities nonfarm employment as the basis for predicting how changes in future Site employment would affect total area nonfarm employment. The analysis of historical data shows a relationship of approximately 2.4 non-Hanford jobs created/lost (for each Hanford job). This 2.4 multiplier is in reasonably close agreement with employment multipliers used in other Site NEPA analysis. For example, the Final SIS EIS used an employment multiplier of 2.2, based on socioeconomic input/output analysis performed by PNL in 1987 and 1991 (DOE 1995i). The socioeconomic model used for the TWRS EIS also was used for another recent Hanford NEPA document, the HRA EIS. The socioeconomic model used in the TWRS EIS is the most recent model specifically designed to analyze the Tri-Cities economy and incorporated the most recent data available at the time the Draft EIS was prepared.

Comment Number 0072.255

CTUIR

Comment P H-6: Sect. H.2.3: There needs to be identification of the age distribution was used, only total population seems to be here.

Response The socioeconomic impact assessment model utilizes and predicts total population only. The model does not utilize or predict age distribution of the local population. Age distribution modeling would have limited utility in analyzing the relative difference in impacts among the alternatives. For the purpose of this EIS, the only socioeconomic indicator reliant on age distribution in the population would be the impact to public schools in the Tri-Cities area. For this analysis, it was assumed that the age distribution in the future population under each alternative would be the same as the present age distribution (Volume One, Section 5.6). The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.256

CTUIR

Comment P H-7: Sect H.2.4: This section needs to be edited to count for accident impacts.

Response The socioeconomic impact assessment model and methodology used for this EIS does not incorporate possible economic impacts of potential accidents. Language has been added to Volume One, Section 5.6 and Volume Five, Appendix H.2.4 to inform the reader that the economic impact analysis does not address potential impacts associated with accidents. The probability of an accident that would have major economic impacts is extremely low, as described in Volume One, Section 5.12 and Volume Four, Appendix E. Please refer to the response to Comment number 0072.225 for a discussion of post-remediation accident impact on Tribal Nation sacred sties and cultural resources. Please also refer to the response to Comment number 0072.34 for a discussion of economic impacts caused by accidents.

Comment Number 0072.257

CTUIR

Comment P H-7: Sect H.3.0: Same comment as above. (See Comment number 0072.256.)

Response Please refer to the response to Comment number 0072.256, 0072.34, and 0072.225.

L.5.7 LAND USE

Comment Number 0036.18

HEAL (Exhibit)

Comment EIS does not deal with most important aspect of permanent land-use commitments.

According to the EIS, there are no potential implications for future land use that need to be dealt with in this EIS. This is because the EIS does not include closure decisions, and Hanford's land use plan is not done. According to the EIS, "No exclusion or restricted use zones have been defined, but this type of land-use issue is expected to be addressed in the land use planning process for the Hanford Site that is currently underway" (p. 5-121). This is a cop-out. The decisions that will be made in this EIS have clear, far-reaching, and critical future land use implications.

The alternatives leave behind waste resulting in risks for future generations that are between significant and downright scary. Some of the alternatives result in risks that absolutely mandate land use restrictions. Potential land use restrictions are a real and important aspect of determining an alternative's impacts.

By limiting the land use commitments to essentially the amount of shrub-steppe that is torn up, the agencies ignore the important health and economic aspects of potential future land use restrictions. In dealing with deadly tank wastes, a few acres of shrub-steppe is nothing compared to keeping Hanford off-limits forever.

Response Volume One, Section 5.7 addresses three distinct land-use implications of the TWRS alternatives. These include permanent land use commitments in the 200 Areas associated with the remedial activities addressed in the EIS, permanent land use commitments in the 200 Areas associated with the potential closure scenario included in the EIS to support a comparative analysis of the alternatives, and land use commitment implications outside the 200 Areas associated with the remedial activities and potential closure scenario.

The impact analysis for commitments in the 200 Areas associated with remedial activities concluded "Temporary and permanent proposed land use commitments for remedial activities under all TWRS EIS alternatives would be consistent with past and existing land uses for the 200 Areas, as well as with proposed use of the area as an exclusive-use waste management area." These land use commitments would range from 0 to 99 acres according to which alternative was implemented and would largely consist of the tank farms and LAW disposal vaults.

For permanent land use commitments associated with the potential closure scenario presented in the EIS, the EIS concluded that land use commitments would include, "the areas that would be covered by the Hanford Barriers under all alternatives except No Action and Long-Term Management." These land use commitments would require approximately an additional 20 to 40 acres beyond those committed under that remedial phase of the implemented alternative.

For land use implications outside the 200 Areas, the EIS indicates that "Groundwater contamination has land use implications. While land uses might not be precluded because of underlying groundwater contamination, the value of land for potential future uses such as agriculture could be diminished or restricted because the underlying groundwater could not be used. Under all EIS alternatives, TWRS activities would contribute to future Site groundwater contamination."

The EIS also states that "No exclusion or restricted use zones have been defined, but this type of land use issue is expected to be addressed in the land use planning process for the Hanford Site that is currently underway." This land use planning process, the CLUP, would consider the implications of the impacts of the TWRS alternatives in the identification of land areas requiring exclusive and/or restricted use. Thus, the information provided in the EIS is a critical part of the land use planning process and provides an important basis for future decisions. When considering the impacts of land use options associated with the TWRS alternatives, land use planners will have available for consideration an extensive amount of information regarding risks to future generations under various land use scenarios. The EIS analyzes health risks associated with alternative land uses in Volume One, Section 5.11 and Volume Three, Appendix D, including residential farmer, industrial worker, and shoreline recreational user. Since the publication of the Draft EIS, a Native American subsistence user scenario has been added to the analysis. For more information on this scenario, please refer to the response to Comment number 0072.198. The EIS also provides information regarding the implications for the waste site intruder or residential farmer who uses waste site drilling spoils site. Finally, the EIS provides data regarding the extent of groundwater contamination that potentially could result from each alternative. All risks and impacts analyzed were extended to 10,000 years into the future.

The EIS does not limit the analysis of land use commitments to "essentially the amount of shrub-steppe that is torn up." None of the land use impacts identified are based on shrub-steppe disturbance as a criteria for determining land use impacts. Rather, for temporary land use commitments, the EIS does identify the amount of land that is not currently disturbed within the 200 Areas that would be needed to support "construction and operating the alternatives and construction activities associated with closure." This land would be unavailable for alternative uses during the period of construction or operations and then after construction or operations was completed. Permanent land use commits land used for waste disposal facilities to permanent waste disposal. These areas become unavailable for alternative uses. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.5.8 VISUAL RESOURCES

No comments were submitted for this topic.

L.5.9 NOISE

No comments were submitted for this topic.

L.5.10 TRANSPORTATION

No comments were submitted for this topic.

L.5.11 ANTICIPATED HEALTH EFFECTS

Comment Number 0005.16

Swanson, John L.

Comment I would like to see the cancer risk estimates presented in the context of comparison with the cancer risk to the involved population due to background radiation and to other "naturally" occurring cancers. I would also be interested in seeing estimated values of something like "dollars per cancer prevented" for the alternatives.

Response The context requested by the comment is presented in Volume One, Sections 4.11 and 5.11, which discuss the effects of radiation on humans, including the cancer risk from exposure to natural or background radiation sources.

DOE and Ecology believe that presenting estimates such as dollars per cancer prevented would be inappropriate because such estimates could be construed as a value judgment. The purpose of the EIS is to provide decision makers and stakeholders with a balanced, unbiased assessment of the impacts associated with the alternatives.

Comment Number 0072.197

CTUIR

Comment P D-2: Table D.1.0.1: The first bullet in the post remediation risk is unacceptable because closure was addressed within earlier sections, and the leakage is tank waste leakage, not some other form or source of leakage.

Response The existing contaminants from past practice are not in the scope of this EIS. The impact of closure is not evaluated for this EIS. DOE will conduct an appropriate NEPA review in the future (59 FR 4052). For purposes of comparing the alternatives, a single and consistent method of closure, closure as a landfill, was assumed for all alternatives. This does not mean that closure as a landfill is proposed or necessarily would be selected in the future. Volume One, Section 3.3.1 discusses the closure issue in greater detail. The leakage of tank waste during the remediation is considered in the risk assessment in this EIS. Past tank waste leaks are considered in the analysis of cumulative impacts presented in Volume One, Section 5.13 and Volume Four, Appendix F. For additional information on the relationship between closure and this EIS, please refer to Comment numbers 0072.08 and 0101.06 for discussions of the closure issue and 0030.02, 0091.01, and 0012.15 for a discussion of vadose zone contamination. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.198

CTUIR

Comment P D-12: Sect. 2.1.3: Please insert a subsistence Native American scenario into this section. The subsistence Native American scenario represents a Native American living on the land subsisting from all the natural resources inherent on the Hanford site. This scenario involves complete acts or activities, is assumed to have access to ground water and is assumed to live anywhere on the site or anywhere along the Columbia River.

Response In consultation with the affected Tribes, a Native American scenario has been developed and used to evaluate the post-remediation risk to a Native American user of the Hanford Site. This scenario represents exposures received during a 70-year lifetime by a Native American living on the land and subsisting on its inherent natural resources. Subsistence activities included in this scenario include hunting, fishing, and gathering of plants and materials. Pathways include those defined for the residential farmer scenario in the Hanford Site Risk Assessment Methodology (HSRAM) (DOE 1995c), plus additional pathways, such as sweat bathing, which represent activities unique to the Native American subsistence lifestyle. The ingestion rates of native foods are based on a combination of EPA-suggested intake rates (EPA 1989b), intake rates used for the Native American scenarios in the Columbia River Comprehensive Impact Assessment (Napier et al. 1996), and data obtained through consultation with the affected Tribes. A complete description of the Native American exposure scenario and the method for its evaluation have been added to Volume Three (Appendix D, Section D.2.1). Results of the post-remediation risk calculations for the Native American scenario have been added to Volume Three (Appendix D, Section D.5.0). A summary of the scenario description and the risk results have also been added to Volume One (Section 5.11.2). For related information on post-remediation accident impacts to Tribal Nation sacred sites and cultural resources, please refer to the response to Comment number 0072.225.

Comment Number 0072.199

CTUIR

Comment P D-14: Please insert the subsistence Native American scenario here.

Response The risk assessment for the EIS was revised in Volume One, Section 5.11 and Volume Three, Appendix D to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. Please refer to the response to Comment number 0072.198 for more information on the Native American scenario.

Comment Number 0072.200

CTUIR

Comment P D-16: Please insert table D2.1? Exposure pathways included in subsistence Native American Scenario: Subsistence Native American Exposure factors; Subsistence Native American Summary Intake factors.

Response Three new tables containing the data and assumptions used for evaluating post-remediation exposures for the Native American scenario were added to the post-remediation methodology discussion presented in Volume Three, Appendix D, Section D.2.1.3. Table D.2.1.2 presents the exposure pathways included in the Native American scenario, Table D.2.1.3 presents the Native American scenario exposure factors, and Table D.2.1.4 presents the Native American scenario summary intake factors. In addition, please refer to the response to Comment number 0072.198 for more information on the scenario.

Comment Number 0072.201

CTUIR

Comment P D-23: External-exposure route shielding is spelled incorrectly.

Response The spelling error has been corrected in Volume Three, Table D.2.1.6.

Comment Number 0072.202

CTUIR

Comment External-other factors 'shielding' is spelled incorrectly.

Response The spelling error has been corrected in Volume Three, Table D.2.1.6.

Comment Number 0072.203

CTUIR

Comment Same comment as above. (see comment number 0072.202)

Response The spelling error has been corrected in Volume Three, Table D.2.1.6.

Comment Number 0072.204

CTUIR

Comment P D-32: The Strenge-Chamberlain 1995 reference does not differentiate between roots and leafy matter.

Response The risk calculation for all receptors indicates that the contribution of roots and leafy vegetables to the overall risk is very small compared to drinking water. This is demonstrated in the uncertainty analysis developed for the Final EIS and presented in Volume Five, Appendix K.

Comment Number 0072.205

CTUIR

Comment P D-33: The fish ingestion pathway should be based upon the whole fish and not just on what is considered to be 'edible' portions. For further information contact CTUIR technical staff regarding this issue.

Response The concept of edibility varies from culture to culture and Native Americans might consume portions of fish and other animals not commonly consumed by other cultures. The Native American scenario added to the Final EIS, which was developed through consultation with the affected Tribal Nations, includes pathways for ingestion of fish organs, animal organs, and wild bird meat. Intake of fish organs was accounted for by increasing the total fish muscle tissue intake by 10 percent and assuming that contaminated concentrations in fish organs were 10 times the concentrations in fish muscle tissue. Intake of animal organs and wild bird meat was similarly accounted for by increasing the total meat ingestion rate. Please refer to the response to Comment number 0072.198.

Comment Number 0072.206

CTUIR

Comment P D-35: Please re-look at this paragraph, it is awkward and needs to be redone in relation to recent material regarding the Chernobyl accident. Additionally, there is new information regarding genetic affects as presented in NCRP no. 116.

Response Although some epidemiological data for the Chernobyl accident are available in the scientific literature, the studies are not yet complete and the ICRP has not yet issued revised recommendations for hereditary risk factors based on Chernobyl data. The international risk community is now evaluating the hereditary effects of the Chernobyl accident by tracking the incidence of hereditary effects in the progeny of the exposed population and statistically comparing this incidence to that of a nonexposed control population. Until these studies are complete and the ICRP publishes revised recommendations regarding hereditary risk, it would not be appropriate to use Chernobyl data as the basis for an evaluation of hereditary risk.

In response to this comment, the genetic effects information in National Council on Radiation Protection and Measurement (NCRP) No. 116 has been reviewed. This information suggests that the human and animal genetic studies mentioned in the EIS might underestimate the genetic effects of ionizing radiation. The text of the EIS in Volume Three, Section D.2.1.3.3 has been modified to indicate that genetic effects might be greater than indicated by previous human and animal studies, but that the data are not sufficiently validated to permit analysis at this time.

Comment Number 0085.04

Klein, Robin

Comment At the same time, we must act aggressively and do what we can now to prevent further calamity and contamination. Also, the Draft EIS considers these hypothetical users over the next 10,000 years. It is ludicrous to consider such bearing uses, or to consider controls or restrictions for use of soil, groundwater, whatever, so many years hence. Therefore we have a responsibility, an obligation to clean up the site to the fullest extent possible, and as aggressively as we can to reduce spread and impact of the contaminants.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Consideration of land uses over long periods of time extending into the future was carried out for purposes of comparing alternatives that would have impacts far into the future. The alternatives evaluated represent a reasonable range of alternatives for accomplishing the TWRS mission. Long-term impacts are calculated to support the decision-making process. The EIS also presents short-term impacts associated with implementation of the alternatives and within the 100-year administrative control period. Both long-term and short-term impacts are presented to provide the public and the decision makers with information on environmental and human health impacts that support the comparison of the impacts among the alternatives. Because both short- and long-term impacts are provided, no change to the document is warranted.

Comment Number 0085.05

Klein, Robin

Comment For the record, the anticipated numbers of cancers and fatalities in the Draft EIS that would result from various scenarios and alternatives are a subject of scientific and political controversy in and of themselves, and should not be taken as absolute in this Draft EIS, but rather as relative measures.

Response The risk calculations were performed to support the impact assessment and comparison of alternatives. These risks were not intended and should not be interpreted to represent absolute risks. The Final EIS in Volume One, Section 5.11 and Volume Three, Appendix D presents ranges of risk for each alternative, which provides a better estimate of the potential risks associated with each alternative. For the Final EIS, an expanded uncertainties analysis has been incorporated in Volume Five, Appendix K. This analysis addresses the nominal bounding risk estimate.

L.5.11.1 Remediation Risk

Comment Number 0005.56

Swanson, John L.

Comment One page 5-154 it is said that the cesium and strontium capsules contain no nonradiological chemicals. This is not true; they contain nonradioactive isotopes of cesium and strontium as well as stable isotopes produced on decay of the radioactive isotopes, and also the added chloride and fluoride. (On page 6-22 it is said that these capsules contain hazardous, characteristic, and/or listed wastes).

Response Wording to clarify that the capsules contain chloride, fluoride, and decay products (barium-137 and zirconium-90), in addition to the cesium and strontium, has been added to Volume One, Section 5.11. Risk from nonradiological chemicals during remediation was not evaluated because no nonradiological chemical emissions are associated with any of the capsule alternatives. Wording to clarify this point has also been added to Volume One, Section 5.11.

Comment Number 0028.01

DHHS

Comment The Draft EIS TWRS section dealing with potential adverse human health effects resulting from environmental releases of radioactive or hazardous materials, Volume Three and Appendix D, appears to be well developed and comprehensive:

1. Radiological and hazardous waste exposures to the public from treatment, storage, and disposal operations were estimated using information on waste loads (source terms) and potential at-risk years. Exposure modeling included meteorological data, hydro-geologic data, and potential release scenarios that included both facility and transportation accidents. Pathway modeling included use of GENII-S environmental modeling code. The function and source of each model type are well documented.
2. Risk estimate endpoints for the public included a) cancer incidence from radionuclide and chemical exposures, b) cancer fatalities from radionuclide exposure, c) adverse effects from transportation and/or transportation accidents.
3. Risk from radiological exposures were estimated using ICRP 60 risk factors. The uncertainties in the risk analysis procedure included model uncertainty, scenario uncertainty, and parameter uncertainty (sampling error, data sources).
4. The risk to public health from the transportation and storage of DOE waste materials, as expressed by the Draft EIS TWRS are reasonable.

Response DOE and Ecology acknowledge the comments concerning risk assessment. In response to public comments, the risk assessment has been enhanced by adding a Native American scenario to the evaluation of anticipated post-remediation risk and the analysis and presentation of risk ranges to request uncertainties. Please refer to the response to Comment number 0072.198 for a discussion of the Native American scenario and Comment number 0085.05 for a discussion of risk ranges.

Comment Number 0069.08

Pollet, Gerald

Comment Next, it is wrong to assume that the public in the near term, that is between now and the year 2028, will remain at the Site boundary in calculating risks. Even if you use the Site boundary, the risk calculations are out of date, and fail to consider risks from people using the river, and the new residences that are far closer than the previous north Richland case used.

Response The risk assessment in the Draft EIS addressed users of the Columbia River, the Fitzner Eberhardt Arid Lands Ecology Reserve, and areas of the Hanford Site north of the Columbia River. This information is presented in Volume One, Section 5.11 and Volume Three, Appendix D. The risk assessment in the Draft EIS does not use north Richland as the Site boundary. Rather, the assessment uses a modified boundary, which includes areas likely to be released by DOE in the near future. The maximally-exposed individual receptor is assumed to be located much closer to TWRS contamination sources than north Richland. The site boundary and receptor locations are discussed in Volume Three, Section D.2.2.3. Potential changes in onsite and offsite population and its effect on the risk calculation are addressed in the uncertainties discussion in Volume Five, Appendix K, which has been added to the EIS.

Comment Number 0069.09

Pollet, Gerald

Comment Third, the EIS must clearly show the risk from releases and explosions during the remediation period for each alternative. It's important that you show and use a conservative assumption as to the impact of delay. Throughout the EIS, in determining costs, you use a 40 percent cost contingency factor. In other words the costs are inflated just 40 percent as a contingency. Risk is a function of time, and what is amazing is that there is no contingency factor for time throughout this EIS in calculating risks. So we say that a plant will run 4 years, because that's the design basis for Phase 1 plant. Well if we have a 40 percent contingency for cost, one would also rationally say we might want to have a 40 percent contingency in terms of delay for that same plant. Therefore we have to re-calculate the risks.

Response Risks from releases during remediation were addressed in the Draft EIS in Volume One, Section 5.11 and Volume Two, Appendix D and remediation accidents, including explosions, were addressed in Volume One, Section 5.12 and Volume Four, Appendix E. The EIS analysis used bounding assumptions in analyzing health and accident impacts. A 60 percent efficiency factor was calculated into the remediation operations for each alternative. This assumption is presented in Volume One, Section 3.4.1. This is reflected in the length of operation time for each alternative in the TWRS EIS, and therefore, provides a contingency in the schedule. The probability of an accident (which would drive the risk) is based on the operation duration with the 60 percent efficiency factored in. Based on the assumed efficiency factor, the substance of the comment's suggestion that the EIS use a conservation estimate for facility operations has already been incorporated into the analysis, and therefore no change to the document is warranted. Please also refer to the response to Comment numbers 0072.225 and 0069.09 for discussions of accident risk during remediation and the 100-year administrative period.

Comment Number 0072.17

CTUIR

Comment For each scenario, the airborne release fraction (ARF) and respirable fraction (RF) should be presented separately, not as a single factor, because the nonrespirable fraction would be the fraction that deposits.

Response The airborne release fraction (ARF) and respirable fraction (RF) for planned atmospheric releases, such as would occur during routine TWRS remediation operations, would be the same. This is because planned releases would pass through a filtration system and all particulates that escape the filter would be in the respirable size range. Nevertheless, these particulates would eventually deposit, although they would stay suspended for long periods of time and be dispersed over large areas. The exposure calculation accounts for the contribution from these deposited particles. Please refer to the response to Comment numbers 0072.250, 0072.251, and 0072.17 for related information. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.207

CTUIR

Comment P D-87: Ground releases resulting in contaminant error concentrations would result in exposure to subsistence Native Americans.

Response The receptors evaluated for the remediation risk assessment (involved worker, noninvolved worker, and general public) were selected to represent a reasonable range of plausible onsite and offsite exposure scenarios that could arise during the construction and routine operational phases of the TWRS program. Because use restrictions and administrative controls would be in place at the Site throughout the remediation period, an onsite Native American scenario is not plausible. Plausible onsite exposures would be to the TWRS workers and noninvolved workers having access to the Site routinely during the remediation period.

Although an offsite Native American scenario is plausible during remediation, the exposures for such a scenario would not differ appreciably from the exposures presented in Volume Three, Section D.4.0 for the general public. This is because the inhalation pathway, which dominates all other pathways in the offsite remediation risk calculation, does not vary between the Native American scenario and the general public scenario. Because the remediation risk for the general public provides a reasonable approximation of the risk to the Native American, risk during remediation to the Native American has not been calculated separately and the EIS has not been changed. For a discussion of inhalation exposure for onsite receptors, please refer to the response to Comment number 0072.29, and for a discussion of inhalation impacts during remediation associated with sacred sites please refer to Comment number 0072.247.

The onsite Native American scenario, although not plausible during remediation, is considered plausible for the period following remediation. DOE and Ecology have developed a Native American scenario in consultation with the affected Tribes. This scenario has been added to the analysis of post-remediation risk presented in Volume Three, Appendix D and Volume One, Section 5.11.2 of the EIS. Please refer to the response to Comment number 0072.198.

Comment Number 0072.208

CTUIR

Comment P D-89: Sect. D 4.2.2: Please indicate what fraction of the Hanford site permit would be the allowable admission rates for the tank farms tank waste retrieval and evaporators.

Response At this time, it is not known what alternative will be implemented, and potential emissions associated with tank waste disposal actions are not covered by existing permits. Once the decision is made, the applicable permits would be obtained including possible revision or amendment of existing permits. Volume One, Section 6.0 discusses possible permitting necessary for implementation of the different alternatives. The chemical emissions for each of the alternatives are presented in Volume Five, Appendix G and are compared with the applicable Federal and State standards or permissible levels. Please refer to the response to Comment numbers 0072.243 and 0072.246 for related discussions. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.209

CTUIR

Comment P D-102: PP2: Please change dilution to dispersion.

Response Dilution has been changed to dispersion in the discussion of transport for this and all other alternatives in Volume Three, Section D.4.1 through D.4.9.

Comment Number 0072.210

CTUIR

Comment P D-105: What portion of each tank is expected to volatilize during gravel filling. As the tanks liquid is displaced by the gravels mass, raising the liquid level and disturbing the settled contents, a portion of the tanks contents can be assumed to exhale.

Response Tank emissions during gravel filling were calculated and included in the impact assessment. Emission data are provided in Volume Five, Section G.3. Additional technical data are provided in the Administrative Record for the TWRS EIS and are available for public review in the DOE Reading Rooms and Information Repositories locations listed in Volume One, Section 7.0. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.211

CTUIR

Comment P D-118: Sect. 4.1.1: Please indicate what portion of the overall source term is represented by the tanks contents.

Response One hundred percent of the source term is from the tank contents as presented in Volume Two, Appendix A. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.212

CTUIR

Comment P D-268: Sect. D.4.14: The mention of accumulation of contaminants in food products indicates that there may have been discussion of Native American food products. Please indicate when and where you have consulted with the affected Tribes regarding this topic.

Response The cited statement refers to a generic source of food products used for the remediation risk analysis. The remediation risk assessment in the Draft EIS addresses risk to the TWRS worker, the noninvolved worker, and the general public, but does not specifically address risk to a Native American receptor. Risk to a Native American receptor during the remediation period would be dominated by the inhalation pathway. For this reason, it would be similar to the risk presented in Volume Three, Appendix D, Section D.4.0 for the general public. The discussion of uncertainty in the risk assessment has been moved from Volume Three, Appendix D to a new Volume Five, Appendix K.

In response to Tribal Nations comments, DOE and Ecology have consulted with the affected Tribes and have developed a Native American scenario for inclusion in the post-remediation risk assessment for the Final EIS. The analysis of post-remediation risk to the Native American receptor has been added to Volume Three, Appendix D, Section D.5.0. Please refer to the response to Comment numbers 0072.149, 0072.55, 0072.198, 0072.207, and 0072.225 for more information on this topic.

Comment Number 0072.213

CTUIR

Comment P D-271: PP1: The consideration that age dependence is not expected to be as important as other factors is unacceptable to the people of the CTUIR whose very lives depend on the health and safety of their elders.

Response The statement regarding age dependency pertains to the internal dose calculation and its sensitivity to the overall dose and risk results. The statement "Age-dependent variations are considered to be less important because the generally higher internal dose factors (ICRP 1975) for the lower age groups are offset by lower breathing and food consumption rates" does not support or oppose the risk response for low or high age groups. For clarity, this sentence has been changed in Appendix D to read "Age-dependent variations are considered to be less sensitive..." In addition, the exposure duration for the Native American scenario added to the risk assessment assumes 70 years instead of the 30 years used for the other receptor scenarios. Please refer to the response to Comment number 0072.198 for related information. The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.214

CTUIR

Comment P D-272: PP 2: This paragraph is confusing, where was the total population evaluated?

Response The population for the onsite and offsite risk calculations is presented in Volume Three, Tables D.2.2.3 and D.2.2.4, respectively.

Comment Number 0090.05

Postcard

Comment Please listen to us say no:

I urge USDOE and the State of Washington to fully calculate the risks of explosions and leaks from any delay in vitrifying these wastes.

Response For a discussion of the relationship between closure, including past tank leaks, please refer to the response to Comment numbers 0012.15, 0072.08, 0101.05, and 0101.06. The risk of tank deflagrations and explosions has been further analyzed by DOE and Ecology for the Final EIS. The results of the new analysis have been incorporated into the Final EIS in Volume Four, Sections E.2.2, E.3.3, E.4.3, E.5.3, E.6.3, E.7.3, E.8.3, E.9.3, E.10.1, and E.10.2. A bounding risk from delay in vitrifying these wastes is presented in Volume Four, Section E.2.2 where the risk is shown from accidents that could result if vitrification is delayed indefinitely under the No Action alternative. Please refer to the response to Comment numbers 0069.10, 0069.12, and 0081.07 for more information regarding risk analysis relative to delays in remediation.

L.5.11.2 Post-Remediation Risk

Comment Number 0009.02

Broderick, John J.

Comment Potential health effects must be reasonable--not zero. There is not enough money to try to clean Hanford so completely that there will be no health impacts. For this reason, the remediation of the tank waste must permit leaving some waste in place with reasonable number of potential health effects.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. The risk assessment is intended to provide an unbiased analysis of the anticipated health effects associated with the alternatives, and health effects are only one of many impacts analyzed in the EIS.

Comment Number 0012.17

ODOE

Comment Risk Assessment

The risk assessment in the EIS is sufficient to support the proposed action. We do not believe it is sufficient to support any decision which would leave waste in Hanford tanks.

The risk assessment shows long-term substantial environmental and public risks across most of the Hanford Site. The uncertainty in these estimates is so large, we believe the risk assessment should therefore not be relied upon or used as a decision making tool to micro-manage cleanup. It should only be used as a rough measure of the relative effectiveness of the various alternatives at reducing risks. The risks shown are large and justify complete removal and vitrification of all tank wastes.

The risk assessment shows great risk reduction from ISV. It does not however, include the large uncertainty in the technical feasibility of this alternative. ISV has only been demonstrated to a depth of 15 feet in soil. It has not been demonstrated for the depth and areas required for ISV of tank wastes. The risk assessment gives no indication a large uncertainty exists for this alternative. The uncertainty this creates in the ultimate risks is too large for this to be considered a viable alternative.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

The risk assessment was conducted to support a comparison of alternatives rather than to determine the absolute risk associated with a particular alternative. Health effects are but one of many impacts considered in selecting the preferred alternative.

DOE and Ecology understand the concern regarding uncertainty and have identified the need to provide additional information in the EIS to clarify the sources and magnitude of uncertainty in the risk calculations. Further uncertainty analysis has been completed and presented in the EIS in Volume Five, Appendix K. Issues concerning uncertainty in the implementability of the ISV alternative are discussed in Volume One, Section 3.4 and Volume Two, Appendix B. The ISV design is recognized as being conceptual in nature and having a high degree of associated uncertainty.

Comment Number 0036.12

HEAL (Exhibit)

Comment Risk from tank waste may be underestimated.

For the preferred alternative, the risk calculations assume that 99 percent of the waste will be retrieved. HEAL supports this assumption and the goal of total retrieval. However, it is unlikely that fully 99 percent will actually be retrieved given current and reasonably foreseeable technologies. Therefore, the risk may actually be much greater due to a larger amount of waste left in the tanks. This is not a request to change this assumption. Rather, it is a point stressing the importance of retrieving all the waste.

Response As is pointed out in Volume Four, Appendix F, Section F.2, the goal of the Tri-Party Agreement is to leave no more than 1 percent of the waste in the tanks after retrieval. Until waste from a sufficient number of tanks has been retrieved, it is not known whether the residual content will be greater or less than the goal of the Tri-Party Agreement. The amount and type of waste that would remain in the tanks after retrieval is also uncertain. The engineering data for the waste retrieval and transfer function common to all ex situ alternatives were developed using 99 percent retrieval as a goal. This information is presented in Volume One, Section 3.4 and Volume Two, Appendix B. The retrieval assumption also included a conservative assumption that the 1 percent residual would be as soluble as the 99 percent retrieved from the tank. This assumption provides a bounding case for impacts to groundwater and health risks under conditions where less that 99 percent of the waste is retrieval. Please refer to the response to Comment numbers 0005.18, 0089.07, 0072.59, and 0076.01 for related information. Because of the uncertainties associated with waste retrieval and the assumptions used in the EIS to bound the impact analysis, no change to the document is warranted.

Comment Number 0036.19

HEAL (Exhibit)

Comment Risk confirms importance of this program.

The high human health risks posed by all of the alternatives emphasize the importance of the Hanford tank waste disposal program. While the uncertainty involved with the EIS's risk calculations is high, the calculations still serve as a rough guide to future health risks.

The EIS shows that the human health risks are directly related to the amount of tank waste left behind. Assuming only 1 percent of the waste is left behind still leaves the farmer at 10,000 years with a 3 in 10,000 chance of cancer. The risk resulting from tank waste being left behind is demonstrated by the Ex Situ/In Situ Combination alternative in which 90 percent of the contaminants are removed by retrieving 50 percent of the waste volume. The risks resulting from this alternative for the farmer at 10,000 years are 3 in 1,000 -- an increase of an order of magnitude over the ex situ alternatives.

The reduction in risk gained in removing 99 percent of the contaminants as opposed to 90 percent shows the importance of the tank waste treatment and disposal program.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0038.04

Reeves, Merilyn

Comment It has also been assumed that the Hanford tank wastes pose a great risk to future generations. And this EIS confirms that assumption.

The EIS shows that the future risk is directly correlated to the amount of waste left behind in the tanks.

The impact of leaving only a small amount of contamination behind is evidenced by the difference in long-term risk for the preferred alternative, where one percent of the waste is left in the ex situ, in situ alternatives, where there is 10 percent left behind, and by leaving nine percent more waste the risk for the residential farmer in 5,000 years increases the factor by 10. These clearly show that the only responsible solution is to retrieve all the waste.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0040.03

Rogers, Gordon J.

Comment I reject dangers to hypothetical intruders as not a realistic concern (for the In Situ Fill and Cap alternative); which is also connected to the administrative control assumption.

Response It is common for purposes of NEPA assessment to assume that government agency administrative controls will end after a period of 100 years. In the absence of administrative controls, there is a probability of inadvertent human intrusion into the waste remaining onsite. To assist in differentiating between the alternatives, and to provide a more complete picture of the health risks posed by leaving waste onsite, the risk assessment included a hypothetical intrusion scenario. The scenario analyzed, well drilling, was considered the most likely intruder scenario. The probability of occurrence of this scenario is evaluated in the uncertainty analysis presented in Volume Five, Appendix K. Please refer to response to Comment number 0101.01 for a related discussion.

Comment Number 0041.02

Berry, Bill

Comment On Appendix D, the long-term analysis of risks, which unavoidably involves uncertainty to the point of being meaningless, assumes that a large industrial facility of 2,200 workers might exist on the Site in the future. The analysis then assumes that the facility would have a land use area of 785 sq. km., yielding a population density of 2.81 individuals/sq. km. Although this analysis may produce a type of average risk assuming the facility could be randomly located anywhere within the 785 sq. km. area (the facility clearly would not require anything near the entire area), a better approach would be siting the facility within the area of highest risk. This approach would provide a bounding estimate of risks to workers in the vent that the future industrial facility was located at the worst possible location.

Response The uncertainties regarding the risk assessment are presented in Volume Five, Appendix K, which has been added for the Final EIS. The industrial worker scenario is not land-area dependent; therefore, in calculating the total risk to the industrial worker, the population density of 2.81 and land use area of 785 km^2 were not used. As discussed in the response to Comment number 0041.03, population density and land use area were needed only for the residential farmer calculation. Volume Three, Table D.5.14.1 has been modified to show that population density and area of land use are not applicable to the industrial scenario. Please refer to the response to Comment number 0012.17.

The comment suggestion regarding the assumed siting of the industrial facility was considered. In response to this comment, the risk to the industrial worker has been recalculated assuming the facility is located in the area of highest risk. The text in Volume Three, Section D.5.14, has been modified to reflect the revised assumption.

Comment Number 0041.03

Berry, Bill

Comment In Table D.5.14.1 the population density for the recreational scenario appears incorrect (1950/104=18.75). I did not check the calculated incidence and fatalities to determine the population density that was used in the calculation. Those numbers should be checked or an explanation of why the lower population density was used should be provided as a footnote with the table.

Response The population density value given in Volume Three, Table D.5.14.1 for the recreational scenario was in error and has been changed. However, the cancer incidence and cancer fatality calculations are correct. To perform these calculations, a value for receptor population was required for each scenario. For the residential farmer scenario, a population estimate was not available; therefore, the population was calculated by multiplying an assumed population density by the Hanford Site area. Population estimates were available for the other scenarios; therefore, a population density was not needed. Population densities are shown in the table for all scenarios for the sake of consistency. The text in Volume Three, Section D.5.14 has been modified to clarify how population density was used in the calculations.

Comment Number 0055.07

Martin, Todd

Comment Moving off of costs, the risks that we see in the EIS are profoundly troublesome to me and I think they under estimate the actual risk. This is not something that I think should be changed, but I think it should be noted. 99

percent retrieval is probably a dubious assumption. It is the correct assumption and it is where we should be going but we are probably not going to get there. In addition, if sluicing does result in more leaked waste we can expect to see much higher risks when you are seeing a residential scenario 10,000 debt years down of three in 10,000 cancer rate with only 1 percent of the waste left behind. Imagine what it is for 2 percent, 3 percent, or maybe 10 percent.

Response As discussed in Volume One, Sections 3.3.1 and 3.4.1, there are many technical uncertainties associated with the alternatives for remediating tank waste. Although the design information for these alternatives is an early planning stage, the technologies represented are considered sufficient to bound the range of viable technologies that are applicable to tank remediation. For purposes of analysis, 99 percent retrieval efficiency was considered a reasonable assumption for the ex situ alternatives. Please refer to the response to Comment number 0036.12 regarding tank waste retrieval assumptions and Comment numbers 0005.18, 0089.07, 0072.59, and 0076.01 for additional discussions regarding the 99 percent retrieval assumption.

Because of uncertainties regarding the amount and type of residual waste that would remain in the tanks, it was assumed for the ex situ alternatives that the residual waste would contain 1 percent of all constituents in the original tank inventory, including the water-soluble constituents. In actuality, the residuals would contain less of the water-soluble constituents because they would be preferentially retrieved through sluicing. The assumption that 1 percent of the water-soluble waste remains in the tanks thus provides an upper bound on the impacts associated with the ex situ alternatives. The In Situ Fill and Cap and Ex Situ/In Situ Combination 1 and 2 alternatives leave more waste in the tanks and provide an upper bound on the impacts associated with the amount and type of waste disposed of onsite. Additional discussion of the uncertainties surrounding retrieval are presented in Volume Five, Appendix K.

Regarding leaks during sluicing, the predicted groundwater contaminant concentrations used for the risk analysis in the Draft EIS were calculated assuming that SSTs leaked a volume of 15,000 liters (4,000 gallons) per tank during retrieval. Detailed discussion of the tank release assumptions used for the groundwater modeling effort is presented in Volume Four, Appendix F, Section F.2.2. For additional discussion regarding this assumption, please refer to the response to Comment numbers 0029.01, 0030.03, and 0072.75.

Comment Number 0069.03

Pollet, Gerald

Comment This is a long-term risk scenario where the risks to people in this area here from groundwater contamination are essentially 1 person dies out of every 100 exposed. And that is without taking into account the type of assumption that should be made for leaks today. That means, the risks are far greater if we leave any tank waste in-place. Call it in situ capping, it's gravel, folks. It's cemented gravel on top of it. It will reach groundwater.

Response For the No Action, Long-Term Management, and In Situ Fill and Cap alternatives, the maximum anticipated post-remediation risk (incremental lifetime cancer risk) reaches levels as high as 1 in 100. However, as shown in Volume One, Table 5.11.4, the post-remediation risk for the other alternatives is anticipated to be less (i.e., no risk or risk less than 1.0E-06).

Impacts associated with past leaks from the tanks, based on data that became available following publication of the Draft EIS, are addressed in Volume Four, Appendix F and in the cumulative impacts discussion in Volume One, Section 5.13. For more information related to this issue please refer to the response to Comment numbers 0012.05, 0030.02, and 0091.01.

Comment Number 0069.06

Pollet, Gerald

Comment Now I come to the issue of risks. The, I'm going to turn this off, Environmental Impact Statement makes a number of assumptions about risks that are clearly erroneous, and out of date as well. First, it apparently uses a recreational exposure scenario for calculating risk, which we have criticized repeatedly recently, of the public using the Columbia River just 56 hours a year. It is ludicrous. In fact, we believe that a rational scenario for recreational exposure is 1,040 hours a year. The risks shown for recreational exposure, and I want to remind everyone that and for the record remind everyone that risk is a function of time, therefore the risks presented for these scenario's are 18 times too low.

Response The exposure scenarios used in the risk assessment were based on the recommendations published in the HSRAM (DOE 1995c). These recommendations have been approved by the signatories to the Tri-Party Agreement for use in Hanford Site risk assessments. In the case of the recreational shoreline user scenario, the HSRAM scenario was modified to increase the exposure duration from one week to two weeks for 30 years. This provided a more bounding estimation of risk than would have resulted from using the HSRAM scenario and is considered by DOE and Ecology to be appropriate. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0069.07

Pollet, Gerald

Comment Second point as to this exposure scenarios along the Columbia River, folks where is the Native American Treaty Right usage? It is not presented here. That is a usage, guaranteed by the Treaty of 1855, which one can rationally assume will be asserted during this timeframe, and which allows Native American treaty right tribes to live along this area of the Columbia River, and to gather foods and fish in the usual accustomed places while living along the river for extended periods of time.

Response Please refer to response to Comment numbers 0072.37, 0072.198, 0072.252, and 0072.225 for discussions of the analysis of impacts in response to Comments submitted by Tribal Nations regarding treaty rights, cultural resources, and future land use.

Comment Number 0072.18

CTUIR

Comment No Native American exposure scenario is included. During the revision of the EIS, if such a scenario is added, it *must be preceded by consultation with CTUIR.*

Response The risk assessment for the EIS has been revised to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. The scenario used for the analysis was developed through consultation with representatives of the affected Tribes. Please refer to the response to Comment number 0072.198 for more information on the Native American scenario. For impacts associated with post-remediation accidents, refer to the response to Comment number 0072.225.

Comment Number 0072.19

CTUIR

Comment Deposition of particulates was not included.

Response The size of the particulates released during remediation would be very fine. These particulates would stay suspended in the atmosphere for long periods of time and would be transported over very large distances. A typical deposition velocity for particulates dispersed in the atmosphere is 1.0E-03 m/s. The post-remediation risk from deposition of particulates released to the atmosphere during remediation is very small. This risk is 3 to 4 orders of magnitude smaller than the inhalation risk during remediation. Anticipated health risk during and after remediation is contained in Volume One, Section 5.11, and Volume Three, Appendix D. Air quality issues are discussed in Volume One, Section 5.3. Please refer to the response to Comment numbers 0072.32 and 0072.240. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.20

CTUIR

Comment Genetic effects must be included, both for individual generations and for multiple generations.

Response The health effects endpoints used for the risk assessment (cancer incidence and cancer fatalities) were selected for consistency with other EISs prepared by DOE and with the endpoints used for the accident analysis presented in Volume Four, Appendix E. Cancer incidence and cancer fatalities are the endpoints commonly used for NEPA reviews, where the purpose of the assessment is to compare impacts among alternatives rather than to calculate absolute risks. A calculation of hereditary effects would not affect the ability of the decision makers and stakeholders to discriminate among the alternatives, because the results of the calculations would provide data that would support the same understanding of the relative difference among alternatives as does the existing calculation of cancer occurrences and cancer fatalities. For this reason, the decision to omit consideration of genetic risk from the EIS is considered appropriate, and the EIS has not been changed. The anticipated hereditary effects associated with the alternatives may be calculated by multiplying the radiological doses (rem) presented in Volume Three, Appendix D by the dose-to-risk conversion factor of 1.3E-04 (genetic risk per rem) published by the ICRP in 1991. Please refer to the response to Comment number 0072.206.

Comment Number 0072.21

CTUIR

Comment Existing soil and groundwater contamination was not included in the source term.

Response Existing soil and groundwater contamination are not included in the scope of the TWRS program and were specifically excluded from consideration in this EIS. However, existing soil contamination is addressed, in terms of its cumulative impacts with the TWRS alternatives in Volume One, Section 5.13 and Volume Four, Appendix F. Please refer to the response to Comment numbers 0030.02, 0072.08, 0012.15, 0091.01. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.22

CTUIR

Comment No evaluation of socio-cultural quality of life was included.

Response Volume Three, Appendix D is the technical support document for analyzing remediation and post-remediation health risks to human health and ecological and biological resources. This appendix does not and was not intended to provide an assessment of quality-of-life issues. The human health analysis presented in Volume Three, Appendix D is summarized in Volume One, Section 5.11. Impacts to ecological and biological resources are summarized in Volume One, Section 5.4.

To the extent that impacts to human health and biological and ecological resources are an indicator of the socio-cultural quality of life, the relative differences in impacts reported in Volume One, Sections 5.11 and 5.4 provide the public and decision makers with information on which a comparison among the alternatives may be formed. This same statement would apply to all areas of impact assessment summarized in Volume One, Section 5.0. In addition to human health and ecological and biological impacts, Section 5.0 documents potential impacts by alternative to geology, air quality, water quality, land use, biological and ecological resources, the economy, public services, and visual effects, among others. In total, the analysis presented in Section 5.0 represents the potential impacts of the alternatives on the human and natural environment and hence on the socio-cultural quality of life.

The broad range of data regarding potential impacts are presented in the EIS so that the public, agencies, Tribal Nations, and decision makers can be aware of potential impacts during the decision making process. It is the role of each of these participants in the decision making process to compare the impacts and apply their values when determining which among the factors that will influence the selection of the alternative to be implemented should be considered in comparison to other factors. The role of the EIS is to objectively present alternatives, provide a comparison of impacts among alternatives, and provide an opportunity for public, agency, and Tribal Nation participation in the NEPA process. Please refer to the response to Comment numbers 0072.37, 0072.53, 0072.271, and 0072.252. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.23

CTUIR

Comment For ecological evaluation, instantaneous dilution in the River is unacceptable.

Response The ecological impact analysis presented in Volume One, Section 5.4 and Volume Three, Appendix D does not assume instantaneous dilution of groundwater reaching the Columbia River. Potential hazards were estimated for direct exposure to the groundwater before dilution, with organisms using no other water source. Please refer to the response to Comment number 0072.217 for a discussion of dilution factors used in the analysis. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.24

CTUIR

Comment The ecological dose limits need to be revised (terrestrial is more protective than aquatic), and the ecological Hazard Indexes (HI) that were developed for the EIS need to add a safety factor for sensitive life stages.

Response The ecological radiation dose limits used for terrestrial and aquatic receptors are consistent with those recommended by the International Atomic Energy Agency (IAEA) (IAEA 1992) and NCRP (NCRP 1991), respectively. IAEA states that "It would appear that chronic does of 1 $mGyd^{-1}$ or less to even the more radiosensitive species in terrestrial ecosystems are unlikely to cause measurable detrimental effects in populations and that up to this level adequate protection would therefore be provided....In the aquatic environment it would appear that limiting chronic dose rates to 10 $mGyd^{-1}$ or less to the maximally-exposed individuals in a population would provide adequate protection for the population" (1$mGyd^{-1}$ equals 0.1 rad d^{-1}, and 10 mGy d^{-1} equals 1.0 rad d^{-1}, the units used as benchmarks in the text) (IAEA 1992). NCRP (NCRP 1991) addresses aquatic organisms only and concurs with the 1.0 rad d^{-1} value used as a benchmark in the EIS.

It is unclear what safety factor would be appropriate to protect sensitive life stages. The ecological hazard indexes (HIs) used in the EIS to estimate potential hazards from nonradioactive chemicals are conservative in that they are based on high exposure parameter exposures. For example, the No Action alternative analysis assumes direct contact with stored wastes, which is highly unlikely. Adding a safety factor to the HI in this scenario would not alter the conclusion in the EIS that such exposure would be lethal. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.54

CTUIR

Comment Hypothetical Future Land Users should include specific Native American usage scenarios - these are not "hypothetical" but inevitable.

Response The risk assessment for the EIS has been revised to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. The land use scenarios analyzed in the risk assessment are referred to as hypothetical in the sense that they would not occur until TWRS activities and other remediation activities outside the scope of this EIS are completed. Please refer to the response to Comment number 0072.198 for information on the Native American scenario.

Comment Number 0072.215

CTUIR

Comment P D-274: Sect. D.5.0: It is noted that there is no Native American scenario. Please insert a Native American scenario after consultation with affected Tribes.

Response The risk assessment for the EIS was revised to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. The scenario used for the analysis was developed through consultation with representatives of the affected Tribes and the results of the analysis are presented in Volume One, Section 5.11 and Volume Three, Appendix D. Please refer to the response to Comment number 0072.198 for more information on the Native American scenario.

Comment Number 0072.216

CTUIR

Comment P D-275: Sect. D.5.1: Please insert MUSTs after DSTs.

Response The text of Volume Three, Section D.5.1 has been changed as requested in the comment.

Comment Number 0072.217

CTUIR

Comment P D-276: PP4: What exactly is the dilution factor used here? In addition, all contaminates in the ground water must be evaluated in the surface water.

Response As stated in the referenced paragraph (Volume Three, Section D.5.1.2), the dilution factor used is 1.21E-04. This factor indicates that a groundwater plume intersecting the river with a concentration of 1.0 Ci/L will produce a surface water concentration of 1.21E-04 for the entire Columbia River (from Hanford to the Pacific Ocean). Not all contaminants were addressed because some contaminants are not mobile in groundwater. The analysis addresses those groundwater contaminants that are the most mobile and contribute appreciably to risk. The transport of contaminants from tanks to groundwater and surface water is discussed in Volume Four, Appendix F. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.218

CTUIR

Comment P D-277: Sect. D.5.14: PP4: There are no risk free areas, please indicate exactly what this means.

Response This paragraph was included to explain why "holes" appear in the risk distributions on certain risk contour plots. These "holes" appear as white areas that have risk values less than the minimum contour interval (i.e., less than 1.0E-06). They are not risk free but have less risk than lowest value contoured. The text in Volume Three, Appendix D has been modified to clarify this point.

Comment Number 0072.219

CTUIR

Comment P D-279: PP 1: The surface water exposures should have been calculated for all constituents, not just five using an unknown dilution factor.

Response All the constituents are used in the analysis, but only five constituents (i.e., carbon-14, technetium-99, iodine-129, neptunium-237, and uranium) with high mobility (low K_d) will contribute appreciably to risk within the 10,000-year time period. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.220

CTUIR

Comment P D-284: Sect. D.5.6.1: Other sources that should be evaluated here should include tank leakage, because the one percent if left in the tanks will add to the current leakage inventory and continue to migrate just as current leakage inventory does.

Response The effects of contamination from past activities are not within the scope of the EIS but will be addressed in a future NEPA analysis on tank farm closure. Please refer to the response to Comment number 0072.08. The potential cumulative impacts of past tank leaks, TWRS alternatives, and other Site actions are addressed in Volume One, Section 5.13 and Volume Four, Appendix F. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0072.221

CTUIR

Comment P D-432: Sect. D.6.2.2: Ecological effects that should be documented here include loss of habitat, disintegration of habitat, loss of diversity.

Response Loss of habitat, disintegration of habitat, and loss of diversity are examples of the "variety of potential indirect effects on other ecological variables" mentioned in the text of Volume Three, Section D.6.2.2. These items have been added to the text of the methods and results sections for clarification. The following sentences have been added to Volume Three, Section D.6.

"Examples of potential indirect effects include decreased biodiversity, habitat loss or alteration, and impacts on productivity and nutrient turnover. Any direct effects on individual organisms exposed to stored wastes could lead to a variety of indirect effects on the ecosystem, including decreased biodiversity, habitat loss or alteration, and impacts on productivity and nutrient turnover. Since the direct impacts of air and groundwater exposure are estimated to be small, any associated indirect impacts on the ecosystem would be correspondingly minor. Thus, potential direct impacts on organisms and any associated indirect impacts on the ecosystem would be expected to be relatively small. Corresponding indirect impacts on the ecosystem would be similarly unlikely."

The direct impacts of loss of habitat, fragmentation of habitat, and loss of diversity for ecological and biological resources are provided in Volume One, Section 5.4.

Comment Number 0072.222

CTUIR

Comment P D-433: Sect. D.6.2.4: The conceptual model for terrestrial organisms needs to take into account impacts that result in the loss of diversity and associated potential ecosystem imbalances.

Response The conceptual model is intended to illustrate potential pathways by which ecological receptors may be exposed to contaminants. Loss of diversity and other alterations in the ecosystem, though important, are potential indirect effects of organism exposures to contaminants, and were not used as assessment or measurement end points in the analysis. Potential indirect effects have been added to the text of Volume Three, Section D.6.2.2 and to Volume One, Section 5.4. Please refer to the response to Comment number 0072.221.

Comment Number 0072.223

CTUIR

Comment P D-434: There should be an arrow from waste to plants and animals and an arrow from plants to all of the animals. It is well known that hawks and shrikes use vegetation for nesting, soil for dusting. Coyotes have been known to eat plants and are in constant contact with the soil.

Response The conceptual model figure shows those pathways that were evaluated in the analysis. The scenario examining direct exposure to stored wastes assumed the "soil" contaminant concentrations were identical to those in the waste, effectively connecting "waste" compartment directly to the "plant" compartment, as suggested. Adding additional exposure pathways with a very small contribution to total risk would not alter the conclusion in the text that direct exposure to stored wastes would be lethal. The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.224

CTUIR

Comment P D-435: The CRITRII model uses simple food chain and bioaccumulation factors to estimate doses to a very few select species in a very complex set of ecosystems. This model extrapolates from grain values and leafy vegetable values eaten by standard wild animals (the pocket mouse and the male deer) assuming that the biochemistry is similar to the typical lab rat. There is no differentiation for embryos, fetuses, pregnant females, developing young, or very old animals. Additionally there are assumptions for biological steady states which negates underlying health problems an animal could have. It would seem then that because of the large amount of unknowns associated with the biochemical uptake and transfer mechanisms, the resulting uptake factors, the impacts to different age groups and sexes of the assessment group, the lack of information of underlying health, the small receptor group size, the lack of true representativeness, the role of each species in stabilizing the biodiversity, that the uncertainty analysis would have explained the results noting these factors.

Simply leaving the reader to assume that the only secondary sources of uncertainty are those which are the most easily quantified is very unfortunate. Please address the uncertainties listed above.

Response The conceptual model used to estimate hazards to terrestrial organisms and the CRITRII model used for estimating maximum radiation doses to aquatic organism exposed to groundwater entering the Columbia River make a series of simplifying assumptions, including the use of representative species. These models do not distinguish among species subpopulations, such as differing age groups, and they assume steady-states for such factors as the transfer of contaminants through the food chain.

Volume Three, Appendix D does not address sensitive subpopulations, but transfer factors used to estimate uptake by plants and assimilation in the mouse are mentioned as uncertainty sources, as are the No Observed Adverse Effect Levels used to estimate HIs. In addition, the analysis used bounding assumptions such that risk is more likely to be overstated than understated. For example, the No Action alternative analysis assumes direct contact with stored wastes and consumption of contaminated groundwater with no dilution of the water in the Columbia River, both of which are highly unlikely. It is unlikely that detailed uncertainty analysis would alter the conclusion that direct exposure to stored wastes would be lethal. The uncertainty discussion in Volume Three, Section D.6.5 has been modified to address the issue raised in the comment by adding the following sentences.

"The CRITRII model was used only for estimating maximum radiation doses to aquatic organism exposed to groundwater entering the Columbia River at 300 and 500 years. These estimates were all lower than one millionth of a rad per day, the benchmark recommended by NCRP (1991) as protective of aquatic organisms. It is unlikely that detailed uncertainty analysis would alter the conclusion that groundwater risks to aquatic organisms are very low."

Comment Number 0081.09

Pollet, Gerald

Comment I have two minor points that I wish to say. One is, I think that in this EIS something unique was done that is very valuable, and we'd like to thank Ecology and U.S. DOE for including these visualizations of the risks. In these risk isopleth maps for the first time. It allows the public to see that if in fact you take a look at leaving waste behind, along the Columbia River, the risk of fatal cancer at a glance you can see there are areas that have extremely high risks of fatal cancer. I think this is, it's an innovation to not just present data in tables, but to present this as a map where you can visualize what the risks are for different locations.

Response DOE and Ecology acknowledge the comment regarding the contour plot method used in the EIS to illustrate the areal risk distributions resulting from the risk calculations. DOE and Ecology continually strive to present these complex issues in an understandable form and believe the areal distribution of risk is one of the best innovations in presenting the results of risk assessments.

Comment Number 0089.12

Nez Perce Tribe ERWM

Comment Page D-15

The Hanford Site use scenarios including, Residential Farmer, Industrial, Recreational Shoreline User and Recreational Land User are not adequate to describe a Native American use scenario. The recreational scenarios only assumes usage for 14 days per year for 30 years. Information is now being compiled on the Hanford Site for Native American use scenarios. This information is currently being prepared through the Columbia River Comprehensive Impact Assessment effort. Please contact Joe Fitch of the Nez Perce Tribe ERWM for specific information regarding Nez Perce Tribal use and Native American use scenarios.

Response The risk assessment for the EIS has been revised to include an evaluation of anticipated post-remediation risk to a Native American user of the Hanford Site. The scenario used for the analysis was developed through consultation with representatives of the affected Tribes. Under this scenario, an individual engaged in a subsistence Native American lifestyle is assumed to spend 365 days per year on the Site over a 70-year lifetime. Please refer to the response to Comment number 0072.198 for information on this scenario. For information on the recreational use scenario, please refer to the response to Comment numbers 0041.03 and 0069.06.

Comment Number 0101.02

Yakama Indian Nation

Comment In order to base performance assessments on assumptions that are consistent with providing reasonable assurance of protecting public health and safety and the environment far into the future, <u>a design confidence level for the entire Hanford Sites performance must be established</u>. Then, the suite of scenarios developed to define conditions to be evaluated over the time frame protection is intended must be objectively established, consistent with providing the design confidence level intended. The legal term frequently used to define the necessary confidence level is reasonable assurance. This is generally recognized to be a very high level of confidence, consistent with the intent of various environmental laws and the Atomic Energy Act to protect public health and safety and to protect the environment.

Response DOE and Ecology recognize the potential for diversity of criteria across the projects at Hanford and concur with the consistent Hanford Sitewide environmental performance design criteria. The level of confidence in the TWRS EIS risk assessment provides reasonable assurance that impacts will not be higher than the level assessed in the EIS. In the TWRS EIS, the long-term scenarios are based on 95 percent confidence that they are bounding risks.

In accordance with CEQ requirements, the EIS is prepared early in project planning well in advance of detail design criteria, which would be needed for rigorous probabilistic risk assessment. As more information becomes available relative to the tank waste, the level of uncertainty will be reduced and more precise estimates of impacts will be possible. Please refer to the response Comment number 0101.03 for a related discussion and 0072.225 for a discussion of the NEPA requirement to analyze impacts commensurant with their likelihood and potential consequences.

L.5.12 ACCIDENTS

Comment Number 0012.21

ODOE

Comment Table E.15.0.2 on page E-248 of Volume Four considers loading of waste glass with 40 weight percent of waste oxide. It reports a population dose of 7,900 person-rem for the Ex Situ Intermediate Separations alternative. This is beyond the limit by weight that waste oxide can be put in glass. Loadings of over 30 weight percent waste oxide are no longer glass. They are sodium silicates. As a consequence, the population dose is wrong. Errors such as this greatly increase the uncertainty in the potential real risk to the population, as compared to the modeled risk in the EIS.

Response The 40 percent waste oxide loading used for this sensitivity analysis also included a 1.5 blending factor. Use of the 1.5 blending factor would result in a net waste oxide loading of 27 percent. Published literature supports waste oxide loadings in excess of 30 weight percent. Therefore, the populations dose of 7,900 person-rem for the Ex Situ Intermediate Separations alternative is appropriate for analysis and no change to the document is warranted.

Comment Number 0072.225

CTUIR

Comment P E-3: PP 4: bullets 3-4: Page E-3: These bullets state that "unmitigated consequences" would be the basis of comparison, while page E-27 states that ingestion and groundshine were not evaluated as accident consequences because mitigation measures were assumed to occur. This is inconsistent. In addition, mitigation is never 100 percent successful, and the potential impact areas, food interdiction requirements, evacuation and relocation costs, and many other factors are all clearly consequences of the more severe accidents. Assuming that intervention is only partially effective (as is really the case), also means that, depending of the half lives of the materials released, there would be long-term and multigeneration impacts from some of the accidents. Intervention itself can be extremely destructive, as an example of event consequences that must be included. Regardless of the habitual methods for performing Safety Analyses, a full accident evaluation must include all potential consequences. CTUIR technical staff can also provide recommendations for translating environmental concentrations into human, environmental and socio-cultural risks.

Response The bullets are in reference to unmitigated consequences being compared to the Hanford Site risk acceptance guidelines for developing safety controls for the TWRS Accelerated Safety Analysis. DOE and Ecology have further analyzed the risk from the unstabalized tanks collapsing after the 100-year institutional control period. Because this is a likely event and there would be no institutional controls, evacuation and interdiction of food consumption would not be a mitigative barrier. The resulting analysis includes the added risk from groundshine, ingestion, and deposition. The new analysis is presented in Volume Four, Sections E.2.3 and E.3.4. Text also has been added to the methodology in Volume Four, Section E.1.1 to reflect this change.

All other remediation accident scenarios either have very small offsite consequences or the probability of the event is extremely unlikely. The Final EIS provides an analysis of the environmental and socio-cultural impacts from these accidents with the amount of detail commensurate with their likelihood and potential consequences as directed in Recommendations for the Preparation of Environmental Assessments and EISs, Office of NEPA Oversight, DOE, Washington, D.C., May 1993 (DOE 1993d). The text has been modified in the methodology in Volume Four, Appendix E to provide a qualitative assessment of the potential environmental and socio-cultural impacts and mitigative measures that would be taken. Please refer to the response to Comment numbers 0072.226 and 0072.26.

Comment Number 0072.226

CTUIR

Comment P E-13: Sect. E.1.1: Accident risk evaluation in general has a long history, yet methods are still archaic. As we have described elsewhere, the evaluation of risk from normal operations and from accidents needs to span the full range of potential impacts, including not only human dose, but also environmental and socio-cultural impacts. Methods are available for deriving guidelines for accident risks that include risk acceptance criteria for different accident frequency classes for each risk measure. For any revision of such risk acceptance guidelines, CTUIR expects to see risk acceptance criteria for each type of impact that could occur from accidents, and can offer technical and regulatory guidance in selecting appropriate risk levels.

Response The direction from Recommendation for the Preparation of Environmental Assessments and EISs, Office of NEPA Oversight, DOE, Washington D.C., May 1993 (DOE 1993d) is to calculate the potential risk from accidents (e.g., the number of LCFs from exposure to radiological constituents). The risk is not to be measured against risk acceptance guidelines, but against potential risks calculated in the other proposed alternatives. Risk is measured against risk acceptance guidelines in safety analysis reports for operation and facility design. Risk assessment guidelines help provide guidance in establishing administrative and mechanical barriers to mitigate or prevent unacceptable accidents from occurring. No change to the document is warranted.

Comment Number 0072.227

CTUIR

Comment P E-27: PP 4: Groundshine and ingestion pathways must be included.

Response DOE and Ecology have further analyzed the risk from the unstabalized tanks collapsing after the 100-year institutional control period. Because this is a likely event and there would be no institutional controls, evacuation and interdiction of food would not be a mitigative barrier. The resulting analysis includes the added risk from groundshine, ingestion, and deposition. The new analysis is presented in Volume Four, Sections E.2.3 and E.3.4. Text also has been added to the methodology in Volume Four, Section E.1.1 to reflect this change. Please refer to the response to Comment number 0072.225 for a discussion of impacts of remediation accidents.

Comment Number 0072.228

CTUIR

Comment P E-29: PP 3: Maximally-Exposed Individual General Public: Since the conventional offsite boundary dose was omitted from the evaluation, the MEI noninvolved worker dose (at 100m) must be considered the MEI offsite dose as well. Although not clearly stated, we presumed that the general population dose was estimated either by 160 annular sector analysis or by assuming that at each distance the entire population resides at plume centerline. In either case, the single point estimate result represents an average, with half the population being at higher risk. For this reason, we assume for the rest of this evaluation that the population dose is an average and the MEI worker dose is the same as the public MEI dose.

Response The conventional offsite boundary dose for the maximally-exposed individual (MEI) was not omitted from the evaluation (e.g., Volume Four, Table E.2.2.2 shows the MEI general public dose from a spray release due to a mispositioned jumper).

The population dose is not an average. Onsite and offsite population dose calculations were based on population-weighted Chi/Q values generated from onsite and offsite population distributions (i.e., estimates of the distribution of the population relative to the facility where the accident is postulated to occur). Both the Site and offsite areas were broken up into 16 sectors. The sector with the bounding population-weighted Chi/Q was assumed in the scenario. In addition, bounding 99.5 percent maximum sector Chi/Q values were used in the dose calculations.

The MEI worker dose is not the same as the public MEI dose. Dose is dependent on Chi/Q, which is dependent on distance. These values are reflected in the Chi/Q values (time integrated atmospheric dispersion coefficient) used for each receptor in the analysis. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.229

CTUIR

Comment P E-38: Table E.2.2.1: The column labeled "risk" either needs to be explained or omitted. The column labeled "severity" also needs some explanation - what does "No" mean with respect to severity, and how was this determined? Does this entire table apply to each tank individually? If so, then all of the anticipated accidents summed over all the tanks suggests that there would be several reportable incidents per year. Since the consequence analysis did not include any risk measure except dose, the consequences of these events (and especially programmatic impacts) are probably greatly underestimated.

Response Table E.2.2.1 in Volume Four is a screening table that is similar to those used elsewhere in the document. The table and purpose of the table were defined in Volume Four, Section E.1.1.2, which contains the explanations of "risk," "severity," and "no" and how the data were determined. The table does not apply to each tank individually but to the tank farms collectively. The intent of the analysis was to measure only health effects resulting from accidents; therefore, no change to the EIS is warranted. Please refer to the response to Comment numbers 0069.06, 0072.225, and 0072.226.

Comment Number 0072.230

CTUIR

Comment P E-40: Sect. E.2.2.1.1: It would be helpful if the discussion of the particular accident scenarios included the numerical reference from table E.2.2.1.

Response The accident scenario described can be traced to Volume Four, Table E.2.2.1 by using the name of the accident; therefore, no change to the document is warranted.

Comment Number 0072.231

CTUIR

Comment P E-40: Table E.2.2.2: Please note that in these tables there is information presented for the MEI public, although the prior discussion did not indicate that this would be the case. If this is also done consistently in the later tables, the discussion at the beginning of the section should include description of the MEI public offsite individuals location.

Response The location of the general public MEI is defined in Volume Four, Section E.1.1.5, Receptor Location. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.232

CTUIR

Comment P E-42,43,44,45,46: Tables E.2.2.4-E.2.2.5: The totals from Tables E.2.2.4 and E.2.2.5 should be added, because exposure to toxics and corrosive would be simultaneous and the effects are not necessarily independent. For the mispositioned jumper accident, the MEI worker would experience both effects at the same time, though the same portal of entry (the lungs), and therefore the effects are at least additive if not supra-additive.

Response Toxic and corrosive effects are independent and for that reason these efforts are not additive. Corrosive chemicals cause localized destructive physical damage to the exposed cells and underlying tissue with which there is direct contact (e.g., skin, eyes, and lining of the lungs). Toxic chemicals are absorbed through the cell membrane wall into the blood stream or lymphatic system where target organs are affected. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.233

CTUIR

Comment P E-57: PP1: What is the reason for using the 50 percent inventory rather than the 100 percent inventory? Is there an official Record of Assumption to track when and by whom this decision was made? This section indicates an onsite residential population of 183 people, but this is not described earlier under receptor locations. Please clarify. Given the current controversy around the possibility of any dome collapse (for example, with overload and filtration of releases upward through gravel, and so on), it might be useful to discuss all dome collapse and dome failure scenarios in a little more detail.

Response A discussion of the 100 percent inventory is found in Volume Four, Appendix E, Section E.1.1. As defined in Section E.1.1, the highest radioactivity concentration for each radionuclide was combined to define a hypothetical highest concentration tank inventory or "super tank" used to bound accidents. For single tank accidents or spray releases, this methodology is reasonable. However, for multiple tank accidents it would be unreasonable to represent all the tanks as the super tank; therefore, the nominal tank inventory would be more reasonable when an accident involves multiple tanks.

The decision to use a nominal inventory for accidents involving multiple tanks was made during the consequence analysis of the post-remediation accident scenario. The population living on the Hanford Site after the institutional control period was assumed to be 10 percent of the current Hanford Site population work force or 1,090, as discussed in Volume Four, Appendix E, Section E.2.3. The dome collapse and dome failure scenarios have been addressed in detail in Volume Four, Appendix E, Section E.2.3 and this analysis has been modified in the Final EIS to address information unavailable for inclusion in the Draft EIS analysis.

L.5.12.1 Nonradiological Occupational and Transportation Accidents

Comment Number 0072.25

CTUIR

Comment The accident scenarios need to be better described in the EIS, without referring the reader constantly to other documents, especially since there is such controversy about how frequently the accidents might happen, or even if they could happen at all.

Response The information requested is contained in the referenced documents in DOE Reading Rooms and Information Repositories for public review. The use of references in the EIS is consistent with CEQ guidance that EISs be as concise as feasible and that where appropriate supporting data and technical analysis be incorporated by reference (40 CFR 1502.21). The document is very lengthy and DOE and Ecology believe they have struck an appropriate balance between presentation of analysis in the EIS and incorporating by reference supporting materials. The information requested in the comment is a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0072.26

CTUIR

Comment The SAR approach to accident risks is inadequate for an EIS type of analysis: the full range of types of risk (including environmental and socio-cultural) need to be included since all of these would be affected by accidents.

Response DOE and Ecology have further analyzed the risk from the unstabalized tanks collapsing after the 100-year institutional control period. Because this is a likely event and there would be no institutional controls, no recovery action is accounted for. The resulting analysis includes the added risk from deposition to the environment and cultural resources. Therefore, the airborne release rate (ARR) and RF are presented separately in the EIS. The analysis is presented in Volume Four, Sections E.2.3 and E.3.4 of the Final EIS. Text also has been added to the methodology in Section E.1.1 to reflect this change.

All other scenarios occur within the 100-year institutional control period and have either very small offsite consequences or the probability of the event is extremely unlikely. DOE and Ecology have determined to evaluate the environmental and socio-cultural impacts from these accidents with the amount of detail commensurate with their likelihood and potential consequences as directed in Recommendations for the Preparation of Environmental Assessments and EISs, Office of NEPA Oversight, DOE, Washington, D.C., May 1993 (DOE 1993d) and following consultation with the commentor. The evaluation added to each alternative does not include a rigorous quantitative analysis but provides a qualitative assessment of the potential environmental and socio-cultural impacts resulting from deposition and mitigative measures that would be taken to offset these impacts. Please refer to the response to Comment number 0072.225.

Comment Number 0072.234

CTUIR

Comment P E-100: Sect. E.6.0: Where is the discussion of the environmental Impact due to the removal of the sand, gravel and silt? Additionally, where are the discussions regarding the impacts to known cultural sites associated with the proposed borrow sites?

Response Environmental and cultural site impacts associated with removal of sand, gravel, and silt are analyzed in Volume One, Sections 5.1, 5.5, and 5.7, and summarized in Section 5.14.

Comment Number 0072.235

CTUIR

Comment This table indicates that under the intermediation separation alternative (the preferred alternative), the closure caps (the Hanford Barriers) will require approximately over 85,000 trips to bring silt from McGee Ranch, 97,000 trips from Borrow Pit 30 for tank fill material, 122,000 trips to bring riprap from Vernita Quarry, and 100,000 trips to bring sand from Borrow Pit 30. What total volume of each material does this represent? This table indicates that *all* of this material is needed for the barriers, and no alternative sites are presented. Since the selection of a preferred alternative includes a de facto decision about closure, this EIS must include a discussion of the environmental and cultural harm that will be caused by this huge amount of clean fill, and the mitigation that will be performed should this closure plan be pursued. Closure is an inseparable part of the preferred alternative, so an excuse that closure is not in the scope of this EIS will be unacceptable.

Response The total volume of material removed from the potential borrow sites for hypothetical closure scenario is as follows:

- Silt from McGee Ranch = 853,000 yd^3
- Tank fill from Borrow Pit 30 = 986,000 yd^3
- Riprap from Vernita Quarry = 1,220,000 yd^3
- Sand from Borrow Pit 30 = 1,000,000 yd^3

The environmental and cultural impacts to the borrow sites listed are discussed in Volume One, Sections 5.1, 5.4, 5.5, and 5.7, and summarized in Section 5.14.

A hypothetical closure scenario was addressed to show the relationship between closure and remediation of the tank waste. For discussion of the closure scenario, please refer to the response to Comment numbers 0072.08 and 0101.06 and for more information regarding borrow site impacts, refer to the response to Comment number 0019.03. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0081.07

Pollet, Gerald

Comment There is one other area of risks that we would like to spend another piece of paper on, and that has to do with explosion risks. We believe that the assumptions used are erroneous, and the Department of Energy had more than ample time to incorporate additional data about the risk of explosions in far more tanks than that are on the watch list today. The Wyden Safety Watch List Law requires the listing of tanks that have the potential for uncontrolled release of fission products, i.e., an explosion. We know that the Department has been sitting for months and months on a recommendation that 25, in other words twice as many tanks, have the potential to explode. That greatly changes the risk assumptions used and the presentation of data in the EIS.

Response In December 1995, Westinghouse Hanford Company (WHC) recommended to the DOE that 25 additional tanks be added to the Flammable Gas Watchlist. DOE-RL submitted the same recommendation to the U.S. Department of Energy, Headquarters (DOE-HQ), the organization responsible for formally making the decision. DOE-HQ requested that the Chemical Reactions Sub-Panel review and comment on the basis for the recommendation. DOE-HQ, on the basis of the sub-panel review, recommended to DOE-RL that the recommendation to add the tanks to the Watchlist to be withdrawn. DOE-RL withdrew the recommendation about the same time that WHC withdrew its original recommendation to DOE-RL.

The risk of tank deflagrations and explosions has been analyzed further by DOE and Ecology. The results of the new analysis that shows the event to be more credible (a higher annual frequency) have been incorporated into the Final EIS Volume Four, Appendix E, Sections E.2.2, E.3.3, E.4.3, E.5.3, E.6.3, E.7.3, E.8.3, E.9.3, E.10.1, and E.10.2.

L.5.12.2 Radiological Accidents

Comment Number 0069.10

Pollet, Gerald

Comment Fifth, we know that there are five times as many tanks with the potential for a hydrogen gas explosion as this EIS assumes. This assumption, found in the documents provided which are Westinghouse documents, the assumption is six flammable gas tanks. There are 25 awaiting to be added to the Watchlist. Which is the Wyden Watchlist. They've been awaiting being put on that Watchlist, which is a legal requirement for tanks of the potential to explode, since long before this EIS was issued. The department has known that tanks, additional tanks have the potential for hydrogen buildup above the flammability limit for a year now. It is not shown in the EIS at all. You should be clearly showing the annual risk of delay in terms of tank leaks, pressure vents, and explosions. Clearly show the risks per year of each alternative, and reveal which wastes would be retrieved, and which delayed in each alternative.

Response The annual frequency of a hydrogen deflagration as analyzed in the Draft EIS was based on 25 flammable tanks (Volume Four, Appendix E, Section E.2.2). Please refer to the response to Comment number 0081.07.

A bounding risk from the delay in remediating these wastes is presented in Volume Four, Section E.2.2, where the risk is shown from accidents that could result if remediation is delayed indefinitely under the No Action alternative. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0069.11

Pollet, Gerald

Comment The ultimate question is which alternative gets on with retrieval of wastes, with what risks on the fastest timeline... beyond the design basis accident, i.e., greater than 10 to the -6th one million events. It's also incredible that the same one million chance, or greater, is given to red oil exothermic reactions. Based on the Westinghouse report which say's that the exothermic reaction will only occur by the 135 centigrade. Yet, in 1994, when the Department of Energy agreed not to restart the Plutonium Finishing Plant, it had placed administrative controls on the calciner, which are equivalent to the evaporators in many respects, had place administrative controls because it's own studies, including those done at Los Alamos and at Hanford, showed that the exothermic reactions could occur at temperatures far less than 135. This data was available, but ignored. It basically means that the risks presented here are entirely underestimated. Especially for tank explosions and pressure events, and other releases.

Response The Hanford solvent extractions separations plants (e.g., Plutonium Finishing Plant) operate with nitric acid systems where tributyl phosphates could react to form red oil. The exothermic events relating to red oil have occurred in mixtures of fuming nitric acid and normal paraffinic hydrocarbons (which are commonly called red oil). The explosion occurs when the mixtures are overheated and low molecular weight gaseous decomposition products are generated. Safeguards have been put in place at these facilities to limit the chance for a runaway thermal reaction, which would produce large quantities of flammable hydrogen gas. Unlike the Plutonium Finishing Plant, the waste in the Hanford Site tanks has been neutralized before transfer to the tanks and the waste is being maintained at an alkaline and not at an acidic pH. The material used for construction of the Hanford Site tanks is not suitable to store acidic wastes; therefore, alkalinity was and is measured and controlled before waste is placed or transferred into the tanks.

Red oil, a reaction product of tributyl phosphate, nitric acid, and heavy metal nitrates, cannot be formed on the alkaline wastes stored in the tanks. In the unlikely event that red oil is routed to the waste complex due to a process upset in an operating plant (i.e., material is not neutralized with sodium hydroxide [caustic]), contact with the large volume of diluted caustic in the storage tanks would neutralize the waste. Because the Hanford Site tank waste is in an alkaline and not an acidic state, a red oil exothermic reaction was determined to fall in the incredible range (less than 1.0E-06/yr) and the potential risks have not been underestimated in the EIS. The information relative to this issue was included in the Draft EIS in Volume Four, Appendix E; therefore, modification to the document is warranted.

Comment Number 0069.12

Pollet, Gerald

Comment One must wonder is the Department of Energy delaying placing additional tanks on the legal Watchlist until this comment period is closed? Why aren't we showing the risks from hydrogen events and from exothermic reactions, as the Department's own studies have shown them to be?

Response These decisions regarding placement of tanks on the Watchlist were made independent of the EIS schedule and do not reflect an intent to not address these issues in the EIS. Please refer to the response to Comment numbers 0069.10 and 0081.07.

Comment Number 0069.13

Pollet, Gerald

Comment As Todd Martin said earlier this evening, all that we know about some of these events is that they have a far greater probability than 1 the million. We cannot put a definitive figure on them. I would agree with that. We can't put a definitive figure on them. But we do know, for instance for the exothermic reaction, we know that the Department of Energy has had 3 explosions, at Hanford and Savannah River, involving this same material, same exothermic reaction. Yet this EIS is based on a Westinghouse study that assumes the possibility of one event is greater than one in a million. We have had three events, therefore, in the last 50 years and that does not equal a rate of occurrence of one in a million.

Response Please refer to the response to Comment numbers 0081.07 and 0069.11, which address similarly worded comments.

Comment Number 0072.27

CTUIR

Comment Deposition needs to be included, and therefore the ARF and RF need to be presented separately.

Response Please refer to the response to Comment numbers 0072.17, 0072.26, and 0072.251, which address similarly worded comments.

Comment Number 0089.19

Nez Perce Tribe ERWM

Comment The risks from tank wastes to the environment and the public appear to be understated and inconsistent with those on the Risk Data Sheets for the Hanford Site.

Response The risks to the environment and the public from tank waste as stated in the TWRS EIS are based on more current data and analyses than those used in the RDSs. Also, they serve different purposes. RDSs are used to obtain funding for Hanford operations and evaluate the cost of

environmental, socio-economic, and health impacts. The TWRS EIS only evaluates the health risks in terms of health effects, not cost; therefore, no change to the document is warranted.

Comment Number 0090.03

Postcard

Comment Please listen to us say no:

to ignoring the risk of tank explosions.

Response Please refer to the response to Comment numbers 0081.07 and 0069.11, which address this issue.

Comment Number 0098.05

Pollet, Gerald

Comment Explosion risks in this EIS. This EIS is based on a 1995 Westinghouse document that assumes a plutonium or uranium nitrate and tributyl phosphate or other solvent exothermic reaction, i.e., a red oil explosion, will only initiate at a 135 degrees centigrade and bases a lot of the risk estimates in terms of things like evaporator risks and explosion risks on that assumption. That assumption was disproven by Los Alamos National Laboratory study a year before this Westinghouse report which is the basis of the EIS. I would like to know why we are paying contractors to ignore official findings of the Department of Energy including there at Hanford which said, We had to put administrative controls on Plutonium Finishing Plant because of an acknowledgement that this reaction could occur temperatures far below 135 degrees centigrade. I think that Westinghouse should be penalized for producing a document that ignored the rest of the data at Hanford and from Los Alamos National Lab about the risk of a red oil explosion. The state needs to take a look at that and take a look at how those explosion risks are calculated because frankly, they did the same thing that the state fought in terms of the Plutonium Finishing Plant and they continue to try to get away with saying that this exothermic reaction only occurs at 135 degrees. Secondly, the data ignores the fact that the evidence shows that these reactions release hydrogen at flammable ... above the flammable limits at far lower temperatures and you're likely first to get a hydrogen explosion before you get the explosion from the red oil.

Response Red oil explosions are considered an incredible event and not discussed in the risk evaluations in the EIS; however, data pertaining to red oil explosions in the Hanford waste tanks are presented in Volume Four, Appendix E.

Please refer to the response to Comment number 0069.11, which provides a more extensive discussion of the issue in response to a similarly worded comment.

L.5.12.3 Potential Toxicological Accidents

No comments were submitted for this topic.

L.5.13 CUMULATIVE IMPACTS

Comment Number 0019.17

WDFW

Comment Page 5-210, section 5.13.3.1, second paragraph. The EIS states that "closure of the SSTs and DSTs is beyond the scope of this EIS." If closure is beyond the scope, WDFW believes it is inappropriate to mention potential borrow sites for post-remediation activities since a thorough analysis has not being performed.

Response Although closure is not included in the TWRS EIS scope, as discussed in Volume One, Section 3.3.1, a generic closure method was included in all the alternatives (except No Action and Long-Term Management) to allow meaningful comparison of the in situ and ex situ alternatives on a relatively equal basis. It is necessary to address potential impacts at borrow sites in order to identify all impacts that may occur. The borrow sites shown in the Draft EIS were used only for calculational purposes. The EIS was modified in the Summary and Volume One, Sections 1.0, 3.3.1, and 5.0 to clarify that the borrow sites addressed are only identified for calculational purposes. A decision on which sites would be used will be made in the future when NEPA analysis is prepared for closure purposes. Please refer to the response to Comment numbers 0078.08 and 0019.03 for more information on this topic. Because the information contained in the Draft EIS is correct, no change to the text was made at the location specified in the comment.

Comment Number 0053.02

Carpenter, Tom

Comment I think that we have got waste that have leaked into the ground under the tanks. The figure varies. I have heard 950,000 gallons is the official figure of what has leaked from the single-shell tanks into the ground; however, a number of engineers out there have told me that, for instance tank 105A which had a serious steam event back in the mid-60's resulted in a great deal of contamination going down to the ground underneath the tank and the 500,000 gallon tank ended up needing over a million gallons of cooling water. So cooling water or evaporating water that was not counted as leaks to the ground. So that 950,000 gallon figure is not accounted into there.

Response Approximately 600,000 to 900,000 gallons of liquid are known or assumed to have been released to the soil beneath leaking tanks and this information is presented in the EIS in Volume One, Section 1.0 and 4.2. Cooling water that may have leaked from SSTs would be included in that volume. Cooling water that has evaporated would not be included in the leak volume. It is because of the insufficient information available regarding contamination of soil and groundwater that closure is not within the scope of the TWRS EIS. For more information on this issue, please refer to the response to Comment numbers 0091.01, 0030.02, 0072.63, and 0072.08. The Final EIS analysis of cumulative impacts, including soil contamination from past leaks has been modified and is presented in Volume One, Section 5.13 and Volume Four, Appendix F.

Comment Number 0101.05

Yakama Indian Nation

Comment Need to Consider Cumulative Impacts--Consideration of key actions and their resulting impacts having already occurred or potentially occurring in the future should be assessed by the subject EIS, consistent with NEPA guidance regarding consideration of cumulative impacts. Particular attention should be paid to impacts from other waste disposal sites, partially remediated sites or contaminated ground water posing an additional hazard from either simple additive effects and/or more complicated synergistic effects.

We consider it is inappropriate to base actions on a partial evaluation of impacts affecting the public health and safety and the environment, particularly when it is known or expected that other impacts from known or expected actions are cumulative.

Response Cumulative impacts of past, present, and future Hanford operations, together with the potential impacts of the TWRS alternatives, are included in the cumulative impacts section (Volume One, Section 5.13) of the EIS. No potentially synergistic effects were identified.

L.5.14 UNAVOIDABLE ADVERSE IMPACTS

Comment Number 0019.18

WDFW

Comment Page 5-230, Table 5.14.1, Phased Implementation alternative, Row on Biological Resources. There is a discrepancy between the figures on shrub-steppe habitat loss here (540 acres total) and that mentioned on 5-123 which states 690 acres. This is the second comment regarding clarification on upper impact level for the Phased Implementation alternative. What is the correct figure?

Response Please refer to the response to Comment number 0019.14 for the corrected information on the potentially affected acreages.

L.5.15 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

No comments were submitted for this topic.

L.5.16 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

No comments were submitted for this topic.

L.5.17 CONFLICTS BETWEEN THE PROPOSED ACTION AND THE OBJECTIVES OF FEDERAL, REGIONAL, STATE, LOCAL, AND TRIBAL LAND-USE PLANS, POLICIES, OR CONTROLS

No comments were submitted for this topic.

L.5.18 POLLUTION PREVENTION

No comments were submitted for this topic.

L.5.19 ENVIRONMENTAL JUSTICE

Comment Number 0072.53

CTUIR

Comment Despite initial scoping agreements to include environmental justice as a separate section (per Executive Order 12898), no such section was prepared. The mere counting of the number of Native Americans residing in the three closest counties is not adequate.

Response DOE agrees that re-compiling existing demographic information would not satisfy the intent of Executive Order 12898. The environmental justice initiative has a technical component that involves analyzing whether there is a disproportionately elevated and adverse health or environmental impact on any minority community or low-income community and, if such impacts are identified, mitigating those impacts. In response to the environmental justice requirement, the TWRS EIS project included the following tasks.

- Identify potentially affected low-income populations and minority populations within an 80-km (50-mi) radius of the Hanford Site central plateau.
- Conduct technical analyses to establish if disproportionately high and adverse impacts to low-income and minority populations are associated with any EIS alternative.
- Identify mitigation measures, if appropriate.

The basic EIS consists of a description of the affected environment and environmental consequences in Volume One, Sections 4.0 (supported by a more detailed analysis in Volume Five, Appendix I) and Section 5.0 (supported by detailed analysis in Volumes Two through Five), respectively. Volume One, Section 4.0 contains a description of the potentially affected minority, Native American, and low-income populations (Section 4.6). Section 4.0 also contains, where appropriate, other information pertinent to those populations within the affected environment including relationship of Native Americans to the Hanford Site in Section 4.4 (biological and ecological), Section 4.5 (cultural resources), Section 4.7 (land use), and Section 4.8 (visual resources). A more detailed description of each is provided in the associated section of Volume Five, Appendix I.

Identifying potentially affected minority populations, Native American, and low-income populations in the 80-km (50-mi) area surrounding the Hanford Site central plateau involved analyzing census data (Section 4.6). Identifying this area for analysis conforms to the geographic maximum extent of potential environmental impacts as described in the other sections of the EIS. This area included Benton County, Washington, and portions of nine other counties in Washington and Oregon, as well as portions of the Yakama Indian Reservation. The 1990 census was used as the source of the population data. Data were produced and analyzed for all census blocks located completely or partially within the 80-km (50-mi) area surrounding the Site. The results are summarized in Volume One, Section 4.6 and provided in greater detail in Volume Five, Appendix I. This section also included an acknowledgement that Tribal Nations located outside of this area "have historical and treaty interest in the Hanford Site area."

Socioeconomic data presented in Volume One, Section 4.6 were limited to Benton and Franklin Counties, Washington. The more limited area was identified because the socioeconomic impacts (e.g., jobs, tax revenue, retail sales, housing, and public facilities and services) of the Hanford Site on areas beyond the two-county area historically have been slight. Considering a smaller area does not diminish the impact of the Hanford Site on the Tribal Nations who have treaty rights and privileges to the Site. Other links to the Site are described in the relevant sections of the description of the affected environment.

The second portion of the environmental justice analysis was a description of the analysis of the potential environmental consequences of each of the TWRS alternatives presented in Volume One, Section 5.0, and in the other related appendices. Generally, these sections (i.e., Section 5.1 through 5.12) address impacts to air and water, ecological and biological resources, and human health and safety. Sections 5.13 through 5.20 contain analysis issues such as the impact of the alternatives on commitment of resources and land uses as well as environmental justice and mitigation measures.

For the environmental justice analysis, based on the minority, Native American, and low-income populations within the 80-km (50-mi) area, as well as Tribal Nations outside the 80-km (50-mi) area with treaty interests in the Hanford Site, each of the areas of technical analysis presented in the EIS was reviewed to determine if any "potentially disproportionate and adverse impacts" would occur. If "an adverse impact" was identified, a determination was made as to whether the impacts on minority, Native American, or low-income populations would be "disproportionately affected."

Volume One, Section 5.19 of the Draft EIS identified two areas of potentially adverse and disproportionate impact relative to Tribal Nations -- continued access restrictions to portions of the 200 Areas that would continue under long-term land use restrictions and potential disproportional post-remediation health impacts under in situ disposal alternatives. Subsequent to the publication of the Draft EIS, consultation with Tribal Nation identified other areas of concerns regarding potential adverse impacts to cultural resources. This section has been modified to identify those areas of concern. As required by the environmental justice initiative, Section 5.20 identifies potential mitigation measures that DOE could adopt to address the potential environmental justice impacts identified in Section 5.19.

Please refer to the response to Comment numbers 0072.149 and 0072.252 for information regarding consultation with Tribal Nations.

Comment Number 0101.08

Yakama Indian Nation

Comment Requirements-Based Alternative Designs Needed -- The TWRS design alternatives in the EIS that are considered fail to reflect a requirement-based approach in the conceptual design process. This effectively forecloses consideration of Yakama Nation cultural values and associated requirements. Hence, impacts within the realm of socio-economic impacts related to these values and requirements are not addressed in the EIS. For example, the potential economic burden on future generations or the impact of alternative closure designs for waste sites or interim storage facilities on the Indian use of nearby religious sites are not assessed in the subject EIS, although the values affected by these impacts are of prime importance to the Yakama Nation.

Response The TWRS alternatives considered in the EIS reflect a requirement-based approach to the conceptual design, but because of the large number of potential alternatives, a broader range of requirements was taken to develop the full range of reasonable alternatives. As indicated in the Draft EIS Volume One, Section 3.3.1, the alternatives were developed using the following requirements:

- That a No Action alternative be addressed in the analysis (NEPA);
- That the EIS developed representative alternatives for detailed analysis that bound the full range of reasonable alternatives when a wide range of alternatives were available for analysis (NEPA);
- That 99 percent of the waste from the tanks will be retrieved for the ex situ alternatives (except for the ex situ/in situ combination alternatives); and
- That management and disposal practices of radioactive waste, as well as the degree of separations required to facilitate near surface disposal of LAW and offsite disposal of HLW, will be consistent with DOE and Atomic Energy Act regulations.

This process allowed the analysis and consideration of cultural values and other associated issues in the EIS. For each of the alternatives, impacts to the human and natural environment, including impacts to Tribal Nation cultural values, were analyzed in the EIS. A description of the existing environment was provided in Volume One, Section 4.0 and Volume Five, Appendix I and impacts to the environment were provided in Volume One, Section 5.0 and associated appendices. Based on comments submitted by Tribal Nations and consultation with affected Tribal Nations during and following the comment period, the text of the EIS has been modified to reflect comments regarding the affected environment and potential impacts to Tribal Nation cultural values. Please refer to the response to Comment numbers 0037.01, 0072.271, 0072.53, 0072.154, 0072.252, and 0072.268 and 0072.149 for discussions of changes to the EIS based on consultation with Tribal Nations.

Regarding potential burdens to future generations, the EIS addresses potential health impacts to future generations, out to 10,000 years into the future, for a variety of potential future Site users. The Final EIS was modified to include a Native American Subsistence scenario based on consultation with affected Tribal Nations. Please refer to the response to Comment number 0072.198 for a discussion of this scenario. Other potential burdens to future generations are addressed to the extent the impact analysis indicates that a natural resource would be adversely impacted. Other impacts, such as impacts associated with accident risk, are not addressed in detail in the EIS because their small likelihood and potential consequences. Please refer to the response to Comment numbers 0072.26 and 0072.225 for discussions regarding accident impacts.

Impacts associated with alternative closure designs for waste sites were addressed within the context of the scope of the TWRS EIS. Closure is not within the scope of the EIS, hence, the EIS addressed a single closure scenario to provide the public, Tribal Nations, and decision makers with information needed to compare the relative impacts of each alternative. Please refer to the response to Comment number 0072.08 and 0019.03 for a discussion of closure and its relationship to the EIS.

L.5.20 MITIGATION MEASURES

Comment Number 0019.06

WDFW

Comment The Final Environmental Impact Statement Safe Interim Storage (SIS) of Hanford Tank Wastes made a firm commitment to develop a stand alone Mitigation Action Plan. The SIS project should be commended for being consistent with USDOEs Land and Facility Use Plan. The SIS project is part of the TWRS program. However, the TWRS EIS does not make the same explicit commitments as the SIS EIS did for mitigation of Priority Shrub-Steppe Habitat. There appears to be inconsistency within the TWRS program in interpreting and implementing the Land and Facility Use Policy.

The TWRS project will impact from 540 to 690 acres of shrub-steppe habitat. WDFW has several specific comments asking for clarification on acreage (refer to specific comments). WDFW strongly recommends compensatory mitigation for this project. The project should develop a stand alone Mitigation Action Plan, since the Biological Resource Mitigation Strategy has not been completed or reviewed by the natural resource agencies. At this point in time, the Biological Resource Mitigation Strategy may not meet mitigation requirements defined by WDFWs and USFWs mitigation policies. Besides biological arguments, this recommendation is based on USDOEs Land and Facility Use Policy which states "it will sustain the natural resources for which it is steward." By performing compensatory mitigation for this project, USDOE-RL is consistent with its Land and Facility Use Policy.

Response There is no inconsistency within the TWRS program. The EIS explicitly states that a Mitigation Action Plan will be performed as required by NEPA. Like the SIS project, the TWRS EIS program will make commitments for mitigation will be made in the TWRS EIS, the specific requirements will be contained in the Mitigation Action Plan. Under the regulations that implement NEPA (40 CFR 1500-1508), the EIS is not the place to document the specific mitigation measures that will be performed. The mitigation measures for the TWRS EIS may be far more complex than the measures identified by the SIS EIS so it is not feasible to document these in the Final EIS.

The 540 to 690 acres of shrub-steppe habitat mentioned in the comment refer to disturbances during tank farm closure activities, which is outside of the scope of this EIS and will be addressed in a future NEPA analysis. Please refer to the response to Comment number 0019.14 for more information on the potentially affected acreages. The information requested in the comment represents a level of detail that DOE and Ecology believe is not necessary for meaningful discrimination among the alternatives.

Comment Number 0019.19

WDFW

Comment Page 5-260, section 5.20.2. Request the word "Potential" be removed from section title. The section includes discussion of mitigation for shrub-steppe habitat, but vague language is used throughout without any firm commitment to doing mitigation. Again, WDFW strongly recommends mitigation for impacts to shrub-steppe.

Response General commitments for mitigation are contained in the TWRS EIS. The Mitigation Action Plan (MAP) will contain the specific requirements for mitigation. The term potential mitigation measures is the correct term because, as explained in Volume One, Section 5.20, page 5-260 of the Draft EIS, the mitigation measures included in this section are not included in the alternatives. One or more of these mitigation measures identified in Volume One, Section 5.20.2 could be included in the alternative selected for implementation. One likely mitigation measure is to mitigate impacts to the shrub-steppe habitat, as DOE has done for numerous other projects at Hanford. Following publication of the Final EIS, a Mitigation Action Plan will be prepared identifying additional mitigation measures DOE intends to implement.

Comment Number 0019.20

WDFW

Comment Page 5-262, section 5.20.2, third paragraph containing bullets. WDFW strongly recommends this idea be developed under its own section and that an explicit commitment be made for development and implementation of mitigation for the loss of shrub-steppe habitat. This would be consistent with Secretary Hazel O'Leary's Land and Facility Use Policy which states "USDOE will sustain the natural resources for which is steward", and would also be consistent with an earlier TWRS program EIS action.

Response Please refer to the response to Comment numbers 0019.06 and 0019.09 for discussions that respond to this issue.

Comment Number 0072.06

CTUIR

Comment Regardless of the proposed final Hanford tank waste retrieval and closure plans developed under the TWRS-EIS process, and prior to permitting of a treatment/disposal facility by the state under RCRA, a CTUIR aboriginal-lands human health and environmental sampling and analysis network must be established in order to help the CTUIR identify and mitigate potential future contamination impacts in a variety of environmental media. Existing environmental networks, albeit fragmentary, in both northeastern Oregon and southwestern Washington long have measurably demonstrated the regional environmental distribution of Hanford-source radionuclide and hazardous contaminants in air, water, soil, vegetation, and wildlife.

Response Cultural and archeological surveys of the areas that might be impacted by the project were performed and are summarized in Volume One, Section 5.5. Future environmental impacts on all environmental media were fully assessed and are presented in Volume One, Section 5.0 and associated appendices. A Native American exposure scenario is included in the Final EIS in Volume One, Section 5.11 and Volume Three, Appendix D. DOE annually samples and reports the regional contaminant levels in all environmental media on and near the Hanford Site in the Annual Hanford Site Environmental Report (PNL 1996), which is made available to the public and is summarized in Volume One, Section 4.0 and Volume Five, Appendix I of the EIS. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

L.5.21 MISCELLANEOUS

Comment Number 0034.01

Belsey, Richard

Comment Health and safety, the Hanford tanks are the greatest threat to public health and worker safety and the environment in the whole Hanford Site.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0046.02

DiGirolamo, Linda Raye

Comment Scientist and technicians got the DOE into a horrible, life threatening, INDUSTRY in Washington State and they are dancing around the gravity of the "CRUD" this industry creates. This nuclear "CRUD" is not only not biodegradable it is also EXPANDING in its lethal abilities...making it a true, toxic hazard which will not only never degrade but will most probably lead to the cause of the destruction of our whole planet. How? a) Nuclear winters (already experiencing), b) climate changes, c) Atmospheric interruptions d) river poisonings e) well water poisonings f) human and animal mutations...etc. (too many impacts to list on this page).

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0061.02

Longmeyer, Richard

Comment If there are any planned activities which will disturb or destroy these monuments, NGS requires not less than 90 days' notification in advance of such activities in order to plan for their relocation. NGS recommends that funding for this project include the cost of any relocation(s) required.

Response DOE and Ecology acknowledge the comment and the notification requirements. DOE and Ecology intend to comply with all requirements. No change to the text was appropriate based on this comment.

Comment Number 0072.164

CTUIR

Comment P 5-3: PP 2: Please indicate the process of determining which environmental component has uncertainties to be discussed. This is a VALUE laden statement which needs definition and consultation with the CTUIR.

Response The process for determining which environmental component has uncertainties associated with the environmental impacts analysis involved determining whether the methodology used in the impacts analysis involved using data regarding waste characteristics, technologies, or processes that were uncertain due to the level of confidence in the quality of the data or the maturity of performance data regarding the technology or process. In cases where data are incomplete or unavailable, NEPA requires DOE to "make clear that such information is lacking" (40 CFR 1502.22). If the incomplete information is relevant to reasonably foreseeable significant adverse impacts, the agency must: 1) include information in the EIS that informs the decision maker of the status of the information; 2) summarize the existing credible scientific evidence relevant to evaluating the potential impacts; and 3) evaluate the potential impacts "based on theoretical approaches or research methods generally accepted in the scientific community."

For the TWRS Draft EIS, this process was accomplished by including in the analysis of each environmental component a discussion of the assumptions used in the impact analysis, information on the implications of the assumptions used, and information on the uncertainties associated with the data, assumptions, and/or methodologies used in the analysis. Based on this and other comments received on the Draft EIS, a new appendix (Volume Five, Appendix K) has been included in the Final EIS to provide a single-source of information regarding the uncertainties associated with the analysis of the proposed action.

The referenced statement, as well as the entire Draft EIS, has been subject to consultation with the CTUIR, other affected Tribal Nations, and other interested parties. Please refer to the response to Comment number 0072.149. The changes to the EIS mentioned previously were a result of the consultation process, as well as other comments received on this and other related issues. Other comments and consultation input from Tribal Nations resulted in changes to specific assumptions and uncertainties analysis. These changes are documented throughout in this appendix. Please refer to the response to Comment number 0101.08 for a related discussion.

Comment Number 0098.04

Pollet, Gerald

Comment Groundwater data. I find it incredible and I am going to address this, make this personal - Mike Thompson from the Department of Energy - for you to stand in front of the audience and talk about the borehole probably being contaminated when the Department of Energy's own occurrence report conclusively states that, Borehole contamination is not the cause of the contamination found in ... underneath the SX Tank Farm. That the correlation between boreholes, this proves the claim that an individual borehole was contaminated and that would be the source of this cesium finding. Now if that is the official position of the Department of Energy in its occurrence report, I think it is not permissible for you to stand up and without even acknowledging the official position, try to destroy the credibility of the data presented from your contractor.

Response The position stated by Mr. Thompson at the Seattle TWRS EIS Meeting, and in previous meetings with the Hanford Advisory Board was, "although the conceptual model describing cesium-137 in an aerially extensive plume as deep as 125 feet may eventually prove to be correct, there are other conceptual models (involving preferential contaminant flow down the drywells) that can explain the observed data. There is insufficient evidence in hand to conclusively discriminate between the two primary potential conceptual models for cesium-137."

At the time of the TWRS EIS meetings, the SX Tank Farm Report was not written. Only the data reports were available for review. The interpretation, displayed in graphical form, showing a plume of cesium-137 to a depth of 125 feet (and possibly beyond) was not substantiated by published analysis of the full suite of data. It was unknown if there had been adequate consideration of all pertinent data required to discriminate between multiple viable conceptual models that could result in the observed data. The release and distribution of graphical representation of one of several potential conceptual models prior to release and distribution of the data analysis report has prompted considerable debate in the technical community. The debate focuses on the interpretation of the distribution of cesium-137 in the soil. Debate over the potential transport of mobile contaminants (technetium-99, tritium, and chromium) is considerably less polarized. Please refer to the response to Comment number 0012.15.

Cesium-137 has been found in the lower regions of some of the drywells in the SX Tank Farm. The occurrence of gamma-emitting radionuclides (presumably cesium-137) in these drywells has been known for years, and has previously been interpreted to be borehole contamination. The new interpretation that there is an aerially extensive plume of cesium-137 in the soil is not consistent with what is known about cesium-137 transport through the soil as demonstrated by laboratory studies and field observation. Cesium-137 is an alkali element, univalent cation, with properties similar to other alkali elements (lithium, sodium, potassium, and rubidium). Adsorption preference on mineral surfaces behaves according to Coulomb's Law, in the Lyotropic Series (adsorption to mineral surfaces for cesium is greater than rubidium, potassium, sodium, and lithium); cesium-137 adsorbs with higher affinity than other alkali metals. In laboratory studies and in Hanford soil washing tests, it also has been demonstrated that cesium-137 ions absorb into the structure of molecules, specifically to "wedge sites" of micas, where they can substitute for potassium ions, and are hard to displace. Cesium-137 does not complex (interact with common inorganic anions such as ferrocyanide) and has little interaction with most organic chemicals. Ammonium ions may displace cesium-137. Cesium-137 exhibits high adsorption coefficients K_ds (>1,000) in dilute solutions. K_ds decrease with solution strength, but even at a K_d as low as 4.5, the contaminant should move as little as approximately 20 feet through the soil column.

The SX Tank Farm drywells have been drilled through contamination from tank leaks. The drywells are not sealed to prevent the flow of contamination down the annular space between the casing and the soil. A drive shoe is attached to the bottom of the casing, which is larger in diameter than the casing, thus providing for a potential annular space for vertical contaminant transport. When these wells were deepened, the existing (potentially contaminated) casing was driven deeper as new pipe was welded to the top of the casing string and driven downward. Flooding of drywells has been known to occur in other tank farms, providing another transport mechanism for contaminants. There are data showing the two deep drywells are contaminated on the inside of the casing. The data indicate that contamination has entered the boreholes.

The DOE commissioned an expert panel to review the SX Tank Farm drywell logging data and the interpretations to determine which conceptual model for cesium-137 transport is correct: 1) an aerially extensive cesium-137 plume to at least 125 feet or 2) a more shallow soil plume and deeper, localized contamination due to preferential flow down the unsealed drywells. The panel has requested additional field data to make that determination.

There are a number of potential mechanisms that may have caused the contamination recently measured. Until additional data are collected, the mechanism or mechanisms responsible cannot be reliably determined. Volume Five, Appendix K contains a discussion of the levels of contamination measured, potential mechanisms that could have caused the contamination, and how each mechanisms might affect the results presented in the EIS.

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L.6.0 STATUTORY AND REGULATORY REQUIREMENTS

L.6.1 RCRA/CERCLA

Comment Number 0019.01

WDFW

Comment Environmental restoration at the Hanford Site includes new construction associated with remedial and response actions as result of release(s) of hazardous substance. These activities are within the realm of the Comprehensive Environmental Response, Compensation, Liability Act (CERCLA) and Resource Conservation and Recovery Act. WDFW considers this proposed action to be within the ambit of CERCLA.

Response The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) defines the applicability of RCRA and CERCLA and the Washington State Hazardous Waste Management Act for the various actions being taken at the Hanford Site. The proposed action and alternatives addressed in the TWRS Draft EIS have been determined in the Tri-Party Agreement to be within the bounds of RCRA regulation. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.02

CTUIR

Comment As a stand alone document this EIS should clearly state its relationship with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the State of Washington's applicable hazardous waste management laws. The impacts of privatization including the entering of contracting obligations must be specifically addressed in the TWRS EIS. Furthermore, the DOE's trust responsibility to American Indian tribes and its natural and cultural resource steward responsibilities must also be specifically addressed in the TWRS EIS.

Response As stated in Volume One, Section 6.0, the Tri-Party Agreement defines the applicability of RCRA, CERCLA, and the Washington State Hazardous Waste Management Act at the Hanford Site. The TWRS program is primarily a RCRA compliance action and remediation of the tank waste is a RCRA action, not a CERCLA action. The State of Washington has been delegated the authority to administer the RCRA program. The environmental impacts of the Phased Implementation alternative, which are similar in impacts to the privatization effort, have been stated in the Draft EIS. No other environmental impacts of entering into contracting obligations have been postulated. Any contractors involved in Hanford work must comply with the Tri-Party Agreement and applicable Federal, State, and local laws and regulations. Regarding DOE trust responsibilities, a statement has been added in Volume One, Section 6.0 that defines DOE's policy on interacting with Native American organizations.

Comment Number 0072.03

CTUIR

Comment The idea of RCRA is to cover all aspects of the "cradle-to-grave" management of hazardous wastes: generation, transportation, storage, treatment, disposal and closure. The goal of the TWRS-EIS should be to safely and effectively retrieve, treat, and isolate, from the human and natural environment certain Hanford wastes that may seriously harm human, natural, and cultural resources through time. However, the current TWRS-EIS does not achieve this goal.

Response As stated in Volume One, Section 6.0, the EPA has delegated authority to Ecology to administer the RCRA program in the State of Washington. EPA, Ecology, and DOE have negotiated the Tri-Party Agreement, which defines actions necessary to comply with RCRA for Hanford tank waste. A goal of the TWRS program is to comply with the Tri-Party Agreement. Several alternatives analyzed in the TWRS EIS, including the preferred alternative, achieve that goal. Those alternatives are shown to safely and effectively retrieve, treat, and isolate tank waste in ways that comply with applicable regulations and minimize ecological and human risk. For a discussion of this issue, please refer to Volume One, Section 6.2. Please refer to the response to Comment number 0072.02.

Comment Number 0072.04

CTUIR

Comment CERCLA is applicable in this case because of widespread subsurface contamination and the designation of numerous Operable Units in the Tank Farm areas. These areas resulted from the long-term degradation of Hanford tank farms that allowed such dangerous and persistent high-level radioactive and hazardous mixed wastes to leak into the subsurface. Historically and today, the contaminated subsurface continually leaches contaminants further into the vadose zone, into the groundwater, and ultimately into the Columbia River--a critical Tribal resource. Comprehensive source-term identification and control must be a fundamental component of the overarching TWRS program.

Response The existing vadose zone and groundwater contamination is not within the scope of the TWRS EIS. Inventory characterization and control during tank waste retrieval, treatment, and disposal has been addressed in the Draft EIS in Volume One, Section 3.4 and Volume Two, Appendix B. Please refer to the response to Comment numbers 0072.08, 0101.06, 0012.15, 0030.02, 0098.04, 0019.03, and 0091.01 for discussions of the issues of closure, vadose zone contamination, and the applicability of CERCLA to the TWRS action, respectively.

L.6.2 TRI-PARTY AGREEMENT

Comment Number 0032.01

Heacock, Harold

Comment We consider the cleanup, stabilization, processing, disposal of the tank waste to be the focal point of the Hanford cleanup program.

We also strongly support the Tri-Party Agreement as the definitive document for the Hanford cleanup program. Compliance with the Tri-Party Agreement is a major responsibility and obligation of the Department.

The Department must in its selection of an alternative for the cleanup of tank wastes maintain and comply with its commitments under the Tri-Party Agreement.

Several of the alternatives considered in this Draft EIS do not meet the requirements of either the Tri-Party Agreement or statutory cleanup requirements for waste cleanup and disposal and should not be considered further.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

As required by CEQ, the TWRS Draft EIS identifies and analyzes the range of reasonable alternatives for the proposed action and the alternative of no action. Potential violation of existing laws, regulations, or agreements is not considered a basis for eliminating otherwise reasonable alternatives from consideration under NEPA guidance. Please refer to the response to Comment number 0072.05 for a discussion of NEPA requirements to consider a range of alternatives and 0072.52 and 0072.80 for a discussion of why an EIS is required to analyze all alternatives, even when they do not comply with regulations.

Comment Number 0047.03

Ahouse, Loretta

Comment It is of the utmost importance the Tri-Party Agreement be abided by. Please, do not delay, just get on with the cleanup. The Tri-Party Agreement outlines clearly what are the priorities for citizens in Washington State.

I am very concerned that the Department of Energy is considering not abiding by this agreement.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE fully intends to abide by the Tri-Party Agreement. The preferred alternative, Phased Implementation, is consistent with the Tri-Party Agreement requirements and major milestones. Part of getting on with the cleanup is complying with Federal law (i.e., NEPA), which requires preparation and public review of an EIS for any major Federal action including an action such as defined in the Tri-Party Agreement. Please refer to the response to Comment numbers 0072.80, 0034.05, 0072.05, 0038.02, and 0009.01.

Comment Number 0062.01

Longmeyer, Richard

Comment I've been following the process of the cleanup at Hanford for many, many years now. I have made comments at public meetings before, and I'm well aware of the action that had been going on for many years in trying to accomplish the process. It concerns me some that we've seen many mile posts, or milestones missed in the Tri-Party Agreement. The original Tri-Party Agreement when it was enacted was touted as the way of accomplishing the cleanup, and when we began to see that we weren't going to accomplish some of the mile posts, they just decided well we'll just renegotiated the agreement. And it has somewhat lessened the impact that it was intended to have of putting some time bounding on the process of cleaning up Hanford.

In particular, this year we now have the new process of privatization of the vitrification plant. And really what we've done is just push the process of accomplishing the vitrification farther and farther behind, as we've gone on and on. And as the individual from HEAL during his comments stated, we study and we study, and really don't accomplish much in the way of a cleanup.

Response DOE is committed to complying with the Tri-Party Agreement and making every effort to meet Tri-Party Agreement milestones. Tri-Party Agreement milestones are identified in Volume One, Section 6.0. Please refer to the response to Comment numbers 0047.03, 0072.02, 0072.03, and 0072.52.

Comment Number 0068.01

Martin, Todd

Comment The Tri-Party Agreement has been spoken about several times tonight, and I want to address that as well. One of the problems we've had, indeed what is left us with the legacy of Hanford is the problem of accountability. How do we make the Federal government accountable? The Tri-Party Agreement is that mechanism. It is up to this point we've had a Tri-Party Agreement that has had a very long list of specific dates DOE must meet, as well has intermediate steps to get to those dates. These are things that we can hold DOE accountable to. The Tri-Party Agreement, as it now exists under the privatization plan, has been reduced to just a few handful of milestones that are generally way out in the future. Those are very easy ones for the Federal government to sign up to, because they don't have to necessarily make the progress to meet those. There is no affective accountability mechanism being built into the Tri-Party Agreement right now.

Response The TWRS EIS is providing the required environmental impact analysis for the proposed action and alternatives in support of compliance with the Tri-Party Agreement and applicable Federal and State regulatory requirements. DOE is accountable to Washington State and the EPA, which have enforcement authority for the Tri-Party Agreement. Please refer to the response to Comment numbers 0062.01, 0047.03, 0072.02, 0072.03, 0038.02, and 0009.01.

Comment Number 0069.14

Pollet, Gerald

Comment We think it is wrong for the departments to put into the EIS an assumption that waste that remains at Hanford forever and is dubbed low-activity waste, is anything but high-level nuclear waste. And in fact the State of Washington has taken that position before. And it would require a new policy issuance from the Department of Ecology to reverse course on that.

Response The terms used in the EIS are defined by or consistent with the Tri-Party Agreement and regulatory authority and opinion. Ecology is a party to the Tri-Party Agreement and a co-preparer of this EIS and has agreed to dispose of Hanford tank waste as set forth in the Tri-Party Agreement. Under the Tri-Party Agreement, the tank waste will be processed into two fractions, a concentrated HLW fraction containing the majority of the radioactive constituents, which would be disposed of offsite in a potential geologic repository, and a LAW fraction containing a low concentration of radioactive constituents, which would be disposed of onsite at the Hanford Site. The NRC staff concluded that the low-activity fraction would not be HLW. Please refer to the response to Comment numbers 0035.04, 0052.01, 0069.05, 0072.118, and 0072.111. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0072.52

CTUIR

Comment It is still not logical to evaluate alternatives which violate the Tri-Party Agreement, which is a volume-based retrieval agreement. The sentence (p. S-13) stating that the Tri-Party Agreement allows privatization in order to "improve performance and reduce costs without sacrificing worker or public safety of environmental protection" suggests that there is room for negotiating variations in the retrieval/disposal/closure process that combines risk-based and volume-based approaches. If this is the case, then CTUIR must be a party to the discussions so that the proper technical and regulatory issues are adequately addressed. The Tri-Party Agreement currently requires that each tank be retrieved to a pre-determined percentage, and only if this is not practicable will negotiations be started on an individual tank basis for an alternative remedy. The TWRS EIS did not seem to recognize this.

Response Major Federal actions significantly affecting the environment are required by NEPA to consider alternatives to the proposed action. Neither NEPA nor its implementing regulations (40 CFR 1500-1508) make any provision for excluding an otherwise reasonable alternative from the analysis on the basis of noncompliance with existing law, regulation, or agreement. Rather, an EIS must state how alternatives considered will or will not achieve requirements of environmental law and policy (40 CFR 1502.2d). For a related discussion please refer to the response to Comment numbers 0072.80 and 0072.05.

DOE recognizes the CTUIR interest in the Tri-Party Agreement. Section 10.10 of the Tri-Party Agreement acknowledges and defines the involvement of affected Tribal Nations. DOE remains committed to fulfillment of the stated requirements.

Any item in the Tri-Party Agreement may be renegotiated if agreeable to the parties. Tri-Party Agreement Milestone M-45-00 does not include the word "only" as stated in the comment. Therefore, the Tri-Party Agreement identifies circumstances that could result in modification of retrieval criteria. It does not exclude modification in response to other circumstances.

Comment Number 0094.02

Moore, Jennifer

Comment I think the Tri-Party Agreement should adhere to be ... I mean, excuse me, I think the Department of Energy should adhere to the Tri-Party Agreement which they entered into willingly.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Having agreed to the Tri-Party Agreement, DOE has complied with and will continue to comply with the Tri-Party Agreement. The Tri-Party Agreement provides a mechanism for dispute resolution, annual review, and renegotiation. This mechanism permits accommodation of unforeseen implementation problems, new information, better, faster, or cheaper technology, or other factors that the parties agree require consideration and decision. Please refer to the response to Comment numbers 0062.01 and 0072.52.

Comment Number 0101.09

Yakama Indian Nation

Comment The EIS should be revised to take into consideration the conditions and regulatory impacts, including potential cost impacts, associated with the potential future regulation of privatized and/or Government nuclear facilities and nuclear material possession and handling.

Response The potential effect of regulation on privatization was considered throughout the analysis of potentially applicable regulations. Other than the likelihood of NRC licensing of privatized facilities, no major difference was noted. Any change in regulation of government nuclear facilities is speculative and without basis for analysis in the EIS; therefore, no change has been made to the EIS.

L.6.3 INCIDENTAL WASTE

Comment Number 0005.57

Swanson, John L.

Comment On page 6-19 it is said (following a sentence regarding incidental waste) "Therefore, DST waste not exceeding the Class C standards would be suitable for disposal as incidental waste." This is an illogical conclusion (with reference to the preceding sentence), and I do not believe that it is a correct interpretation of "policy."

Response This sentence was not intended to be a conclusion. The sentence has been revised to state that the incidental waste would not exceed the concentration limits for Class C LLW, as defined in 10 CFR 61.

Comment Number 0069.05

Pollet, Gerald

Comment When we look at these alternatives. Let me go back up, throw on this slide for the alternatives. When we look at the alternatives, we look at, what we're talking about is claiming some fraction of these wastes are high-level, and some fraction are low-level. This EIS is based on assumption that violates Federal law. Federal law considers all wastes that are in the tanks as the by-product of the nuclear weapons separations process, and the reactor created fuel that was basically melted down, turned into the liquid high-level waste. All of it is high-level waste. And one question is whether not we as the public, and the State of Washington, should be willing to say that, oh, after you separate it some portion is going to be claimed to be low activity, and therefore low-level waste and can be buried at Hanford forever, and only a tiny smidgeon needs to be considered legally high-level waste. The law is very clear. It is all high-level waste. Therefore, no matter how you calculate this repository fee, because it is based on essentially the waste content, it really doesn't vary. It doesn't vary legally, because it is based on the waste content. So whether or not you separate it, the repository fee isn't going to vary.

Response No Federal law requires placing DOE HLW in a geologic repository or prohibits separating HLW components from a residual of other waste components. Nor are there Federal laws that prohibit disposal of the LAW residual in accordance with applicable LLW disposal criteria. In support of a denial of petition for rulemaking (58 FR 12342), the NRC reviewed DOE's earlier plans to separate Hanford Site tank waste into concentrated HLW for geologic disposal and LAW for disposal onsite in near-surface vaults. The NRC concluded that, on the condition that most of the originally generated radioactive material would be recovered, the residual waste material should be classified as incidental waste because these wastes are incidental to the process of recovering HLW. The NRC concluded that the residual waste would not be HLW and therefore not be subject to NRC licensing authority (58 FR 12342). DOE has authority to dispose of the incidental waste in accordance with LLW disposal criteria. Applicable regulatory requirements are discussed in the Summary and Volume One, Section 6.0.

The amount of HLW that ultimately could be accepted at a national repository is a function of available subsurface area and emplacement constraints among HLW and SNF within this area. In addition, there is a statutory limit on emplacement of HLW and SNF in a first repository (70,000 MTHM) until a second repository is in operation. As a planning basis, the Department has allocated 10 percent of the statutory capacity of the first repository for defense SNF and HLW.

The physical amount of available subsurface area for HLW and SNF disposal and the associated number of packages of HLW and SNF would be defined through repository design and performance assessment activities based on information collected during repository scientific investigations. Neither of these activities is completed. However, for planning purposes, the repository Advanced Conceptual Design assumes that 12,900 canisters of defense HLW, each containing 0.5 MTHM, can be accommodated within the statutory limit.

A number of factors are important in estimating disposal costs including number and size of canisters handled, number of waste packages, operation and capital costs, and number of shipments to a repository. In addition, there are common costs that must be allocated among waste generators, such as development and evaluation costs, to ensure full cost recovery. Using radionuclide inventory of Hanford HLW relative to other waste would not provide an equitable basis for cost estimating. Please refer to the response to Comment numbers 0004.01, 0057.04, and 0081.02 for information regarding repository cost and capacity issues. Because the information contained in the Draft EIS is correct, no change to the text was made.

L.6.4 OTHER

Comment Number 0005.08

Swanson, John L.

Comment Going into this review, I was most interested in seeing how the HLW disposal aspects were handled- because I have been hearing different stories for some time regarding not only what the costs of such disposal were likely to be, but also what are the laws/rules governing such disposal and what are peoples interpretations/speculations on things such as how much space will be available for defense HLW in the first repository. Unfortunately, this EIS did nothing to clarify the issues; in fact, I feel that it contains misinterpretations of the facts. I feel that a much greater effort should have been devoted to understanding and explaining the issues involved in this area. Maybe the picture is really so muddled that it is not possible to understand; if so, it is a pretty sad commentary on the abilities and actions of the DOE. Some examples of my and/or your confusion in this area are:

(a) I do not believe that there is a "canister count" limit for defense HLW in the first repository, but this draft repeatedly assumes one- and compares the number of canisters estimated for the different alternatives to that assumed number.

(b) I do believe that there is a MTHM limit on the first repository; and that all of the alternatives that send all of the HLW to the repository would contribute the same to this limit (e.g., the extensive separations and the ex situ/no separations case would send essentially the same amount of radioactivity to the repository).

(c) I have heard that there is an "equivalent MTHM" value that is to be applied to defense HLW, but I see no mention of it in this EIS. (The EIS says that ~100,000 MTU were processed at Hanford, and that the TOTAL limit on the first repository is 70,000 MTHM; unless there is an "equivalent MTHM" factor, the Hanford waste alone would exceed the total capacity of the first repository).

I hope to be able to dig into these issues to resolve them to my satisfaction, but that likely won't happen until the EIS comment period has expired so I will send these comments now. If I should be able to learn more in time, I will send you additional comments.

Response As noted in Section 6.2.1, DOE's Waste Acceptance System Requirements Document contains a limitation of 13,200 canisters of defense HLW at the first repository (DOE 1994g). The EIS uses the best estimates of future HLW storage capacity for comparisons.

As noted in Section 6.2.1, the OCRWM has set aside 7,000 MTHM of the first repository capacity for disposal of DOE-owned spent nuclear fuel and HLW. This capacity allocation only addresses the thermal and radioactivity loading of the repository. There also may be practical limitations to the volume capacity if large volumes of relatively dilute HLW are to be disposed of, such as under the Ex Situ No Separations alternative. The extensive separations and no separations alternatives would contribute essentially the same to the thermal and radioactivity loading but orders of magnitude different volumes.

The Nuclear Waste Policy Act, under section 114, requires the NRC to limit the emplacement in a first repository to a quantity of spent fuel containing in excess of 70,000 MTHM or a quantity of solidified HLW resulting from the reprocessing of such a quantity of spent fuel until a second repository is in operation. For planning purposes, DOE has assumed that a standard canister of solidified HLW contains 0.5 MTHM. This is based on equating the relative fuel burnup in megawatt-days per metric ton for HLW compared to the burnup for a standard nuclear fuel. Under this assumption, the repository Advanced Conceptual Design can accommodate up to 12,900 canisters of vitrified HLW in a first repository within the statutory limit on the first repository and the allocation of 7,000 MTHM for defense SNF and HLW. Please refer to the response to Comment numbers 0004.01, 0081.02, and 0069.05 for related discussions. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0005.58

Swanson, John L.

Comment Also on page 6-19, it is said "DST waste is currently designated HLW." I thought that the DST wastes in the two NCRW tanks and in the PFP tank were considered to be TRU waste instead of HLW.

Response The sentence has been revised in the Final EIS to state that, "most DST waste is currently designated as HLW."

Comment Number 0009.13

Broderick, John J.

Comment Some of the sections on Implementability use compliance with DOE policy or Federal and State requirements after 100 years as a decision criterion. Do not do this. They will change in a hundred years. Use only the status of the waste and health effects based on scientific analysis as the decision criteria.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors

influencing the evaluation of alternatives. It is agreed that Federal and State requirements may change. However, current requirements must be considered in making decisions that could incur a future commitment for additional action. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0036.17

HEAL (Exhibit)

Comment In addressing the contamination of groundwater, the EIS states, "Current drinking water quality standards do not apply beyond 1,000 years. Therefore, contaminant levels as reported beyond 1,000 years are for comparison to the current standards and are not exceedances of the standards" (p. 5-11). What does this mean? What is the purpose and intent of this passage?

Response The two sentences are incorrect and have been deleted from the Final EIS.

Comment Number 0040.04

Rogers, Gordon J.

Comment Regulatory compliance (for the In Situ Fill and Cap alternative) will of course require resolution; however, here is a perfect example of the appalling unfairness of spending huge sums of limited taxpayer funds to reduce already low risks from nuclear wastes when other risks of injury or death to workers and the public are far larger. I think Congress will see the light on this; and I want to see them tackle this issue.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives. NEPA requires that all reasonable alternatives be evaluated, regardless of compliance to existing regulations. However, DOE and Ecology intend to comply fully with all Federal, State, and local regulations and ordinances applicable to tank waste remediation. The EIS is not a cost benefit analysis. An EIS presents costs and risks in an even handed manner for the public and the decision makers to support a comparison among alternatives. Please refer to the response to Comment numbers 0072.52 and 0072.80 for related discussions.

L.7.0 SCOPING, PUBLIC PARTICIPATION, AND CONSULTATIONS

Comment Number 0012.19

ODOE

Comment Appendix J of Volume Five contains "Consultation Letters" to various regulatory agencies, States and Tribes. While perhaps complying technically with the legal requirements, the "Consultation Letters" do not meet what we believe is the intent of NEPA. That is to consult with and obtain the comments from agencies with regulatory authority or special expertise, States and Tribes. The letters were sent with little information and without discussion. Lacking detailed information, the recipients cannot make meaningful comment on USDOE's plans. Oregon did not have sufficient information until receipt of the draft EIS and was not invited to participate in the formulation of the EIS. NEPA requires cooperation of Federal Agencies in preparation of environmental analyses from inception to ensure good analyses are performed and good decisions are reached based on a through understanding of the potential problems and impacts. A letter near the end of the process which describes the purpose of the EIS in the broadest terms does not accomplish these goals and does not meet the intent of NEPA. Oregon expects to be included from the inception in future analyses and throughout environmental analyses of actions which may impact the Columbia River.

Response The consultation letters contained in Volume Five, Appendix J represent one of several forums for consultation with agencies and Tribal Nations that were provided in accordance with NEPA (i.e., 40 CFR 1501.2, 1501.5-7, 1502.25, 1503.1-4, and 1506.02) and SEPA (i.e., 197-11 WAC) regulations. DOE and Ecology value the input from stakeholders, Tribal Nations, and State and Federal agencies and believe that the intent and spirit of NEPA and SEPA regarding consultation and public involvement during the NEPA process have been met.

The consultation process formally began with the publication of the Notice of Intent Notice of Intent in the Federal Register on January 28, 1994 (FR 4052). At that time, DOE announced its intent to prepare the TWRS EIS and invited all interested parties, including the public, State and Federal Agencies and Tribal Nations, to comment on the scope of the TWRS EIS, as well as significant issues that DOE should consider when preparing the EIS. The Notice of Intent provided background on the scope of the EIS, information on the TWRS program, information on the purpose and need for agency action, alternatives that would be considered in the EIS, and the regulatory framework for the EIS. The Notice of Intent also announced a scoping period of 45 days during which DOE would accept written comments. Further, during the scoping period, DOE conducted five public meetings at which oral and written comments were accepted. Two hearings were held in the State of Oregon. During the scoping period, several state and Federal agencies submitted comments to DOE that were used to define the scope of the EIS, alternatives to be considered in the EIS, and areas of impact analysis to be included in the EIS.

Subsequent to the public scoping process and prior to the publication of the Draft EIS on April 12, 1996, DOE and Ecology held meetings with stakeholders, the Hanford Advisory Board, the Hanford Natural Resources Trustee Council, Tribal Nations, and various state and Federal agencies regarding the preparation of the EIS. Many of these meetings were initiated by DOE or Ecology to solicit input regarding specific issues to be addressed in the EIS or to receive input regarding emerging data relevant to the TWRS EIS. Other meetings were initiated by stakeholder organizations, Tribal Nations, or agencies to receive information from DOE and Ecology regarding the progress and content of the TWRS EIS.

In November 1995, to supplement the scoping process and other consultation activities following the scoping period, DOE and Ecology transmitted formal consultation letters to local, state and Federal Agencies, and Tribal Nations. In response, several state and Federal agencies, and Tribal Nations provided written information on issues considered important to address in the EIS or to request additional consultation meetings to discuss specific concerns.

The next step in the consultation process, as specified by NEPA, is to provide a copy of the Draft EIS to applicable local, state and Federal agencies, and Tribal Nations to obtain comment on the Draft EIS. The Draft EIS was distributed to more than 30 local, state and Federal agencies, and four Tribal Nations. This distribution also included Oregon Department of Energy, Oregon Hanford Waste Board, Oregon Department of Transportation, and Office of the Governor. A notice of availability was published in the Federal Register on April 12, 1996, and April 15, 1996, and a public notice was published in the Portland and Hood River newspapers on April 12, 1996. These notices provided information regarding the alternatives considered in the Draft EIS and solicited written comments from interested agencies, Tribal Nations, and the public during the public comment period (April 12, 1996 to May 28, 1996). During the comment period, a public hearing was held in Portland, Oregon so that agencies and other interested parties could provide oral comments on the Draft EIS. Oregon Department of Energy participated in the planning and operation of the Portland hearing. Oregon Department of Energy also submitted oral comments at this meeting, as well as written comments on the Draft EIS.

Oregon Department of Energy and other agency comments were considered when preparing the Final EIS. Response to the Department's comments on the Draft EIS are provided in this appendix and changes to the EIS have been incorporated as indicated in the responses. DOE and Ecology value the Oregon Department of Energy's comments and believe these comments contributed to improving the EIS. Please refer to the response to Comment numbers 0072.149, 0072.252, 0072.53, and 0072.271 for a discussion of consultations with Tribal Nations.

Comment Number 0101.10

Yakama Indian Nation

Comment The Yakama Indian Nation (YIN) previously commented on the scope of the subject EIS in a letter of March 28, 1994 and on the Tank Waste Remediation System (TWRS) functions and requirements document (DOE/RL-92-60) in a letter of March 23, 1995.

These letters, copies of which are attached to this letter, address issues, many of which remain unresolved with the TWRS Draft EIS. All of the issues addressed below have been previously identified in YIN ER/WM meetings with DOE and DOE contractor personnel working on the subject EIS.

Response DOE and Ecology considered the comments of the Yakama Indian Nation submitted on the scope of the TWRS EIS in developing the scope of the EIS, the alternatives to be considered in the EIS, and the areas of environmental impact analysis included in the EIS. The DOE and Ecology responses to the comments of the Yakama Indian Nation on the scope of the EIS are documented in the Implementation Plan for the Draft TWRS EIS (DOE 1995b). Among the comments incorporated into the EIS alternatives and/or impact analysis were 1) evaluation of an alternative involving the disposal of all wastes to an offsite repository (the Ex Situ No Separations alternative); 2) evaluation of an option that would calcine rather than vitrify the waste stream (calcination option to the Ex Situ No Separations alternative); 3) evaluation of retrieval storage of treated waste; 4) evaluation of railcars for transportation and storage of tank waste (addressed in the interim action SIS EIS [DOE 1995i]); 5) addressing of land-use restriction associated with each alternative; 6) addressing of impacts associated with leaks associated with retrieval; 7) management of gaseous waste streams; and 8) impacts to cultural and natural resources.

The issues addressed in the remainder of the comment letter on the Draft TWRS EIS are addressed elsewhere in this Appendix (please refer to the response to Comment numbers 0101.01 to 0101.09). As indicated in the comment, DOE and Ecology met with the Yakama Indian Nation and other affected Tribal Nations throughout the NEPA process for the TWRS EIS. These meetings and meetings following the publication of the Draft EIS for public comment have resulted in substantive changes to the Final EIS based on the advise and input of representatives of the Tribal Nations. For a discussion of the consultation process, please refer to the response to Comment number 0072.149. Please also refer to the response to Comment numbers 0072.37, 0072.40, 0072.156, 0072.160, 0069.07, 0101.03, 0072.198, 0072.252, and 0072.225 for discussions of selected changes to the EIS based on comments by Tribal Nations. Because the information contained in the comment is addressed elsewhere (e.g., in the Implementation Plan for the EIS, in responses to other comments, or in the text to the Draft EIS), no modification to the document is warranted.

L.8.0 LIST OF PREPARERS

No comments were submitted for this topic.

L.9.0 NEPA-RELATED COMMENTS

L.9.1 EIS PRESENTATION AND DISTRIBUTION

Comment Number 0042.02

EPA

Comment EPA has authorized the Washington State Department of Ecology to be the single regulatory authority for Resource Conservation and Recovery Act requirements on the Hanford Site. Although the formal public comment period began on April 12, 1996, copies of the draft EIS were not received by our Environmental Review Program office in Seattle until May 10, 1996, 30 days into the 45-day comment period. Therefore, we will not be conducting a detailed review of this Draft EIS. However, based on our previous endorsement of the single regulatory authority approach and the extensive involvement of Ecology as a co-preparer of this Draft EIS, we do not foresee having any critical environmental objections to the proposed project.

Response DOE submitted five copies of the Draft EIS to EPA headquarters in Washington, D.C. on April 5, 1996. Subsequently, copies were requested by EPA Region X for purposes of review and an additional five copies were sent to EPA Region X on the day the request was received by DOE. After the EIS had been received by EPA, DOE and Ecology met with EPA staff to facilitate the EIS review. DOE and Ecology informed EPA that the agencies would provide whatever support was necessary to ensure a timely and complete review of the EIS. EPA Region X subsequently informed DOE and Ecology that the agency would not be conducting a detailed review of the EIS. Please refer to the responses to Comment numbers 0007.01 and 0044.01 for information related to this comment.

L.9.2 CLOSURE

Comment Number 0012.12

ODOE

Comment This EIS does not govern closure of the tanks and tank farms. This is appropriate. Decisions on closure of tanks and tank farms and what to do about leaked tank waste must be the subject of a separate EIS.

Response DOE and Ecology acknowledge the comment and provide a discussion that supports the comment in Volume One, Section 3.3 on pages 3-18 to 3-20 of the Draft EIS. Please also refer to the response to Comment numbers 0005.17, 0019.03, 0072.08, and 0101.06 for a discussion of the relationship between the TWRS EIS scope and closure of the tanks.

L.9.3 SCOPE

Comment Number 0010.01

*GRAY*STAR*

Comment One page B-25 is the following paragraph:

DOE is pursuing alternative uses for the cesium and strontium capsules, however, no acceptable uses have been found.

If no future uses for these capsules are found, the capsules eventually would be designated as HLW and managed and disposed of consistent with the TWRS EIS alternative selected for implementation.

As outlined in the attached "Privatization of Isotope Activities: GRAY*STAR, Inc. Expression of Interest, May 28, 1996", we believe that there is an alternative and driving use for the cesium and ultimately the strontium capsules. Further, we believe that there is an immediate need for ALL of the Cesium-137 at ALL of the government laboratories.

If a plan similar to that outlined in the enclosed Expression of Interest is put into effect, there will be several immediate and long range benefits, which include but are not limited to:

1. No need to "bury" the HLW. This would lead to a cost avoidance by the United States taxpayers in the billions of dollars as outlined in the EIS. It would also avoid overall impact to the environment. Or, at worst, allow more room at a repository for other (perhaps civilian) waste.
2. The immediate savings on the WESF building would be approximately $10,000,000 per year with a total cost savings from $112,000,000 to $697,000,000 as outlined in the EIS.
3. The 100 jobs outlined for the WESF building would be reduced and privatized.
4. The tank Remediation would be simplified (thus savings in both costs and environmental impact), because of the simplification of dealing with the wastes after the HLW is removed. (For example, the HLW could be removed from the tanks prior to full TWRS implementation. This would be similar to the project which produced the existing WESF material.)
5. The process could be sped up which would lead to some cost savings and major savings on environmental damage.
6. There would be no legacy of stored DOE HLW in the future, either in 100 years, 1,000 years or 1,000,000,0000 years.
7. The GRAY*STAR will reduce worldwide food borne disease.
8. The GRAY*STAR will open up phytosanitary restrictions and allow for greater trade between nations.
9. The GRAY*STAR will allow the reduction/elimination of post harvest fumigants which are harmful to both health and the environment.
10. The manufacture of GRAY*STAR units will lead to an expansion in heavy steel fabrication orders, helping the economy.

In summary, there is an immediate use for the existing cesium and perhaps strontium capsules now stored in the WESF building. This use will result in major cost savings, both monetary and environmental. This use extends to all of the cesium, and perhaps strontium, which is still in the 177 tanks as well as the MUSTs. Therefore, the impacts as outlined in the EIS could be further significantly reduced.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on cesium and strontium capsules. The TWRS EIS addresses the management and disposal of the capsules. Analysis of potential beneficial users of the capsules is outside of the scope of the EIS. However, the information will support DOE's decision regarding the designation of the capsules to be available for disposal. Please refer to the response to Comment number 0006.01.

Comment Number 0012.11

ODOE

Comment Treatment of the Hanford tank wastes was the subject of an extensive Tri-Party public involvement process two years ago associated with a proposal by USDOE called Tank Waste Remediation System Rebaselining. The Tri-Parties also formed the Tank Waste Task Force at that time to discuss these issues. The public overwhelmingly rejected USDOE's plans to place the low-activity waste from tanks in a grout waste form in favor of vitrifying the waste. All of the public comment from that process is directly applicable to this EIS and should be included in this EIS.

Response In Volume One, Section 1.1, DOE and Ecology acknowledged the important role of the Tank Waste Task Force in considering the revised technical strategy for TWRS and the extensive public involvement process associated with the renegotiation of the Tri-Party Agreement in January 1994. The Draft EIS also stated that one of the major developments since the 1988 Hanford Defense Waste EIS ROD was the termination of the planned low-activity grout project in response to public concerns. Grout was considered in the EIS as an available immobilization technology and addressed in Volume Two, Appendix B. However, it is important to note that the current TWRS planning basis, the Tri-Party Agreement, and the preferred alternative all specify that the LAW, as well as the HLW, will be immobilized with the assumed waste form being a vitrified glass. Please refer to the responses to Comment numbers 0035.04, 0036.13, 0038.01, 0038.05, 0038.10, 0052.01, 0055.03, and 0072.05.

DOE and Ecology considered the values and recommendations of the Tank Waste Task Force in developing the TWRS EIS alternatives. Within the EIS, DOE and Ecology have incorporated the role of the Tank Waste Task Force into the TWRS program and amended Tri-Party Agreement technical strategy and, ultimately into the identification of the preferred alternative. Because the information contained in the Draft EIS is correct, no change to the text was made.

Comment Number 0055.03

Martin, Todd

Comment Second, our second bullet is the TWRS EIS is not responsive to public concerns and here primarily we are referring to the Tank Waste Task Force. Two years ago when we finished up the Task Force, we said call this a NEPA equivalent and let us get on with it. Unfortunately, DOE and Ecology decided to do this EIS. We said okay, that is maybe alright, but what you should do is just look at flushing out the impacts of the preferred alternative. That has not happened. What we have got is a behemoth of a document that analyzes every possible alternative.

Response The Tank Waste Task Force identified several "principles" to guide the Tri-Party Agreement negotiations. These principles were defined as "values that should be applied to the overall agreement." During scoping for the TWRS EIS, individual commentors did support the concept that the Tank Waste Task Force and Tri-Party Agreement serve as "NEPA equivalent" activities. However, the Tank Waste Task Force Report specifically states that the Tri-Party Agreement should not be used as a "shield against enforcement of other laws." NEPA and SEPA are both environmental laws that apply to the proposed tank waste action. Neither statute allows the Tank Waste Task Force report to be used as an EIS. Therefore, DOE believes that an EIS was required to support the decisions related to TWRS proposed action, and that the EIS complies with the Task Force value of not using the Tri-Party Agreement to shield enforcement of other laws. Please refer to the response to Comment number 0034.05 for a related discussion.

Prior to initiating the impact analysis in the EIS, DOE and Ecology reviewed the Tank Waste Task Force Report to ensure that the EIS incorporated the issues of concern identified by stakeholders. Ten items were identified in the Tank Waste Task Force Final Report regarding impacts to the environment, including worker and public health safety and protection of the Columbia River. The TWRS EIS incorporates all of the areas of concern identified by the Task Force into its analysis of potential environmental impacts. Please refer to the response to Comment number 0012.11.

The TWRS EIS achieves the value of "getting on with the cleanup" by combining Federal and State environmental impact analyses into one process. DOE and Ecology are co-preparing the EIS to meet NEPA and SEPA requirements, and thereby reducing "paperwork, analytic, and decision-making redundancy."

Finally, in order to comply with NEPA, DOE was required to do more than "flushing out the impacts of the preferred alternative." First, NEPA requires that all EISs compare the impacts of the proposed action to a No Action alternative. Second, NEPA requires that an EIS 1) "rigorously explore and objectively evaluate all reasonable alternatives," 2) "devote substantial treatment to each alternative considered, including the proposed action, so that reviewers may evaluate all comparative merits," and 3) include reasonable alternatives not within the jurisdiction of the lead agency." These requirements can be found in 40 CFR 1502.14.

Comment Number 0063.01

Donovan, Virgil

Comment This is kind of the way the government works, and Hanford is not above this. There are contractors down there that even that you see at that time would get in bed with them a little bit, and like to see those contracts continue and get bigger for the community, and one thing or another. We see the same thing happening now with Doc Hastings. He wants to convert the Fast Flux Test Reactor to a tritium production plant. Then he wants to follow that up with a bigger tritium production plant. Tritium was used in the bomb because it was cheaper than diterium, which was a much safer material we used to use in the bomb in the warhead. It didn't bother them a bit to make that change. In fact is was a good place to hide the fact that we produced tritium in any reactor, and so we have a certain amount of it we have to dispose of. Well that gave us a good reason to have a bigger stockpile. We had lots of military contractors out there who'd like that, and I'd hate to see it happen again. I don't want us to produce tritium.

Response The production of tritium and future uses of the FFTF are not within the scope of this EIS; therefore, no modification to the text is warranted.

Comment Number 0063.02

Donovan, Virgil

Comment And I think we should be very damn careful about how the politicians get into this, and how much we believe, and how much we believe of the government agencies. Let's keep them at the point, what we're supposed to be looking for here. Clean this plant up. And let's not get into the side issues of building more tritium, which is not needed, or something else to continue operations at Hanford.

Response DOE and Ecology acknowledge the preferences expressed in the comment and share the desire to move forward with remediation at the earliest possible date. Because issues associated with the production of tritium are outside the scope of this EIS, no change to the EIS is warranted.

Comment Number 0067.01

Browning, Joe

Comment I think that the public should take into consideration of a new energy system that would bring energy, or nuclear energy to stop radiation leaks into rivers, land, and air would stop. The energy system is not nuclear power of any sort. It will out produce a nuclear facility, and produce a new system of energy sources throughout. The DOE has wanted to only take this into consideration for talks and technical review. In other words, nothing will ever happen. They will tell the public, such as tonight through Hanford cleanup, that we don't need any more Hanford cleanup because we don't need any more nuclear waste coming into Hanford. All nuclear facilities will basically consider, through this new energy system, would be stopped. The public is not made aware of a new system that will out-produce a nuclear facility, and put a halt to nuclear problems.

Response The scope of the EIS is to evaluate alternatives for the remediation of the tank waste and cesium and strontium capsules. The topics identified in the comment are not within the scope of the EIS; therefore, no change to the EIS is warranted.

Comment Number 0072.09

CTUIR

Comment Both of these critical issues (characterization deficiencies and lack of closure coverage) point to a lack of an overarching programmatic structure, linked to long-term goals, that is framed with a single guiding and truly comprehensive decision document. The current EIS focuses on retrieval as an isolated event that excludes critical assumptions and limiting factors that cannot be separated from preceding, subsequent, successive, incremental, and cumulative actions. The CTUIR SSRP must remain informed about each of these factors which have the potential to result in direct impacts to tribal interests.

Response Please refer to the responses to Comment numbers 0012.14 and 0072.07 for discussions regarding characterization of tank waste. Please refer to the response to Comment number 0072.08 for the reasons for not including closure in this EIS. DOE and Ecology remain committed to open communication and consultation with the CTUIR on all issues potentially affecting Tribal Nation interests. The TWRS EIS addresses the cumulative impacts of past tank waste leaks, the TWRS alternatives, and other related, planned and reasonably foreseeable actions at the Hanford Site in Volume One, Section 5.13. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted. Please also refer to the response to Comment numbers 0072.198 and 0072.252.

Comment Number 0072.46

CTUIR

Comment Since the Hanford Barrier is an integral part of this EIS, along with the potentially tremendous adverse ecological and cultural impacts of mining the fill and cap materials, will this EIS be used *post hoc* to claim that this aspect of closure was pre-approved? The CTUIR can not endorse the Hanford Barrier as part of closure; nor can the CTUIR endorse closure of tanks as a landfill.

Response The TWRS EIS or the ROD will not be used as an evaluation of closure alternatives, including use of the Hanford Barriers. Closure, use of the Hanford Barrier, and the selection of sites for earthen borrow material will be addressed in a future NEPA analysis. Please refer to the response to Comment numbers 0019.03, 0019.04, 0072.08, 0089.04, and 0101.06 for discussions of closure and borrow sites.

Comment Number 0072.47

CTUIR

Comment Contaminated soil is not included. Making a statement that contaminated soil and groundwater are not included does not excuse DOE from making decision based on the complete source term. The insertion of subsurface and groundwater data has implications that point to closure decisions.

Response Please refer to the response to Comment numbers 0019.03, 0072.07, 0072.08 and 0101.06 for a discussion of the reasons closure, including releases from past practice activities, are not included in this EIS, but will be addressed in future NEPA analysis. Additional NEPA evaluations of the environmental impacts associated with closure, such as potential impacts to habitat cultural resources, human health, and cumulative impacts, would be analyzed. Volume One, Section 5.13 of this EIS discusses the cumulative impacts associated with TWRS and other Hanford Site projects. A discussion of emerging vadose zone contamination data is provided in Volume One, Section 4.2 and Volume Five, Appendix K. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted.

Comment Number 0072.48

CTUIR

Comment Contribution of tank waste + soil + gw + all other 200 Area hazardous materials/waste constitute the 200 Area aggregate source term. What apportionment has been considered among these sources relative to the total Hanford long-term and accident risks? The ultimate decision must be based on all sources of risk.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Volume One, Section 5.13 of the EIS, Cumulative Impacts, assesses the cumulative impacts of TWRS and other Hanford projects. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. However, closure, which includes soil and groundwater contamination from past tank leaks and past-practice sites outside of the tank farms, is beyond the scope of the TWRS EIS. These issues will be addressed in future NEPA analysis for closure, or future CERCLA actions, for past-practice sites in the 200 Areas.

Comment Number 0072.49

CTUIR

Comment The risks are estimated due to <u>*new*</u> groundwater contamination and do not include existing groundwater contamination, new contamination as the contaminated soil leaches, nor any other new source of groundwater contamination (from ERDF, US Ecology, other 200 Area materials). This is a serious flaw in the way that source terms at Hanford are estimated - the Record of Decision must "apportion" the risks among all existing and future sources.

Response Please refer to Volume One, Section 5.13, Cumulative Impacts and Appendix F, which assesses the cumulative impacts of TWRS and other Hanford projects and existing contamination using the best available information. The Environmental Restoration and Disposal Facility (ERDF), US Ecology, other 200 Areas impacts, and TWRS impacts were presented in this section as well. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the responses to Comment numbers 0012.15, 0030.02, 0040.06, 0072.08, 0072.47, 0091.01, 0098.04, and 0101.05 for related discussions.

Comment Number 0074.02

Shims, Lynn

Comment I wanted to formally also offer some kind words to the Department of Energy who have worked very hard on this and working hard to change their image. Because I heard today that to replace the monies lost by the gasoline tax revenues that there had been a proposal again to replace your whole department. And it must be very difficult to work on these gray issues and not get enough respect like that. And I'm also very mad about the fact that here we are smack up against the cold war mortgage legacy to us, given to us by the Department of Defense, who get's more money than they ask for in their budgets, and we're left kind of like the garbage men picking up after them all over the world right here in our own backyards because they have to have enough money to fight a war on two fronts. And I wonder if we're one of the fronts that their fighting against, or that they don't care about our own homeland. And that's a persistent problem.

Response Funding of the DOE and its programs from Congress, the relative merits of funding DOE programs compared to other agencies, or national priorities are not included in the scope of this EIS; therefore, no change to the text of the EIS is warranted. Please refer to the response to Comment 0014.04 for a discussion of funding issues.

Comment Number 0075.02

Wright, Peter

Comment And I just want to thank you very much, and I hope you get all the funding you need because we do need, as that woman said, a lot more money to clean it up than we do to continue making the messes.

Response DOE and Ecology support the desire to obtain the necessary funding to complete the project. Funding of the DOE and its programs is not included in the scope of this EIS. The EIS presents data regarding the potential costs of the alternatives analyzed in the EIS to assist the public and decision makers in the consideration of the alternatives. Please refer to the response to Comment numbers 0014.04 and 0074.02.

Comment Number 0076.04

Blazek, Mary Lou

Comment Although we support the preferred alternative, it will not resolve all the issues related to the high-level waste at Hanford. We believe there will continue to be a need for ongoing monitoring, characterization, and pumping and treating of groundwater contamination caused by waste, which has leaked and migrated from the tanks. We will continue to support fast, speedy, and cost-effective cleanup at Hanford. We believe the preferred alternative is a step in that direction. Thank you.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The monitoring, characterization, and remediation of the groundwater caused by past practice activities is not within the scope of this EIS, but remains a concern of DOE and Ecology and will be addressed in a future NEPA analysis. The TWRS EIS discusses, to the extent practicable, the relationship between the tank waste remediation alternatives and future Hanford Site cleanup decisions. Please refer to responses to Comment numbers 0040.06, 0072.07, and 0101.05 and the Volume One, Section 5.13 discussion of cumulative impacts.

Comment Number 0078.01

ODOE (Exhibit)

Comment A year after this process and negotiations ended USDOE changed course. USDOE began a program to reduce costs and privatize the tank waste program. In the process, they laid off the workers that were key to the program. In the process, they laid off the workers that were key to the program for designing and building the glass plants. The plant was to convince private companies to submit bids for and then build plants to convert the tank waste to glass. That would be cheaper and faster than USDOE could do.

Many stakeholders, including Oregon, expressed reservations about USDOEs ability to succeed at privatization.

Response Privatization is discussed in Volume One, Section 3.3 and is simply a contracting mechanism, which is beyond the scope of this EIS. Under this concept, DOE would competitively bid a portion of the remediation work instead of having the Site Management and Operations contractor perform the work. Equivalent requirements for retrieval, treatment, and disposal of the waste would apply regardless of how DOE contracts to perform the remediation. Please refer to the responses to Comment numbers 0079.06 and 0088.05.

Comment Number 0078.05

ODOE (Exhibit)

Comment This EIS makes no decisions about what to do with the tanks or leaked tank waste. This is deferred to a later Environmental Impact Statement. Decisions about the fate of the tanks and leaked waste must be based on a thorough understanding of the fate of this waste. Modeling alone is insufficient. USDOE must begin now a program to determine the fate of all of the waste leaked from the tanks, cribs, trenches, reverse wells, and other disposal facilities.

Response The remediation of leaks and releases during past practice activities are part of tank farm closure and are not within the scope of this EIS. However, DOE has a program to monitor and characterize these releases and will address remediation of these releases in a future NEPA analysis. Volume One, Section 5.13 and Appendix F contain a description of the potential cumulative impacts of tank waste remediation with other Site activities and past practice releases using the best available data. Please also refer to the responses to Comment numbers 0012.15, 0030.02, 0072.08, 0072.47, 0076.04, 0091.01, and 0098.04.

Comment Number 0078.06

ODOE (Exhibit)

Comment The comprehensive impact of disposed and leaked wastes on the groundwater and future health of the environmental and citizens of the Northwest must not be a guessing game. We do not know enough today to decide what to do about these wastes. In depth analysis of the actual fate of the leak tank waste is needed before decisions can be made about what to do with the leaked tank waste and the tanks themselves.

Response There is currently insufficient information to address remediation of past practice activities for the tank farms. The scope of the EIS is the management and disposal of the tank waste and cesium and strontium capsules. Remediation of past practice tank waste leaks is not within the scope of this EIS, but will be addressed in a future NEPA analysis. Please refer to the responses to Comment numbers 0012.15, 0030.02, 0072.08, 0072.47, 0076.04, 0091.01, and 0098.04.

Comment Number 0079.06

Knight, Paige

Comment If privatization fails, you must start over. Do it quickly, but you must do it. The DOE must not have the sole authority to determine failure in this process.

Response The Draft EIS addresses regulatory compliance for each alternative in Volume One, Section 6.2. However, the relative authority and responsibilities of the agencies under the Tri-Party Agreement are beyond the scope of the EIS. The 1996 Tri-Party Agreement amendment contains a contingency plan in the event that privatization failed to meet established criteria. Therefore, both Ecology and EPA are part of the decision-making process concerning the success of privatization. Please refer to the responses to Comment numbers 0072.73, 0072.74, 0078.01 and 0088.05.

Comment Number 0087.02

Tewksbury, Ross

Comment Now, one of the problem that Hanford has had over the years, which seems to be setting back in here with the problems with the budget and the Congress, is that it's doing things on the cheap, or only taking halfway measures, and it winds up being far more expensive in the long run. And the whole history of Hanford is one of the worst examples of this type of thing.

Response DOE and Ecology share the desire and expectation that Congress will provide the necessary funding to perform the remediation alternative selected. However, funding issues are not within the scope of this EIS.

Comment Number 0088.04

Porter, Lynn

Comment Okay, I would like to see Casey Ruuds' research into the waste migrating through the soil towards the groundwater, I'd like to see that fully funded. As I said earlier, I would be really upset and angry if DOE fires Casey Ruuds, because I think we really need him out there.

Response The emerging information concerning contamination in the soil column from past-practice activities was discussed in Volume One, Section 3.3 of the Draft EIS; and the Final EIS has been modified in Volume One, Section 4.2 and Volume Five, Appendix K to add additional discussion of this information. In Volume One, Section 3.4 and Appendix B, the EIS indicates that characterization and monitoring of the vadose zone and groundwater associated with tank leaks is among the ongoing operations that would continue under all alternatives analyzed in the EIS. DOE has implemented a program to better characterize the leaks from past practice activities. However, closure that would address alternatives for remediating contaminated soil and groundwater, the funding of particular projects and the employment of individuals are beyond the scope of the EIS. Please refer to the responses to Comment numbers 0012.15, 0030.02, 0078.08, 0091.01 and 0098.04.

L.9.4 NEED TO PREPARE THE EIS

Comment Number 0005.07

Swanson, John L.

Comment I do not believe that this EIS will be used to aid decision makers, other than to provide for them as much justification as possible for decisions that they have already made. Shouldn't it really have been written before the Tri-

Party Agreement was reached?

Response NEPA does not preclude DOE from identifying a preferred course of action before an EIS is prepared. NEPA does require DOE to provide the decision makers and public with information regarding the potential environmental impacts of any proposed action and reasonable alternatives so that when decisions to irretrievably commit the agency to a specific course of action are made, environmental consequences are considered by the decision makers.

Similarly, the TWRS EIS will provide the decision makers and public with information regarding the potential environmental impacts of the proposed action, which includes the current Tri-Party Agreement approach. The ROD for the TWRS EIS will document the decisions made regarding tank waste management and disposal. DOE and Ecology believe that the EIS will provide one more valuable source of information to be used by the decision maker to reach a final decision on tank waste management and disposal. Please also refer to the response to Comment numbers 0005.09, 0034.05, and 0055.03.

Comment Number 0009.01

Broderick, John L.

Comment I attended the May 2 public hearing in Pasco. One comment that came up several times in the testimony and in discussions in the back of the meeting room was: We should not reopen this issue; we have already decided how to deal with these wastes. My answer to that comment is that it is being reopened because Hanford can not seem to complete projects. We try to clean up Hanford without any health effects, with facilities that take too long to construct, and with project that cost too much money.

Response Please refer to the response to Comment number 0034.05, which addresses a similarly worded comment.

Comment Number 0034.05

Belsey, Richard

Comment And in January of 1994, the agreement was signed. And we thought okay now they are going to get on with it. And the Tank Waste Task Force said get on with it because it is so expensive and it's so unsafe.

Then we found out that they were not going to start with the preferred alternative and go and look at the impact of that, but that because of the size of the program and such they needed to do this full Environmental Impact Statement.

That was not the sentiment of the people of the Northwest who made up their minds and essentially voted with their feet to come and tell us about that in all these meetings.

Response The EIS was initiated because DOE is required by NEPA to complete an EIS when considering an action that could significantly affect the quality of the human environment (40 CFR 1500). Failure to complete an EIS would pose a legal risk to the implementation of tank waste retrieval, treatment, and disposal actions. Also, State law requires preparation of an environmental analysis under the SEPA to support subsequent State actions, such as granting permits for construction and operation of facilities (WAC 197-11).

As indicated in Volume One, Section 1.1, the TWRS EIS is being prepared in response to several important changes since the 1988 Hanford Defense Waste EIS ROD. These changes, which included substantial changes in the actions identified in the 1988 ROD (e.g., signing of the Tri-Party Agreement and changes to the proposed action), required DOE to prepare an EIS. This requirement is based on CEQ regulations (40 CFR 1508.18) that require an EIS when:

- Adopting official policy, such as ... "formal documents establishing an agency's policies which will result in or substantially alter agency programs."
- A Federal action includes "adoption of formal plans, such as official documents prepared or approved by federal agencies which guide or prescribe alternative uses of federal resources, upon which future agency actions will be

based."

In this case, the formal document and plan that would alter DOE policies and require alternative uses of Federal actions was the revised approach to tank waste remediation contained in the 1994 amendments to the Tri-Party Agreement. Therefore, DOE initiated the EIS to comply with NEPA.

In preparing the EIS, DOE was required to evaluate the proposed action, a no action alternative, and reasonable alternatives to the proposed action (40 CFR 1502.14). CEQ regulations (40 CFR 1502.14) require an EIS to:

"Rigorously explore and objectively evaluate all reasonable alternatives..."

"Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits."

DOE and Ecology view the TWRS EIS as a necessary step in the continued progress in managing and disposing of the tank waste. This document ensures compliance with NEPA and SEPA and provides the public and decision makers with an analysis of the comparative impacts on human and natural environment and a range of considered alternatives.

In response to these requirements, DOE developed alternatives for evaluation that included the no action alternative, alternatives based on the Tri-Party Agreement approach to tank waste management and disposal, alternatives recommended for consideration during the scoping process, and a range of reasonable alternatives that were representative of the alternatives available on the continuum from no action to full retrieval and disposal of the tank waste. Please refer to the response to Comment numbers 0005.07, 0005.09, 0055.03, and 0072.05 for related discussions.

Comment Number 0055.02

Martin, Todd

Comment The first thing I would like to talk about is a HEAL fact sheet which is on the back table over there. First bullet we have on this fact sheet is something that has been said before that the TWRS EIS is essentially a step backwards. It ignores a widely supported body of documentation that led to the current Tri-Party Agreement plans. Essentially the work in this EIS has been done before and it has been done better. We should rely on that and go forward. Continues to debate the issues that have long been resolved. What waste form are we going to use? Dr. Belsey spoke very elegantly about sticking with glass. Let us get on with it.

Response In preparing the EIS, DOE and Ecology incorporated past documentation that led to the current Tri-Party Agreement plans to the extent that the information was relevant and provided the best and most currently available data on which alternatives could be developed and the applicable alternative impact analyzed. In many cases, the data used during the Tri-Party Agreement renegotiations were the best available data. However, new data were used to address the substantial issues described in the EIS. Please refer to the responses to Comment numbers 0034.05 and 0072.05 for discussion of NEPA requirements relative to analyzing environmental impact of alternatives for management and disposal of tank waste.

Comment Number 0064.02

Roecker, John H.

Comment I guess I would just like to close by emphasizing what some of the gentlemen have already said about getting on with it. And I'll just give you a little bit more history. The first defense waste management plan was written in 1972. 1972. The second one was written in 1983. The third one basically was written in 1988 when the Tri-Party Agreement was first signed. The fourth one was written in 1994 when the Tri-Party Agreement was renegotiated. We have gone through this study at least four times, the history that I know. We have come up with basically the same conclusion every single time. There has been one change in all those 25 years. And that is we've abandoned grout as the low-activity waste form, and gone to vitrification. Every thing else has changed -- has stayed the same. Nothing has changed. And I guess I just urge DOE, the Federal government, to let's get on with cleanup at Hanford. It's way past due. Thank you.

Response As indicated in Volume One, Section 1.1, management and disposal of the Hanford Site high-level tank waste has been a long-term issue of concern and study. As new data have become available, the strategy planned for the management, treatment, and disposal of tank waste has changed. One change noted in the comment was the decision to use vitrification rather than grout as the preferred waste form for LAW. Other substantial changes included terminating the Hanford Waste Vitrification Plant because of insufficient capacity and the decision to include SST waste retrieval and treatment in combination with DST waste. These changes, among others, represented substantial changes in the proposed action, which has potentially significant impacts on the human or natural environment. DOE and Ecology concur with the view that it is important to "get on" with the clean up of the Hanford Site and the tank waste. DOE views this EIS as a necessary step in the continued progress toward tank waste removal and treatment. Please refer to the responses to Comment numbers 0034.05 and 0072.05 for related discussion of NEPA requirements associated with the EIS.

Comment Number 0065.01

Phillips, Thomas

Comment All I want to say is, in 1988 we had a Tri-Party Agreement that said we would clean up this waste in 30 years. That was 8 years ago. We haven't cleaned up any of the tanks at all at this time. The only change is, as this man pointed out, is we renegotiated it for 40 years. Now we're having discussions about privatization and this Environmental Impact Study, which has taken 2 years, and will take approximately 2½ years before it's done. The privatization, the contracts are going to be awarded some time this year, but no one has said exactly when these plants are going to start cranking out waste, and no one has shown us that there is actually going to be any waste cranked out any time soon. It's projections. I, like all the other people here, feel that we need to get on with it, we need to clean this up, we need to quit studying this to death. It looks like to me that the Environment Impact Study, the privatization plan are just smoke screens to delay doing it so the next administration can come up and pick up the buck that this administration, Miss O'Leary and Mr. Clinton, are passing on to our next generation. No one is doing anything. We need to get on with it.

Response DOE and Ecology share the desire to proceed with remediation at the earliest possible date. A decision was made in 1988 concerning methods to remediate the waste, but due to the development of additional technical information and concerns raised by many stakeholders, DOE and Ecology changed the proposed approach to remediating the tank waste.

The following changes affected the planned approach for managing the disposal of Hanford Site tank waste.

B Plant, which was selected in the Hanford Defense Waste ROD as the facility for pretreatment processes to comply with current environmental and safety requirements, was found not to be viable or cost-effective.

The Tri-Party Agreement was signed by DOE, Ecology, and EPA in 1989, establishing an approach for achieving environmental compliance at the Hanford Site, including specific milestones for the retrieval, treatment, and disposal of tank waste.

Safety issues were identified for about 50 DSTs and SSTs, which became classified as Watchlist tanks in response to the 1990 enactment of Public Law 101-510.

The planned grout project was terminated, and a vitrified waste form was adopted as the proposed approach as a result of stakeholders' concerns with the long-term adequacy of near-surface disposal of grouted LAW in vaults.

The construction of the Hanford Waste Vitrification Plant was delayed because of insufficient capacity to vitrify the HLW fraction of all DST and SST waste in the planned time frame.

The planning basis for retrieval of the waste from underground storage tanks was changed to include the SSTs and treating the retrieved SST waste in combination with DST waste.

These changes resulted in an extensive reevaluation of the waste treatment and disposal plan that culminated in adopting a revised strategy to manage and dispose of tank waste and encapsulated cesium and strontium. The reevaluation of the waste treatment and disposal plan began following a December 1991 decision by the Secretary of Energy to reconsider the entire tank safety and treatment and disposal program and to accelerate the retrieval and disposal of SST waste. DOE plans to issue a final decision on remediation in the early Fall of 1996 and move rapidly into the design and construction phases of the project.

L.9.5 ADEQUACY OF THE DRAFT EIS

Comment Number 0005.02

Swanson, John L.

Comment My overall feelings about this draft are really quite mixed. On a superficial basis, it appears to be quite good-but then I see many statements that I know to be misleading if not inaccurate, which make it appear to be not good. In addition, there are many inconsistencies between sections. Perhaps it would have been better to spend more time on getting a few things "right" (and properly qualified) and less time on excessive detail in relatively unimportant areas.

Response Without specific comments that identify statements that are "misleading if not inaccurate" or inconsistent, the specific responses cannot be made. In cases where inaccuracies or inconsistencies were specifically identified, DOE and Ecology have acknowledged the correction required and incorporated revisions to the EIS. In other cases, information in the EIS was perceived as inaccurate or inconsistent. However, on closer examination, the text or analysis contained in the Draft EIS was determined by DOE and Ecology to be accurate and consistent. DOE and Ecology recognize that in a document this size that addresses complex issues, errors and omissions sometimes occur. The agencies value the public comment process because comments that identify errors and omissions contribute to a more accurate Final EIS. The comment process provides an opportunity for many stakeholders, interested State and Federal agencies, and Tribal Nations to review the Draft EIS document and provide comments that contribute to making the Final EIS a better document.

Comment Number 0005.04

Swanson, John L.

Comment I detect an ambivalence in this draft about the status of assumptions. Sometimes it is said that the assumptions are bounding and/or conservative and other times conclusions are drawn as if the assumptions were known to be true, when different assumptions could lead to different conclusions.

Response The approach in the EIS is to identify assumptions for each alternative and area of impact analysis. When differing assumptions would likely substantially change the analysis presented in the EIS, the EIS identifies and discusses this potential. When feasible, an uncertainty analysis is provided to fully inform the public and decision makers of the potential impact. To better communicate the role of assumptions and uncertainty in the EIS, a new appendix has been added to the Final EIS in Volume Five, Appendix K. Please refer to the responses to Comment numbers 0005.03 and 0012.17.

Comment Number 0005.06

Swanson, John L.

Comment Many of my comments, along with most of those made at the May 2 hearing, fall into the "hindsight is better than foresight" category. However, it is also true (I believe) that this EIS effort was not performed very well as far as resource allocation and schedule are concerned. That is water over the dam now, and we'd better get on with the job of cleaning up the waste now that the obligatory EIS is nearing completion.

Response As with any project, cost and schedule enhancements are feasible, especially when viewed after the fact. However, without specific comments regarding how resources could have better utilized or how the schedule could have been optimized, the generalized assertion contained in this comment cannot be addressed.

Comment Number 0014.02

Bullington, Darryl

Comment Past events relating to the storage and transfer of these materials combined with over 30 years of inaction and indecision regarding safe storage of radioactive fuel materials followed by the generation of these reports with which the public is asked to choose between alternatives which do not include even preliminary feasibility studies is unconscionable.

Response The analysis contained in the Draft EIS was based on conceptual designs, which are contained in the TWRS Administrative Record and DOE Reading Rooms and Information Repositories and are summarized in Volume One, Section 3.4 and Volume Two, Appendix B. This approach is consistent with CEQ requirements to consider environmental impacts early in the decision making process (40 CFR 1500).

Comment Number 0035.01

Martin, Todd

Comment Essentially, the Hanford Education Action League thinks that the TWRS EIS is a step backwards.

We think that this work has been done before and has been done better. It ignores all of the documentation that was developed to support the Tri-Party Agreement over a two-year period, and it also ignores the public process that went into that document development.

Response Please refer to the response to Comment numbers 0005.07, 0005.09, 0034.05, and 0055.03 which address similarly worded comments.

Comment Number 0038.02

Reeves, Merilyn

Comment The Tank Waste Treatment and Disposal program has been developed through extensive public involvement, long technical study process that provided a credible and the technical basis for the program.

In essence, many stakeholders believe that the intent of the NEPA process has been met. An if a declaration had been made that NEPA had been satisfied, it would have been made -- it would have been welcomed by the stakeholders.

But stakeholders understood DOE's concern that an EIS must be completed for the purpose of NEPA compliance. And given this, the stakeholders would have supported an expedited EIS that just fleshed out the impacts of the Tri-Party Agreement preferred alternatives, not another whole study of the gamut of options.

Unfortunately this EIS has been a long time in coming and does not analyze the full range of options in detail. This EIS represents to me just another redundant study, and it does not reflect our value of getting on with cleanup.

Response DOE and Ecology view the TWRS EIS as a necessary step in the continued progress in managing and disposing of the tank waste. This document ensures compliance with NEPA and SEPA and provides the public and decision makers with an analysis of the comparative impacts on the human and natural environment and a range of considered alternatives.

During the scoping process for the TWRS EIS, DOE and Ecology approved the following schedule: publish the Draft EIS in August 1995; publish the Final EIS in April 1996; and publish the ROD in May 1996. The agencies stated that by combining these two processes [NEPA and SEPA], the agencies hope as a result to accelerate the TWRS EIS (DOE 1994m). Following the conclusion of the scoping process, DOE and Ecology determined that the accelerated schedule would not be feasible. DOE and Ecology believe that given the technical complexity associated with tank waste remediation, the emergence of new data since January 1994 that needed to be addressed in the EIS, and the need to address a broad range of potential environmental impacts, the EIS has been prepared as expeditiously as could be reasonably expected. Moreover, the EIS has been and will continue to be completed on a schedule that does not adversely affect compliance with Tri-Party Agreement milestones. Please refer to the responses to Comment numbers 0034.05 and 0072.05 for more information.

Comment Number 0038.12

Reeves, Merilyn

Comment In spite of vigorous and discipline re-base lining, the Hanford Advisory Board realizes that the Tri-Party Agreement can always be improved upon, and therefore we strongly support critical reviews of the program within the context of the Tri-Party Agreement requirements.

However, a critical pillar in the Hanford Advisory Board's support for the Tri-Party Agreement is a belief that it is time to go forward. And we hope that the intention of the systems review, which is what we were addressing at that point in time, the systems requirement review team -- we hope that the intention of the systems requirements review team is not to spend an inordinate amount of time challenging the decisions laid out in the Tri-Party Agreement at this late date.

In a skeptical and wary stakeholder community, such re-examination would certainly be viewed at best as a DOE delay tactic or at worst an attempt to circumvent the provisions of the Tri-Party Agreement.

This is not the EIS, but it is applicable to it. The Board holds similar concerns in regards to the TWRS EIS. Our concerns are heightened by the inability of the Agencies to complete the EIS on or even nearly near the critical schedule.

And the EIS was supposed to be completed as of June of '95. And now DOE and Ecology will be very fortunate if this June in '96 it can come out.

In summary, the Board finds that the EIS is largely an unnecessary document, goes directly against the get on with it value that citizens wanted in the Northwest.

Response Please refer to the responses to Comment numbers 0034.05 and 0052.02 for discussions regarding the need to complete the analysis required in an EIS and the role of the EIS in regulatory compliance. Please also refer to the response to Comment number 0038.02 regarding the scoping process and the schedule for the EIS.

Comment Number 0072.01

CTUIR

Comment In any major federal action, it is critical that assumptions, data, interpretations, conclusions, and uncertainties be clearly identified. Such critical and often limiting factors can have profound ramifications to a comprehensive decision process addressing complex issues, such as the safe and effective retrieval, treatment, and isolation of diverse Hanford tank wastes.

These concepts need more emphasis than what is in the current Tank Waste Remediation System (TWRS)-Environmental Impact Statement (EIS). This EIS deals with the retrieval of radioactive and hazardous waste currently stored at the Hanford Nuclear Reservation in southeastern Washington state. Hanford is located in part on the aboriginal lands of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), where the Tribes retain off-reservation treaty-reserved rights and interests.

Response The assumptions, data, interpretations, conclusions, and uncertainties for each discipline were clearly identified in their respective appendix (inventory - Volume Two, Appendix A; engineering - Volume Two, Appendix B; human health risks - Volume Three, Appendix D; accidents - Volume Four, Appendix E; groundwater - Volume Four, Appendix F; air - Volume Five, Appendix G; and socioeconomics - Volume Five, Appendix H) of the Draft EIS. Key assumptions and conclusions also are identified in the respective sections of Volume One, Section 5.0; Environmental Consequences. A more extensive uncertainty section was added to the Final EIS as Volume Five, Appendix K. Because the information requested in the comment was included in the Draft EIS, no modification to the document is warranted. Please refer to the responses to Comment numbers 0005.03 and 0012.17.

Comment Number 0081.08

Pollet, Gerald

Comment The bottom line is throughout this EIS that the policy makers will view an extremely skewed cost versus risk and benefit analyses in this EIS if they look at it today. And everything in the EIS is driven currently towards saying let's leave it behind. The risks aren't so high. Risk of explosion aren't so high. The risk of fatal cancers aren't so high from leaving it behind. The costs are so much lower than retrieval. When in fact the risks are so much higher from leaving it behind, or any delay, and the costs are actually similar for retrieving, as they are for leaving it behind.

Response Cost and human health risks are presented in the Summary, Section S.7 and Volume One, Sections 3.4, 5.11, and 5.12. The cost and human health risk numbers were developed using the best available information and industry- and government-accepted analytical methods. DOE and Ecology

consider this information to be unbiased and the best available information for the public and decision makers to use in evaluating the alternatives. Please refer to the response to Comment 0081.02 for a discussion of how the repository costs were calculated for the Final EIS.

Comment Number 0087.03

Tewksbury, Ross

Comment Now, many of the assumptions and the estimates are faulty or erroneous because of the facts that you know nobody knows just exactly what's in the tanks, and nobody knows just how much the tanks have leaked, and nobody knows where the leaks have gone, or how far, and nobody knows where to put the high-level waste once it even comes to some final condition, and where it can be put permanently. And there's apparently there's so much stuff that's leaking, with the tanks, and the cribs, and the power plants, everything, that you don't even know where it's coming from. As you have said tonight. So with all the things that nobody really knows, then it's really hard to come up with exact costs and estimates and assumptions.

So as some of the previous speakers were saying, I really, it really upsets me if you come up with some of these standard things that you know the costs and things are really low, that the danger from them is really low or nonexistent when nobody really knows anyway.

Response The EIS fully identifies the assumptions made in performing the analysis and presents the uncertainties associated with the implementation of each alternative. This information is presented in Volume Five, Appendix K in the Final EIS. Although there are details that are unknown about certain aspects of the alternatives, DOE and Ecology believe that there is adequate information available to analyze the alternatives, select an alternative, and proceed with remediation. The costs of the alternatives are presented in ranges to account for the uncertainties. The Final EIS will present ranges in human health risk to provide information concerning the uncertainties associated with these calculations. It should be noted that contamination beneath the tanks from past practice activities is outside the scope of this EIS. Please refer to the responses to Comment numbers 0005.03, 0012.17, and 0072.08.

L.9.6 RECORD OF DECISION

Comment Number 0009.14

Broderick, John L.

Comment There has been a lot of effort by a lot of people to decide on the Preferred Alternative. However, it has the appearance of being selected because that is what has been agreed to before the EIS ROD is available. The usual order of decision is NEPA, then other agreements.

Response The final decision on the selection of an alternative will be made no sooner than 30 days after the publication of the Notice of Availability for the Final EIS is published in the Federal Register and it will be identified in the ROD. The efforts made concerning the Phased Implementation alternative have been to establish DOE's proposed action. NEPA requires that an EIS evaluate the

proposed action and alternatives to it as was done for the TWRS EIS. No modification to the EIS is required because the required procedures were followed. Please refer to the responses to Comment number 0005.07, 0027.01, and 0036.15.

Comment Number 0012.10

ODOE

Comment We urge U.S. DOE to analyze the cumulative impacts from previously leaked tank waste, waste disposed to cribs, trenches, reverse wells, drain fields, ponds, burial grounds, and other locations. The record of decision should require the preparation of a peer-reviewed detailed long-term performance and risk assessment, that includes all of the factors above. This risk assessment should be a joint effort of USDOE with the Nuclear Regulatory Commission, EPA and other state, tribal and Federal agencies with regulatory authority or special expertise for resources at Hanford and should be conducted separately from this EIS.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Cumulative impacts of the TWRS alternatives, past leaks, and past-practice sites are addressed in Volume One, Section 5.13 and Appendix F. Although not within the scope of this EIS, DOE will consider the request separately for a peer-reviewed risk assessment. Please refer to the responses to Comment numbers 0005.17, 0012.15, 0040.06, 0072.08, and 0101.05.

Comment Number 0035.03

Martin, Todd

Comment Another concern we have had is schedule. We were concerned, and the agencies were concerned that if this EIS did not meet its schedule, it could throw the TWRS program into a death spiral.

What has happened is the original record of decision was to be had by June 1995. Now we are going to be lucky if we have a record of decision by June of 1996.

Response Please refer to the response to Comment numbers 0034.05, 0038.02, and 0055.03 which address similarly worded comments.

Comment Number 0040.07

Rogers, Gordon J.

Comment I need to add that these comments are my own as a taxpaying citizen who is concerned with the staggering cost estimates for each of the other treatment alternatives, considering the rather low risk provided we have the common sense and optimism in the capacity of humans to manage and solve problems and threats in the future as has been the case through much of human history. I hope these comments generate some serious thought by DOE and the Regulators in deciding how to proceed.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. Please refer to the response to Comment number 0040.01 for a discussion of factors influencing the evaluation of alternatives.

Comment Number 0043.03

Hanford Communities

Comment We call on the Department of Energy, with the support of regulatory agencies to proceed expeditiously to adopt a record of decision and award a contract with a private firm to begin the design and permitting of a vitrification facility.

Response DOE remains committed to pursuing the earliest possible ROD date and implementing the preferred alternative as soon as possible. The EIS will not delay award of privatization contracts for Phase 1a. DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste.

Comment Number 0072.12

CTUIR

Comment This is a retrieval EIS, not a closure EIS, and the ROD should explicitly state that the selection of any of the retrieval options in no way implies that a particular closure method is thereby approved.

Response DOE will incorporate the recommended language into the ROD. Please refer to the responses to Comment numbers 0019.03, 0072.08, 0072.46, and 0101.06.

Comment Number 0072.13

CTUIR

Comment Existing soil and groundwater contamination should be included as part of the Tank farms source term, and the entire tank waste inventory should be considered as part of an overall aggregate 200 Area source term.

Response The scope of the TWRS EIS is the remediation of the tank waste and cesium and strontium capsules. Please refer to the response to Comment number 0072.08 for a discussion of the reasons for not including closure of the tank farms, including past practice releases of contaminants to the soil column, in the TWRS EIS. However, existing soil and groundwater contamination was addressed in the cumulative impacts presented in Volume One, Section 5.13 and Appendix F. Closure will be addressed in a future NEPA analysis. Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted. Please refer to the responses to Comment numbers 0012.15 and 0072.08.

L.9.7 OUT-OF-SCOPE ISSUES (Other Than Closure)

Comment Number 0011.01

Gilsdorf, Paul D.

Comment If you have any information that could help me find a job I will be eternally grateful. I am a carpenter with a degree in biochem. What does that mean, well I do not know either but I still need a job. Hope you have a great day.

Response Facilitation of employment for individuals, as well as identification of contractors to perform tasks identified in the EIS, are beyond the scope of the EIS.

Comment Number 0014.05

Bullington, Darryl C.

Comment I pray daily that existing governments will find a way to prevent the release of radioactive toxic materials into the air, water, and food by continuing to invent increasingly clever ways to disperse such materials over the planet.

Response The EIS evaluates alternatives to manage and dispose of tank waste and cesium and strontium capsules, in a manner which will protect human health and the environment from the future releases from the tank wastes and capsules.

Comment Number 0014.06

Bullington, Darryl C.

Comment I pray, too, that the diversion of sporting events and political elections will not divert the public's attention from demanding solutions to these most critical decisions of our time. Should action be taken I pray that the government does not attempt to absolve itself from responsibility by giving the cleanup to unproven, unmonitored contractors that win cost-plus-fixed-fee contracts by submitting least cost proposals.

Response The qualifications of potential remediation contractors and the contracting strategies associated with implementation of the actions considered in the EIS are outside of the scope of the EIS. However, in both cases, DOE is required by Federal procurement rules to select qualified contractors to perform all work contracted by a Federal agency. All work contracted must be performed in compliance with applicable Federal, State, and local laws and regulations.

Comment Number 0016.01

J.L. Shepherd and Assoc.

Comment The purpose of this report is to encourage the U.S. Department of Energy (DOE), the Washington State Department of Ecology and other interested parties to reconsider a proposed program for long-term storage and eventual disposal of the WESF cesium-137 source capsules at Hanford, under the Cesium Legacy Project EM30-ADS-84900-00-SA. In our opinion, the contents of these WESF capsules are a national resource and are vital to U.S. interests. To support this position, included in this report is a brief history of previous USDOE encapsulation programs of the WESF contents. We believe that the DOE could restart a cost-effective and waste reducing source encapsulation program, perhaps including the cesium-137 retrieved from the waste tank remediation project. The primary focus of this response is on medical and health related uses of cesium-137 sealed sources. A secondary focus is on cesium-137 source user's commitments to environmental concerns, especially non-burial (source recycling) programs and regulatory constraints and regulation by the U.S. Nuclear Regulatory Commission and Agreement States.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The TWRS EIS addresses alternatives for disposal of tank waste and encapsulated cesium and strontium. The encapsulated cesium and strontium are included in the EIS primarily because they were originally extracted from the stored high-level tank waste to reduce the thermal heat generation in the tanks and would be considered HLW for purposes of disposal. DOE and Ecology have identified the No Action alternative as the preferred alternative. The EIS has been modified in the Summary and in Volume One, Section 1.3 to reflect that No Action is the preferred alternative. DOE is actively seeking commercial interest in the beneficial applications for the encapsulated cesium and strontium, and DOE and

Ecology remain committed to pursuing any viable commercial or other beneficial uses. However, that analysis is outside the scope of this EIS. These uses would not be without substantial cost for reprocessing and repackaging because the current encapsulation was designed principally for storage purposes. If viable commercial or beneficial uses are not implemented, the capsules would be designated as waste at some point in the future and would be disposed of using methods consistent with the alternatives identified in the EIS. Also, it is unlikely that DOE would pursue any course of action to remove and encapsulate additional amounts of cesium, strontium, or other radionuclides unless viable use is made of the current capsule inventory or there is a clear, viable commercial or beneficial interest in the additional amounts. Please refer to the responses to Comment numbers 0006.01 and 0010.01 for more information on this topic.

Comment Number 0016.02

J.L. Shepherd and Assoc.

Comment We have tried to present information which will lead to reconsideration of the burial/disposal proposal for the WESF capsules. The contents of these capsules, besides the cesium in the waste tanks, are the only domestic supply of cesium which can be used in the sources for the many critical and beneficial applications described in this written comment. We have tried to make the point that cesium is a strategic U.S. product, that currently the sole world supplier of this material is Myak, Russia and that the same preliminary techniques used for vitrification can be used in making special form source capsules. We invite anyone reading this comment to contact us with any inquiries, questions, or requests for further information concerning its contents to contact us.

Response Please refer to the responses to Comment numbers 0006.01 and 0010.01 for discussions related to consideration of beneficial uses of cesium and strontium capsules.

Comment Number 0031.01

Billett, John

Comment Even though I have a sheaf of paper in my hands, it will only be a few minutes. I just want to summarize some comments, particularly on the issue of the recycling of the cesium which is the subject I want to put some comments on the record about.

The market for cesium-137 has progressively increased worldwide particularly over the past 27 years due to an increase in medical research and our knowledge of medicine as well as the knowledge in the areas of personnel radiation protection.

The only current supplier of large cesium-137 sources is located in Russia. In the interest of public health and safety we are suggesting that the U.S. should consider domestic cesium-137 extraction from the capsules or tank waste as a strategic material viable to national interest.

Response Please refer to the response to Comment numbers 0006.01 and 0010.01 for discussions related to consideration of beneficial uses of cesium and strontium capsules.

Comment Number 0031.02

Billett, John

Comment Without the use of these special form cesium-137 sources in medical research we would not have many of the lifesaving technologies we enjoy today.

And there are many potential breakthroughs in cancer research and prevention which will not be possible without large cesium-137 sources.

People from all walks of life are affected, including the nurses and patients in nuclear medicine departments.

And we are talking here about x-rays, mammography, cat scan, MRI, oncology, blood banks, the technicians in a dental office, the emergency response personnel for transportation, reactor or nuclear accidents and incidents, and the public teachers and students at university research laboratories and in the biomedical field.

Response Please refer to the responses to Comment numbers 0006.01 and 0010.01 which address similarly worded comments.

Comment Number 0037.02

Eldredge, Maureen

Comment The funding for the entire cleanup program is continually at risk. Last year was a particularly difficult one in the appropriations cycle.

We continually heard and had to deal with allegations of problems, waste, fraud, and abuse in the program. And the fingers kept pointing at Hanford.

We need to start seeing progress. We need to see action. We need to get moving, or we are going to continually face that slideward -- downward trend of funding.

Response The data prepared for each alternative were presented as objectively as possible, including the potential costs (listed in 1995 dollars) associated with implementation. Forecasting Congressional funding is beyond the scope of the EIS and was not included in the implementability discussion sections. DOE is committed to pursuing remediation at the earliest practicable date.

Comment Number 0037.04

Eldredge, Maureen

Comment Which also leads me to the old concept of the big picture. The Department of Energy seems to have a problem with it.

The Waste Management Programmatic Environment Impact Statement which the draft was recently released, and quite seriously panned by everyone, was supposed to look at programmatic impacts of all the waste in the Department of Energy's nuclear weapons complex.

I assume that might include waste coming out of Hanford tanks, but it does not. And there is no cross-linkages between all of the EIS actions. That needs to happen. We need to start looking at the high level, low level, mixed waste in the Department of Energy nuclear weapons complex as a comprehensive total, not as piecemeal efforts.

Response The scope of the TWRS EIS includes management and disposal of tank waste and cesium and strontium capsules. The cumulative impact section addresses the impact of TWRS alternatives within the context of related actions at the Hanford Site and within the DOE complex. The TWRS action is being conducted within the framework of DOE's responsibility to manage and dispose of HLW and to comply with applicable local, State, and Federal laws and regulations.

Comment Number 0043.04

Hanford Communities

Comment The Department of Energy must make very effort to assure the success of the tank waste vitrification program. Adequate funding must be provided for both the privatization initiative as well as the DOE tasks associated with characterization, tank safety and the steps necessary to deliver liquid waste to the vitrification facility. We are concerned about the proposal to take funds out of the Hanford cleanup budget to finance a liability reserve. The impact of taking this money out of the budget will seriously jeopardize the existing TWRS program as well as other programs.

We encourage the Department of Energy to establish a liability reserve fund for this initiative. Funds for this reserve should not come from the Hanford cleanup budget.

Response Privatization and Congressional funding issues are not within the scope of the EIS. The purpose of the privatization reserve funding is not to cover 100 percent of all potential liabilities for the privatization contractor's construction and operation of the immobilization facilities. There are two primary reasons to have the reserve funding pool: 1) to cover the contractor capitalization cost during design and construction in the event of Termination for Convenience on the part of DOE; and 2) to level the DOE budgetary requirements during operation of the contractor facilities.

Before issuance of the RFP, there were a series of conversations with vendors that might be interested in providing immobilization services to DOE. These vendors expressed concern with the potential financial risk associated with project starts and stops. Under privatization, contractors would make a significant capital investment for an extended period of time before receiving any return on the investment. To protect themselves and their stockholders against the possibility of a change in direction and project starts and stops leaving the contractors with a large capital investment, the vendors wanted to ensure that they could be reimbursed for their investment if the change in direction or starts and stops were the responsibility of DOE and not the vendors.

When treatment services are initiated in 2002, the reserve funds would be "drawn-down" to pay for waste treatment services. Rather than being an insurance fund, the reserve is a "bank account" in which funds are saved over a period of time so that DOE can assure private industry that money will be available, when needed, to "pay the bills." Because the analysis requested in the comment is not within the scope of the EIS, no modification to the document is warranted.

Comment Number 0093.01

Devoy, Tiffany

Comment I think when you are talking about 200 plus billion dollars a year going to defense, then 200 billion dollars total to take care of what will be with us for hundreds of thousands of years is not that high of a price tag.

Response DOE and Ecology acknowledge the opinion expressed in the comment. Please refer to the response to Comment number 0075.02.

L.9.8 HEARINGS

Comment Number 0022.01

Shims, Lynn

Comment Thank you very much for the opportunity to comment. Thank you also for holding a TWRS public meeting in the Portland area. In my opinion meetings such as these are not only useful educational methods but also important for clarification dialog, expansion of perspective for all parties and significant value input.

Response Dialogue with stakeholders at public meetings provides valuable information regarding the proposed action, alternatives to the proposed action, and the potential environmental consequences of the alternatives considered in the EIS. Further, dialogue at meetings is critical to informing the agencies of the values, concerns, and issues important to the public. NEPA and SEPA were adopted to ensure that information is exchanged between the government and the public. Under NEPA, the government actively incorporates public involvement in government decisions potentially affecting human health and the environment. The government also must provide decision makers and the public with information that would aid in making informed decisions regarding the alternatives and the impact of each alternative. Public meetings are an important aspect of ensuring that NEPA and SEPA are implemented to the maximum extent possible. Please refer to the response to Comment number 0020.01 for more information of TWRS EIS public involvement.

Comment Number 0022.05

Shims, Lynn

Comment It is appreciated that an attempt was made at the Portland meeting to change the usual design of the meeting to enhance public participation. I believe that the strong opinions of the public were due to the fact that the subject of tank wastes as related to public health and safety are of great importance to us.

Response DOE and Ecology are committed to continually improving public participation in the decision making process. For the TWRS EIS public hearings, the agencies worked closely with the stakeholders to provide alternative formats for meetings that would improve the opportunity for dialogue between the public and agency representatives.

Comment Number 0046.01

DiGirolamo, Linda Raye

Comment With the exception of the speaker for the HEAL group this discussion was far too "technical" for the average citizen.

Response The DOE and Ecology objective was to use to the extent possible in the EIS, language that was appropriate and understandable by the average citizen. One reason for holding a question and answer session at the hearing was to provide an opportunity for the public to present clarifying questions to the agency representatives. Both agencies are committed to continued efforts to improve communication with the public. Your comment will assist the agencies to improve the process, especially where communication was not as effective as preferred.

Comment Number 0062.06

Longmeyer, Richard

Comment Just a final comment. The advertisement for this meeting was a little bit more than it had been in the past. I've attended other meetings, and I get information from Hanford all the time, but I'm glad to see that we have a little better representation here in Spokane this time. Unfortunately it was HEAL that did that advertising. I really feel it's the responsibility of the DOE to do that, instead of HEAL. Now whether the DOE needs to hire an advertising agency to help them to put a better face on the meeting, or whatever, I don't know. But I do appreciate HEAL's effort in that regard, but I do feel it's the DOE's responsibility. Thank you.

Response DOE and Ecology acknowledge the role of HEAL and others in making the Spokane-area public aware of the public meeting. The public meeting was coordinated with HEAL and other stakeholders because the outreach efforts of these groups has proven to be helpful. DOE and Ecology worked closely with HEAL representatives to ensure that the location, date, and format of the meeting maximized public participation. Further, DOE advertised the meeting in the local newspaper and distributed four separate mailings to interested area residents on the Tri-Party Agreement mailing list. These efforts, in conjunction with the efforts of HEAL and other Hanford Site stakeholders were instrumental in ensuring that the public was provided with an opportunity to participate in the decision making process, as required by NEPA. Please refer to the responses to Comment numbers 0066.01 and 0087.01 for more information on TWRS EIS public involvement.

Comment Number 0075.01

Wright, Peter

Comment My only comment is with respect to DOE, and I guess Ecology. I find that I'm really saddened by the fact that there's not a lot more people here. It's the first time I've gone to a government meeting, which may be characterized more by bureaucrats, than by human beings, and found that it's mostly human beings who recognize that we're all in this together. And I really feel that your average is a sign, at least to me, that there's a recognition that all of our kids are going to suffer from this.

Response Participation at the five public meetings on the TWRS EIS varied substantially; however, in total more than 400 individuals attended the meetings and more than 350 individuals provided oral or written comments on the Draft EIS. DOE and Ecology are committed to the public involvement process and continue to strive to ensure the public has access to the decision making process. Please refer to the responses to Comment numbers 0087.01 and 0066.01 for more information on TWRS EIS public involvement.

Comment Number 0087.01

Tewksbury, Ross

Comment And I, first I want to say that it's good that your having a meeting here in Portland, and I want to encourage you to keep having them here regarding each issue as it comes up, and not just in Seattle and Tri-Cities. And I also want to say I hope you don't have any more video meetings. And as I was saying earlier, if you want more people here there's lots of things that you can do, as opposed to doing just the legal bare minimum. You can try and have an article in the paper, rather than just ad's. You can have an ad in the paper every day for two weeks in a row, you know, prior to the meeting. You can have announcements on the radio stations and TV, especially OPB and KBOL. And send letters to everybody on the mailing list to arrive just a few days before the meeting. And there's other stuff too, but that's.

Response Public meetings on the TWRS Draft EIS were held in five cities, including Portland, Oregon. For each issue under consideration at Hanford, the number and location of meetings was carefully considered by DOE, in consultation with the Hanford Advisory Board, Ecology, EPA, and the stakeholders.

DOE and Ecology exceeded the legal requirements for public participation in the public meetings held for the Draft EIS. For example, for the Portland, Oregon meeting, two advertisements were published in the largest daily newspaper in the Portland area; two press releases were distributed to area newspaper, radio, and television stations; and the meeting location was provided in a mailing distributed to more than 4,500 interested parties and in two other mailings to 1,500 interested parties. Oregon Department of Energy mailed a letter to community leaders and stakeholders announcing the meeting and information on the meeting was provided on the Hanford Site Home Page. DOE and Ecology will continue to implement more effective means to communicate to the public and to inform the public of opportunities to participate in meetings on important issues relative to the Hanford Site. However, the TWRS public participation program met or exceeded all requirements under State and Federal regulations and used many innovate methods designed to enhance public involvement.

DOE will consider suggestions regarding publicizing meetings when planning future public participation opportunities. Regarding video meetings, DOE believes that such a format may occasionally be an effective method to expand public participation opportunities, particularly when lack of resources might otherwise preclude them. DOE welcomes any additional suggestions.

Please refer to the response to Comment number 0066.01 for more information on TWRS EIS public involvement.

Comment Number 0088.02

Porter, Lynn

Comment I have a lot of questions that I wish we could have gotten into tonight, I felt like there wasn't enough time for discussion.

Response An inherent limitation to the public hearing format is the time available for interaction between the agencies and the public. To address this concern, DOE and Ecology scheduled a one-hour informal session at the beginning of this hearings. During this time, DOE and Ecology representatives were available to interact one-on-one with the public. Further, once the meeting began, the public was encouraged to ask questions during the discussion of the EIS. This portion of the meeting lasted approximately two hours. The meeting concluded with a one-hour session during which a forum was provided for the public to submit additional formal comments on the EIS. Before the meeting ended, the moderator asked the attendees for additional comments. When no one responded, the meeting was adjourned. After the meeting was adjourned, several agency representatives remained in the meeting room to meet informally with the attendees. The information packets distributed at the meeting contained the names and phone numbers for agency contacts. The public was encouraged to contact the listed individuals for more information or to submit additional comments.

L.9.9 COMMENT PERIOD

Comment Number 0002.01

Roecker, John H.

Comment You are making a mockery out of the public comment period for the TWRS EIS. Forty-five days is entirely too short a period for public review of such a lengthy and important document. If you are truly interested in receiving public input the comment period should be extended to at least 90 days. I know this does not fit with your political agenda of announcing the selection of the privatization contractors before the November election, but the EIS process should be driven by what is technically right not by politics. This is just another example of DOE being driven by political agendas rather than technically sound programs.

Response After consultation with relevant Federal and State agencies, affected Tribal Nations, and stakeholders, DOE and Ecology determined that an extension of the comment period for the Draft EIS would not materially facilitate improved public participation in decision making regarding the proposed action. Please refer to the responses to Comment numbers 0020.01 and 0036.07 for related information.

Comment Number 0003.01

CTUIR

Comment Technical staff of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Special Sciences and Resources Program (SSRP) are currently reviewing the TWRS Draft EIS (DOE/EIS-0189D). We have already developed numerous draft comments on Volume One, and anticipate that we will identify additional issues in the remaining volumes. As a result, the CTUIR-SSRP requests a 45 day extension to the public comment period in order to be able to address this EIS in a manner that truly reflects the time and effort the U.S. Department of Energy (DOE) and Washington Department of Ecology (Ecology) have put into producing it.

Response Subsequent to the receipt of this request for an extension of the comment period, the CTUIR formally withdrew their request for an extension of the comment period. Please refer to the response to Comment number 0013.01.

Comment Number 0005.01

Swanson, John L.

Comment I have the feeling that many of my comments might be dismissed as being "unimportant" because they might not impact the gross comparison of the alternatives. My response to that might be along the lines of (a) if only gross comparisons are desired/needed, why present all the detail, and (b) if the information is important enough to present, it should be presented as accurately and unambiguously as possible.

Response No comment has been dismissed as "unimportant." DOE and Ecology believe that the comments submitted on all issues, including those not involving the "gross comparison of the alternatives," contributed to improving the TWRS EIS and all comments were included in preparing the Final EIS. NEPA and SEPA require the agencies to consider all comments provided during the public comment period, to give equal weight to oral and written comments, and to consider all comments prior to completing the Final EIS. All comments have been reproduced verbatim and responded to individually in this appendix. Copies of the documents from which comments were extracted are provided in DOE Reading Rooms and Information Repositories to permit each comment provider to easily understand how the agency addressed the comment and to ensure that all comments submitted were considered by the agencies.

Comment Number 0007.01

EPA

Comment Pursuant to its responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the Environmental Protection Agency (EPA) is mandated to review environmental impact statements (EIS's).

Unfortunately, our office did not receive copies of the Hanford Tank Remediation Draft EIS until yesterday. As you noted, a copy was sent to another staff member, but he does not have responsibility for NEPA review. We are therefore requesting an extension of the comment period from May 28 to June 28. This gives us adequate time to assemble a review team from other offices within EPA and perform a quality review for this very important EIS.

Response DOE submitted five copies of the Draft EIS to EPA on April 5, 1996. These copies were provided to the EPA headquarters in Washington, D.C. Subsequently, copies were requested by the Region X EPA and an additional five copies were provided. After the EIS had been received, DOE and Ecology met with EPA staff to facilitate the EIS review. EPA subsequently withdrew their request for an extension of the comment period and decided not to conduct a detailed review the EIS. Please refer to the responses to Comment numbers 0044.01 and 0042.02, which address related comments.

Comment Number 0013.01

CTUIR

Comment Since making our original extension request, CTUIR SSRP staff have become aware of critical timing considerations for the TWRS project which provide us with significant reasons why the review of the TWRS project should not be delayed, even though the lack of an extension may reduce the quality and quantity of public scrutiny that the text of the Draft EIS receives. As a result, CTUIR SSRP hereby retract our previous request for an extension of the public comment period for the TWRS Draft EIS.

Response DOE and Ecology acknowledge the withdrawal of the request for an extension of the comment period. Please refer to the responses to Comment numbers 0003.01 and 0013.02, which address related comments.

Comment Number 0013.02

CTUIR

Comment Finally, as a sovereign, the CTUIR enjoys a government-to-government relationship with federal and state governments, including their departments, such as DOE and Ecology. This relationship means that our consultation with the DOE is not limited to the comment periods designated for the public under National Environmental Policy Act and the State Environmental Policy Act. While we are retracting our request for an extension of the public comment period for this Draft EIS, CTUIR staff will be availing ourselves of our right to submit comments outside of the public comment period. While our review of the TWRS Draft EIS will not take the forty-five additional days we had originally requested, CTUIR staff are planning to submit our comments on Friday, May 31, 1996--three days after the close of the public comment period. We expect that Ecology and DOE will give full consideration to our comments despite their delivery outside the bounds of the public comment period.

Response DOE and Ecology are committed to ongoing consultation with affected Tribal Nations throughout the NEPA and SEPA process for the TWRS EIS. This commitment has resulted in numerous meetings with Tribal Nations and the TWRS EIS project team, as well as formal and informal consultations regarding the EIS. The formal comments on the EIS were received by the Agencies and have been given full consideration. Several issues identified in the comments have resulted in subsequent meeting and communication between the CTUIR and the Agencies to address methods by which issues could be resolved. DOE and Ecology value this consultation process and believe it has enhanced the quality of the EIS and the NEPA process. Please refer to the responses to Comment numbers 0013.01, 0072.149, and 0036.07, which address related comments.

Comment Number 0018.01

Mannion, Don

Comment This document is very long and complex. The conduct of proper review seems to be requiring a lot more time than I initially anticipated.

I respectfully request that the review period be extended in order to assure an adequate review by such concerned citizens as myself. Thank you, in advance, for any consideration that you can give this request.

Response After consultation with relevant Federal and State agencies, affected Tribal Nations, and stakeholders, DOE and Ecology determined that an extension of the comment period for the Draft EIS would not materially facilitate public participation in decision making regarding the proposed action. Please refer to the response to Comment number 0020.01, which address related comments.

Comment Number 0020.01

Waite, Corey N.

Comment In my opinion the public comment period for the Tank Waste Remediation System Environmental Impact Statement is far too short. While I am sure that someone from the scientific community could review and comprehend this long, complex report in a short amount of time, this is a difficult task for the average reader. From my college studies in environmental science, I know that it is my right as a citizen to express my concerns, reservations, and questions regarding the actions proposed in this document as they could affect me, my family, my livelihood, and my community. For these reasons, I believe that the public should be given more time and more opportunity to review and disseminate the information contained in this very long, complex, technical report.

Response Dialogue with stakeholders at public meetings provides valuable information to the stakeholders regarding the proposed action and alternatives to the proposed action, as well as the potential environmental consequences of the alternatives considered in the EIS. Further, dialogue at meetings is critical to exchanging information with the agencies regarding values, concerns, and issues that are important to the public. NEPA and SEPA contain provisions that require public involvement in government decisions that potentially affect the quality of the natural and human environment. These regulations also require that information be provided to decision makers and the public so that decisions that potentially impact environmental quality can be made in as open a manner as possible. Public meetings are an important aspect in ensuring that NEPA and SEPA are useful decision making tools for the public and decision makers.

After consultation with relevant Federal and State agencies, affected Tribal Nations, and stakeholders, DOE and Ecology determined that an extension of the comment period for the Draft EIS would not materially facilitate improved public participation in decision making regarding the proposed action. Please refer to the response to Comment number 0036.07, which addresses a related comment.

Comment Number 0024.01

Jordan, James

Comment

1. The Draft EIS for the Hanford Site TWRS was received this date at about 2 p.m. Washington D.C. time. The

transmittal letter states that written comments should be postmarked no later than this date, May 28, 1996. Obviously, there is insufficient time to review this report and make responsible comments. Therefore, we respectfully request that the Public Comment Period be extended to the end of June.

2. JJA, a Science and Technology Consulting firm, is in the process of forming a consortium of qualified contractors to develop, fabricate and install a vitrification technology that is much safer and more technically reliable than any of the alternatives discussed to date. It is the consortium's intention to license this technology invented by Drs. James Powell, Morris Reich, and Robert Barletta to Brookhaven National Lab for development and manufacture.
3. Our analysis of the health, safety and environmental risks and our analysis of the costs of conducting the TWRS campaign show that the BNL concept is substantially superior to the other concepts for removing HLW from the Hanford reservation. Accordingly, we would appreciate additional time and your assistance in including the BNL concept in your consideration of alternatives for Hanford. Specifically, we would appreciate your assistance in running our factors in the same model that you used for the other alternatives.

Response After consultation with relevant Federal and State agencies, affected Tribal Nations, and stakeholders, DOE and Ecology determined that an extension of the comment period for the Draft EIS would not necessarily increase public participation in decision making regarding the proposed action. Please refer to the response to Comment number 0020.01.

The plan to form a consortium to develop the proposed vitrification technology was not included in the scope of this EIS, and therefore is not a factor in determining whether the comment period should be extended. The Draft EIS does not address the agency procurement strategy nor does the EIS limit the agency from considering technology options that may emerge following the completion of the NEPA process. During the procurement process following the publication of the ROD, DOE would be able to consider any available technology bounded by the EIS analysis. For options not bounded by the EIS analysis, in terms of potential impacts to the environment, DOE would be required to complete a supplemental NEPA analysis of the TWRS EIS.

Because of the conceptual nature of all technologies considered in the EIS, DOE adopted a bounding approach when developing the EIS alternatives. Therefore, if during the procurement process, a technology is proposed that demonstrates lower costs and impacts to the environment than those presented in the EIS, DOE would be able to procure and implement the proposed technology. Because of this approach, and because the process described in this comment does not represent a new alternative, DOE and Ecology do not view the delay in the EIS that would be required to develop and evaluate an alternative based on this technology as necessary to improve the decision making process under NEPA.

Comment Number 0036.07

HEAL (Exhibit)

Comment The TWRS EIS has been in development for years. DOE has delayed the release of the EIS. The difficulties the agencies have had in producing the EIS are evidenced by how long it has taken to release the Draft EIS. However, the public is expected to review and comment in only 45 days -- on a document that is over 2,000 pages long.

Because HEAL has consistently held that moving the program forward is paramount, we will not protest what is an insufficient amount of time to substantively comment on the document.

Response DOE and Ecology co-prepared the Draft EIS and concurred on the scope, areas of analysis, and schedule for the EIS following consideration of public comments received during the scoping period for the EIS from January 28, 1994 through March 15, 1994. The time required to prepare the EIS was a function of the complexity of the issues addressed in the EIS.

During the past eight years, DOE has facilitated extensive public participation relative to tank waste in the following policy areas:

- Public participation in the Hanford Defense Waste EIS (1987 to 1988);

- Tank Waste Task Force (1993);
- Public comment on the renegotiation of the Tri-Party Agreement to include the revised approach to tank waste management (1993 to 1994);
- Scoping for the TWRS EIS (1994);
- Public comment on the SIS EIS (1994 to 1995);
- Privatization and related public involvement on the proposed amendments to the Tri-Party Agreement (1995 to 1996); and
- Interaction with the Hanford Advisory Board and its committees (1994 to 1996).

This public involvement has provided DOE with a strong understanding of the values and perspectives of Northwestern stakeholders regarding tank waste management and disposal. Moreover, HEAL, among others, provided comments during the scoping and comment period on the Draft EIS that encouraged DOE and Ecology to expedite the completion of the EIS, whenever feasible.

In response to comments requesting expedited completion of the EIS and in recognition of the extensive past public involvement associated with tank waste, DOE and Ecology concurred on the 45-day comment period. A 45-day comment period is the minimum time that an agency must schedule for receipt of public comments on an EIS. DOE and Ecology also recognized that public review would be limited by the 45-day comment period. To assist the public review, DOE and Ecology held five public meetings during the comment period. For these meetings, the agencies worked closely with stakeholders to provide meeting formats that would maximize interaction with the public. The EIS also was widely distributed to reading rooms and information repositories, as well as made available on the Hanford Home Page on the World Wide Web.

Finally, DOE and Ecology carefully considered all requests to extend the length of the comment period. Of the six requests for extensions received by the Agencies, two were formally withdrawn, two submitted written and/or oral comments during the 45-day period, and the remaining two requests represented general requests for more time on behalf of the public and not the individual commentor. Given that more than 1,400 interested parties received direct mailings, more than 850 copies of all or part of the EIS were distributed to interested parties, and more than 350 individuals submitted oral or written comments, the agencies concluded that sufficient time had been given and no extension of comment period was warranted. Please refer to the response to Comment number 0066.01, which provides more information regarding TWRS EIS public involvement.

Comment Number 0036.08

HEAL (Exhibit)

Comment However, we do want to state for the record the difficulties encountered in obtaining the supporting information on the EIS.

First and foremost is the difficulty in reviewing the EIS's references and supporting information. Many are missing from the information repositories. The most important references are the data packages

that support the various alternatives in the EIS. Some of these data packages were approved for public release in July of 1995 -- nine months is ample time to deliver documents to the information repositories.

Response DOE and Ecology acknowledge the concern expressed in the comment. The agencies remain firmly committed to executing the public involvement requirement mandated by NEPA. This process includes providing all referenced documents in a readable format and timely manner.

All references and supporting documents cited in the Draft EIS were available through the following sources:

Publicly (e.g., regulations and laws)

In DOE reading rooms or information repositories in Richland, Spokane, Seattle, and Portland

By contacting the Hanford Site Tri-Party Agreement information repository.

These documents were available throughout the public comment period to support the public review of the Draft EIS. Due to the volume of the documents supporting the Draft EIS, microfilm was used to save space and resources. One reading room was not familiar with the indexing system used for the microfilm and was provided copies of the paper documents. In several isolated incidences, individuals requesting supporting documents were mistakenly told that certain documents were unavailable in the reading room. To correct this situation, several supporting documents that were used as the data basis for the Draft EIS were provided in hard copy to the reading room and directly to the individuals requesting copies.

Comment Number 0044.01

EPA

Comment We are hereby withdrawing our request for an extension of the comment period.

Response DOE and Ecology acknowledge the withdrawal of the request by EPA for an extension of the comment period. Please refer to the responses to Comment numbers 0007.01 and 0042.02.

Comment Number 0055.01

Martin, Todd

Comment But my first point has to do with problems with the informational repositories. I spent yesterday morning hammering my head against a brick wall out at the informational repository trying to get the data packages that support the EIS. Some of them are there and some of them are not. I get paid to do this although not nearly enough but I can not imagine an interested citizen actually being able to find any of that information if they were so motivated. It was particularly troubling in that there is a very competent and professional staff at this informational repository where at the others it is difficult to find a staff person who actually knows where the Hanford documents are. So that was somewhat troubling to me and I understand that DOE and Ecology and Jacobs are working to fix that

problem and I hope it is fixed by now. Given to that I had those problems I want to thank DOE, and Ecology, and Jacobs for facilitating my getting a hold of these packages yesterday. That was very helpful.

Response Please refer to the response to Comment number 0036.08 for a related discussion.

L.9.10 MISCELLANEOUS

Comment Number 0005.03

Swanson, John L.

Comment At the May 2 hearing in Pasco, I did a poor job of expressing myself regarding the fact that "The assumptions drive the conclusions." This draft is based on MANY assumptions, which is all you could do at this point in time, but I think you could do a better job of making that clear. There generally seems to be places where the proper qualifying statements regarding assumptions are made, but those qualifying statements do not generally follow throughout the text (what is properly qualified early on, or in an appendix, is often stated as an absolute fact later in the text). Yes, it would take more words to do it right, but that should not prevent it from happening. I wonder if some of the writers do not in fact believe that some of the assumptions are really facts.

Response For each area of environmental impacts analysis in the EIS (e.g., groundwater, health, accidents) assumptions were clearly identified in the relevant appendix. Where uncertainties associated with an assumption would potentially result in significant variations in the data or conclusions presented in the EIS, an uncertainties discussion or analysis was included in the appendix. For each area of impact analysis, the assumptions and uncertainties were summarized in the relevant portions of Volume One, Section 5.0.

For the description and comparison of the alternatives, a similar process was used to inform the decision maker and public regarding assumptions and uncertainties. For the alternatives, the detailed analysis was presented in Volume Two, Appendix B, and the summary information in Volume One, Section 3.0. To enhance the decision maker and public understanding, all assumptions and uncertainties addressed in the EIS, as well as the associated calculated relative uncertainties, are now presented in Volume Five, Appendix K. This new format for addressing these issues should improve accessibility to the information and clearly communicate important interrelationships between assumptions and uncertainties. A general review of the EIS was completed to ensure that all assumptions are clearly identified and communicated to the extent practical. Please refer to the response to Comment number 0012.17 for a related discussion.

Comment Number 0027.01

Roecker, John H.

Comment TWRS Alternative Decision Making Process

DOE makes the following statement right up front in the EIS (page 1-3 to be exact), "NEPA and SEPA provide decision makers with an analysis of environmental impacts (both positive and negative) of proposed actions for consideration in decision making." Anyone following the TWRS program during the last couple of years fully realizes that the alternative selection decision has already been made. Before the ink was dry on the January 1994 re-negotiated Tri-Party Agreement, DOE was already canceling engineering and technology development work to support any alternative except the privatization effort (i.e., the Phased Implementation alternative). If DOE had truly not made a defect and unilateral (without State or Public involvement) alternative selection decision, funding for all alternatives would have been continued at an equal level. DOE has just received proposals for Phase 1 of the Phased Implementation alternative and is due award contracts before September. How can DOE possibly say the decision hasn't been made? How can DOE expect to gain public confidence and credibility when it continues to function in such a misleading manner. This EIS is nothing more than an attempt to backfit and justify a decision that has already been made on a political rather than technical basis. That kind of action continues to result in poor DOE credibility. DOE would do much better in the public confidence and credibility arena if it would simply state the truthful facts as they are and let the public judge on that basis rather than continuing to manipulate the information.

Response DOE and Ecology have presented the facts concerning the alternatives for remediation in this EIS and have solicited public comments concerning the EIS. The renegotiation of the Tri-Party Agreement and the planning for the Phased Implementation alternative has been an effort to develop the DOE and Ecology proposed plan. It is frequently the case that agencies have a proposed action developed prior to initiating the preparation of an EIS. The EIS provides an analysis of the environmental impacts of the proposed action and alternatives to it. The EIS is not prepared to justify the selection of any alternative but rather, as required by NEPA, is prepared to provide the public and the decision makers an assessment of the proposed action and its alternatives so they may take environmental issues into account where decisions are made. Because the information contained in the Draft EIS is correct, no change to the text was made. Please refer to the response to Comment number 0005.07.

Comment Number 0066.01

Stilger, Bob

Comment My main comments are about the lack of citizen participation over the past 2½ years. From what, from the answer I got to my question earlier, it sounds like the last major participation that was conducted on this was in late 1970, excuse me 1994, which came at the direction of the Nuclear Waste Advisory Council before it was disbanded. So we've gone through as 2-year period, in which what I regard as substantial changes have been made in the current plans. When I hear that the amount of waste that's due to be cleaned up by 2010 is now at 16 percent, rather than 30 percent. Almost a 50 percent reduction. I regard that as a major change. I regard the plans for privatization as a major change. The fact that these plans have been developed primarily in private, behind closed doors, once again gives me great concern. When I come to a meeting like this and have, what, maybe a 2-hour period to examine what's going on, and have contrary information, or contradictory information presented by on the one hand DOE and Ecology, and on the other hand by HEAL and Heart of American Northwest. I must say, based on past experience, my inclination is to believe HEAL and Heart of American Northwest. Jerry may have long figures, but they're frequently more accurate, and more accessible than the others that are presented. My concern is that over the past 2 years work that was done in the late 80's, and early 1990's to begin to develop more of a relationship between the public and DOE, between the public and Department of Ecology, seem to have been substantially eroded. I don't believe that people know what's going on right now. I think these changes need to be discussed more publicly, in a more accessible manner. Frankly, I can't tell from the limited amount of information that's been available tonight, whether the new plans really are the best plans since sliced bread, or are another example of backsliding and more paper work. Whichever the case is, we're not going to know until there is a more active, and more aggressive, and more thoughtful citizen participation process. Thanks.

Response Since 1994, there have been extensive opportunities for public involvement in the decision making regarding the TWRS program. The public has participated in the TWRS decision making process on the following occasions:

Scoping for the TWRS EIS in early 1994 (five public meetings), consultation with Tribal Nations, and briefings of the Hanford Advisory Board.

A public comment period on the SIS EIS and the Final EIS in late 1995 (five public meetings) and briefings for Tribal Nations, the Hanford Advisory Board, and the Natural Resources Trustee Council.

Privatization and related public involvement on the proposed amendments to the Tri-Party Agreement from late 1995 through early 1996.

Interaction with the Hanford Advisory Board and its committees from 1994 to the present on a variety of issues associated with the TWRS program. The EIS was discussed during public forums held in Richland, Washington, in Fall 1995.

Extensive mailings and public notifications have been provided by the Agencies to encourage public involvement in the NEPA process and to provide the public with information regarding the alternatives and analysis in the EIS.

Substantial changes have occurred in the TWRS program during the past two years. However, these changes have been subject to extensive public participation and have all been undertaken within the context of the Tri-Party Agreement. Because of these changes and changes that preceded the signing of the amended Tri-Party Agreement in 1994, DOE was required by NEPA to prepare this EIS. NEPA requires public participation in the decision making process for actions by an agency that could have significant impacts on the human and natural environment. The NEPA process for the TWRS program provides the public with an opportunity to comment on the proposed action and alternatives to the proposed action.

To facilitate public participation in the NEPA process, DOE and Ecology widely advertised the opening of the comment period and the availability of the Draft EIS for review and comment.

In newspapers throughout the region.

In mailings to more than 4,500 individuals on Hanford Site mailing lists.

Two separate press releases were distributed to media outlets in the regions.

Indirect mailings to more than 1,400 interested parties.

In distribution of more than 600 copies of the EIS.

Additionally, the EIS and supporting documents were available at four public reading rooms or information repositories in the Northwest. The entire EIS was available on the Hanford Internet Homepage (http:\www.Hanford.gov.). DOE and Ecology have taken all steps possible to ensure that the complete information was provided, information was provided in as many locations as possible, and that the public had access to the level of information they needed to effectively participate in the decision making process. While more active, aggressive, or thoughtful public participation is an important goal to which both Agencies are committed, the TWRS public participation program met or exceeded all requirements and expectations under Federal and State regulations. The TWRS public participation program implemented many innovative techniques that were designed to improve public involvement.

Comment Number 0081.10

Pollet, Gerald

Comment Secondly, lastly, we are concerned that the joint state U.S. DOE EIS effort was a noble effort at saving costs and streamlining. And we feel that DOE, U.S. DOE, excuse me, has jeopardized the success of this experiment. Jeopardized it by failing to provide all relevant access, all data, excuse, me, data access for all relevant data to its partner in this EIS. The Department of Energy has been sitting on data about tank leaks. It has been sitting on data and has known that it has evidence about additional types of wastes, radionuclides, not just cesium that have moved from tanks. It hasn't shared that data, and seems to be sitting on that data in such a manner as to try to prevent it from coming out during the public hearing and comment period on this EIS. That would be extremely bad faith. It has to release that data, and maybe even do a supplemental mailing to the public, and share it immediately with its partner if it expects to ever be able to go ahead and do a joint EIS again. And we're very concerned that Ecology can't be a full partner in an EIS when its co-partner has control over all the data, and attempts to sit on it and evade public disclosure. Thank you.

Response All data used in the development of the EIS are available to the public by accessing the TWRS EIS Administrative Record. The emerging data concerning tank leaks and the depth into the soil column the contaminants have moved were identified in Volume One, Section 3.3 on page 3-4 of the Draft EIS. The mechanism for how this contamination may have moved into the soil column at a greater depth than previously believed has not yet been determined. It may have leaked down unsealed bore holes, caused by hydraulic pressure of large leaks, caused by chemical reactions that could change the rate at which the contaminants might move in the soil column, or a combination of these and other factors. Additional information analysis has been performed since the publication of the Draft EIS and the last available information was included in Volume One, Section 4.2 and Volume Five, Appendix K of the Final EIS. DOE and Ecology know of no information that has been withheld from the public.

Comment Number 0085.06

Klein, Robin

Comment It is important that a plan be implemented immediately to retrieve the tank wastes. Oh, and on behalf of a number of individuals here, we'd also like to know what your going to do with these comments, and what the response mechanisms will be. How will you be responding to our comments?

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. DOE and Ecology agree with the need to move forward with remediation of the waste at the earliest possible date.

All oral and written comments have been entered into the public record for the EIS. Transcripts of meetings and written comments have been placed in the Administrative Record for the EIS and made available for public review at DOE Reading Rooms and Information Repositories. Each comment received was also logged, categorized by topic, and responded to individually. A copy of the comment and response has been published in this comment/response document (Volume Six, Appendix L). Based on the response to the comment, appropriate changes have been incorporated into the text. The Final EIS will be provided to the decision makers to support the Agency decision.

Comment Number 0098.07

Pollet, Gerald

Comment Everyone has to get together to fight to get first of all full disclosure, secondly, to make sure that tanks are not left behind, and thirdly, that no decision makers are lulled into thinking it is safe to leave wastes behind because of this EIS and because the Department of Energy does not give its partner, the State of Washington, the data. I think this was a failed experiment in terms of the state collaborating with the Department of Energy. The U.S. Department of Energy blew it and we will oppose joint EISs in the future unless the state really puts down its foot and insists on some truth and changes here.

Response DOE and Ecology acknowledge the preference expressed in the comment and will take this preference and other public comments into consideration when making a final decision on remediating the TWRS waste. The DOE and State of Washington were jointly involved throughout all aspects of the preparation and approval of the Draft EIS and they concur in its results. Co-preparing this EIS instead of preparing two, one by DOE and one by the State of Washington, allowed the overall approval process to be accelerated and saved taxpayers money. All information concerning the EIS was shared between the State and DOE. Please refer to the response to Comment number 0081.10 for a related discussion.