RPP-14284, Revision 1A
CONTENTS OF LONG-TERM PERFORMANCE ANALYSES TO SUPPORT THE RETRIEVAL AND CLOSURE OF TANKS FOR THE WASHINGTON STATE DEPARTMENT OF ECOLOGY

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Acronyms

BBI	Best Basis Inventory
DOE	U.S. Department of Energy
DQO	data quality objective
DST	double-shell tank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FIR	field investigation report
ILAW	immobilized low-activity waste
ILCR	incremental lifetime cancer risk
MUST	miscellaneous underground storage tank
ORP	Office of River Protection
PA	performance assessment
RCRA	Resource, Conservation, and Recovery Act
RPE	retrieval performance evaluation
SST	single-shell tank
TFC	tank farm contractor
TPA	Tri-Party Agreement (also known as the Hanford Federal Facility Agreement and Consent Order)
WMA	waste management area

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1.0 INTRODUCTION

At the Department of Energy's (DOE) Hanford Site in south central Washington State, there are 177 large underground tanks with associated facilities that are used to store radioactive hazardous waste. Some of these tanks have leaked, with the result that there is tank waste in the Site's groundwater. DOE's Office of River Protection (ORP) plans to remediate these storage facilities (RPP-13678, *Integrated Mission Acceleration Plan*) by retrieving waste from the tanks, performing facility stabilization, and implementing soil cleanup. Before such work can be performed, performance analyses of various options must be performed for ORP, DOE Headquarters, and the Washington State Department of Ecology (Ecology). Because of the large number of performance analyses for each tank and the large number of tanks, performance analyses for the different agencies will be integrated to the maximum extent possible. This document focuses on the requirements for performance analyses used to satisfy Ecology requirements.

There are three types of large underground tanks at Hanford: single-shell tanks (SSTs), double-shell tanks (DSTs), and miscellaneous underground storage tanks (MUSTs). The SSTs have a storage capacity ranging from 50,000 to 1,000,000 gallons. Although waste is still present, they do not meet current regulatory requirements for the addition of waste. The DSTs have a storage capacity ranging from 500,000 to 1,160,000 gallons and are expected to meet current regulatory requirements. The SSTs are grouped into 12 tank farms (A, AX, B, BX, BY, C, S, SX, T, TX, TY, and U). For regulatory purposes, the 12 tank farms are grouped into 7 waste management areas (WMAs) (A/AX, B/BX/BY, C, S/SX, T, TX/TY, and U), although the T and TX/TY WMAs are often treated as a unit. The DSTs are grouped only into tank farms (AN, AP, AW, AX, AY, AZ, and SY). MUSTs are smaller tanks (maximum size of 50,000 gallons) that are scattered in various farms.

Section 2.0 provides an overview and summary of this document. Section 3.0 describes the requirements of performance analyses. Section 4 provides the contents of the master performance assessment.

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2.0 OVERVIEW

Recognizing that performance analyses for tank closure will fill many needs and that the information in the performance analyses will be rapidly changing as new and better analyses are obtained, the basic philosophy for producing performance analyses for Hanford tank closure is:

> *A long-term environmental performance assessment for tank closure will be created covering all components of the tank system. This document will be maintained and its structure will be set so that it can be rapidly revised as new information is obtained. The document will fulfill the requirements of the Washington State Department of Ecology and the U.S. Department of Energy.*

It is important to realize that the requirements of this performance assessment will evolve with time. The nature of the regulatory decisions will change as tank closure evolves from design of retrieval methods, through retrieval of tank waste, closure of tank components, remediation and closure of tank farms, and finally to tank system and Site closure. Thus, although the performance assessment created at the beginning phases of this effort may fulfill all of the initial requirements, that same performance assessment may well be insufficient for latter phases of the tank closure process.

Performance assessment information is needed to support the following major decisions:

- What should be done about past leaks ?
  What are the likely environmental consequences from past leaks ?
  What are the likely environmental consequences if various remediation options are performed ?
- What should be done if a leak occurs during waste retrieval from a tank or farm component ?
  What are the likely environmental consequences of continued waste retrieval ?
  What are the anticipated environmental consequences of stopping retrieval ?
- Has sufficient waste been retrieved ?
  What are environmental consequences of the residual waste ?
- Are engineered components for component closure sufficient to protect the environment ?
- After tank farm components are closed, what additional remediation is necessary to protect the environment ?
- After all facilities are remediated and closed, are there other actions besides monitoring that are required ?

Performance assessment information must always be put into historical and Site context. The historical and planned sources of tank wastes in the environment include

- Past leaks from tanks, pipelines, and other ancillary equipment as well as spills and other events
- Potential leaks during waste retrievals

- Residual waste left in tanks
- Residual waste left in other facilities.

In addition, there are environmental impacts from other Hanford actions (for example, past practice liquid discharges, waste disposal in burial grounds, and other remediated sites) that could overlap with tank operations.

For ease of discussion the information supported the above major decisions are categorized as

- Field Investigation Reports
- Retrieval Functions and Requirements
- Post-Retrieval Performance Analysis
- Pre-Closure Performance Analysis
- Tank Feasibility Study
- Tank Closure Performance Analysis

The first category covers reports that are part of the Resource, Conservation, and Recovery Act (RCRA) Corrective Action Program and deals with past leaks. The next three categories deal with decisions on single tanks, but put the information in context of an entire tank farm/WMA. The Feasibility Study and Tank Farm Performance Analyses deal with decisions on a tank farm/WMA basis. Table 1 summarizes the features of each category.

The next section provides general requirements and comments that apply to all performance analyses. They involve consistency among documents, performance objectives and metrics, data documentation, computer codes, and interactions with other projects.

The following sections will treat each category in detail. Each section will be broken into the following subsections as needed:

1. Overview
2. Decisions Supported
3. Scope
4. When Submitted
5. Types of Analyses
6. Sources of Contaminants
7. Types of Data Needed
8. Numeric Calculations Performed
9. Analysis
10. Quality
11. Relationship with Other Categories

Details about each subsection are given in Table 2.

Table 1. Important Features of Performance Analysis

Category	Purpose	Significant Feature
Master Performance Assessment	Provides root document for all other analyses	Contains current understanding of all long-term environmental consequences from tank farms. Constantly updated.
Field Investigation Reports	Determine whether addition correction actions are needed to address past leaks	Gather field/laboratory data to fill in data gaps. Perform numeric calculations to understand transport conceptual model. Recommend additional corrective actions, if any.
Pre-Retrieval Functions and Requirements	Provide environmental information for the design of retrieval systems and in implementation of retrieval	Use existing data to estimate risk (based on an indicator contaminant) of no action, of residual waste, and of potential future leaks as a function of residual waste and any leaked waste.
Post-retrieval Tank Analysis	Determine whether additional retrieval of waste is necessary	Determine inventory of key contaminants in residual waste in tank and in any retrieval leaks. Perform numeric calculations of impacts of waste remaining (including impacts from other tanks and equipment in farm or WMA) assuming no impacts from tank fill.
Pre-Closure Tank Analysis	Determine whether closure of tank can proceed using the methods proposed	Determine impacts from various options to close (including fill and barriers) a tank. Impacts will include impacts from other tanks and equipment in farm or WMA. Provide worker risk information for proposed closure options.
Tank Farm Feasibility Study	Determine actions that are needed to close a tank farm or WMA	Determine impacts from various options to close tank farm or WMA. Provide worker risk information for proposed closure options.
Tank Farm Closure Analysis	Determine whether closure actions as implemented have been successful	Determine impacts from closed tank farm or WMA, once all closure activities (except possibly final surface barrier) are completed.

Table 2. Details of Subsections

Subsection	Description
Overview	Summary of the purpose of the documents in the category, previously established requirements, previous examples, and other significant information
Decisions Supported	Description of decisions that will be based on the information presented. Description of the decision maker(s)
Scope	Description of information covered.
When Submitted	Description of prior events needed.
Types of Analyses	Description of type of performance analyses. Examples are long-term groundwater pathways (including transport to the Columbia River), long-term air pathways, long-term inadvertent intrusion, and long-term ecological analysis. Short-term worker risk will be analyzed, but will be documented separately.
Sources of Contaminants	1) Past Leaks, 2) Leaks during retrieval, 3) Residual waste, 4) waste in ancillary equipment and surface spills
Types of Data Needed	Data that distinguishes this category from others. Generic data (it is assumed that, recharge, hydraulic, geochemical, and geologic data is needed for any transport numeric simulation.
Numeric Calculations Performed	Description of numeric simulations to be run
Analysis	Description of analyses/options to be performed
Relationship with other categories	Description of other categories in this document

3.0 REQUIREMENTS

The following sections will provide detailed descriptions and requirements for the various categories of performance analyses to be performed in tank retrieval/closure.

3.1 GENERAL REQUIREMENTS

This section looks at requirements that apply to all categories.

3.1.1 Consistency among Analyses

There will be a large number of analyses produced, both because of the number of analysis categories, but also because of the large number of tanks, tank farms, and WMAs. The intent is to build on previous analyses whether in different categories for the same tank, or for the same category for different tanks. Data and methods are expected to improve in a systematic way as additional analyses are produced.

The basic strategy to achieve consistency is to have one master performance assessment that covers all parts of the tank system and is constantly updated. Other analyses will use inform from this master performance assessment.

In this document a distinction is made between "performance analysis" and "performance assessment". A performance analysis is a study of the long-term human health and environmental impacts due to tank waste activities. Such a study will be published as its own document or published as part of a document covering more areas. An example of such a more general document is the *Single-Shell Tank System Closure Plan* (RPP-13774). A performance assessment is a stand alone document that contains only the performance analysis.

3.1.2 Performance Objectives and Metrics

As noted in the "Recommended Long-Term Risk Assessment Approach" in Appendix C of the *Single-Shell Tank System Closure Plan* (RPP-13744), the early establishment of performance objectives is important. These objectives are defined in the *Performance Objectives for Tank Closure Risk Assessments,* the current version being (Mann et al. 2003). The objectives, as formally modified, will be used in all performance analyses in this document except as explicitly noted.

3.1.3 Data

As noted in the section above on consistency in documents, data is expected to improve in a systematic way as additional documents are produced. These performance analyses are expected to depend heavily on data actually collected, rather than on assumptions or extrapolations. As new data is collected for each major waste type and geographical unit, they will be put into the context of what is already known and new conceptual models may develop. Data (particularly inventory, release data, and other inputs to contaminant transport modeling), as well as conceptual models, will be changed only when convincing argument shows the new data is better than currently in the database.

Some data will be common among all performance analyses. As noted above, such data will be formally controlled. In particular, dosimetry data will be controlled and will be defined in *Exposure Scenarios and Unit Dose Factors for Hanford Tank Waste Performance Assessment* (the current version being Rittmann 2003).

3.1.4 Computer Codes

All numeric codes used for contaminant transport will meet the requirements in the *Computer code Selection Criteria for Flow and Transport Code(s) To Be Used in Vadose Zone Calculations for Environmental Analyses in the Hanford Site's Central Plateau* (the current version is Mann et al. 1999). The STOMP Subsurface Transport Over Multiple Phases, Version 2.0 Users Guide (White and Oostrom 2000) and VAM3DF – Variably Saturated Analysis Model in Three Dimensions for the Data Fusion System: Documentation and User's Guide, Version 2.0 (Huyakon and Panday 1999) computer codes have been used for Ecology-reviewed ORP performance analyses (Field Investigation Reports (FIRs) and the Immobilized Low-Activity Waste Performance Assessment (ILAW PA), respectively), and both codes meet the requirements in Mann et al. (1999).

3.1.5 Short-Term Risk Analysis

Tank waste retrieval and tank closure activities will be designed so that any short-term impacts (whether to the workers or to the public) are as low as reasonably achievable. However, ORP may find that this goal is in conflict with the goal of minimizing long-term risks due to increased risk to workers. For these cases or for cases where costs are extreme, the relevant documents will report short-term risks (occupational injuries, illnesses, and fatalities) for workers and the general public and costs based on the analyses of relevant accident scenarios or design costs. The analysis of such term-risk will NOT be part of long-term assessment analyses or documents, but will be documented separately.

3.1.6 Interactions with Other Projects

Varieties of other projects are producing performance assessments at the Hanford Site, or produced data, that are useful for such performance analyses. Extremely successful relationships have already been formed. Relationships will be maintained among:

- Tank Closure Project
- River Protection Project's Strategic Planning and Mission Analysis Group
- Integrated Disposal Facility Performance Assessment activity
- Solid Waste burial Ground Performance Assessment
- Groundwater Protection Program
  Characterization of Systems
  Remediation and Closure Science Project
  Hanford Site-Wide Assessments Project
  Waste Site Remedial Actions Project
- Environmental Impact Statement activities

Many of the tank farm performance analyses require that the impacts be placed in context of Hanford Site impacts. Such a context will be based on work done by the Hanford Site-Wide Assessments Project, whether the work is formal updates of the Hanford Site Composite Analysis (*Composite Analysis for Low-Level Waste Disposal in the 200-Area Plateau of the Hanford Site,* Kincaid et al. 1998) or special runs of the System Assessment Capability (*An Initial Assessment of Hanford Impact Performed with the System Assessment Capability,* Bryce et al. 2002).

When DOE establishes a Hanford Site Risk Assessment Coordination Panel, this activity will play an active role in its tasks and will follow the Hanford Site standards that the panel creates.

REQUIREMENTS FOR MASTER PERFORMANCE ASSESSMENT

3.1.7 Overview

The master performance assessment documents the current understanding of the long-term environmental consequences from Hanford Site tank farms and associated equipment. These documents will be thoroughly referenced and will rely on the best available data. They will be structured (see Section 4) to be complete, yet allow rapid updating to reflect newer, better data, information, and understanding. This document would also fulfill the performance assessment requirements in the DOE's order on "Radioactive Waste Management" (DOE O 435.1).

3.1.8 Decisions Supported

The master performance assessment will support all decisions as it will be the root document on which decision-specific documents will be based.

3.1.9 Scope

The master performance assessment will investigate all long-term impacts to the environment, including impacts to ground water, surface water, air, and the inadvertent intruder. The goal is to provide the current understanding using best available data and information.

The reason for one master root document is that a large number of various decisions will be made based on long-term environmental information and understanding. Having many uncoordinated documents increases the likelihood that important ideas and data will be missed and that conflicting information will be used without knowledge. Thus, having one root document that is continually updated will lessen the potentially for inconsistency while maximizing the visibility of key data and data that changed.

3.1.10 When Prepared

The initial version, based on existing computer simulations, will focus on single-shell data farms and will be issued by September 2004. The first full revision will add impacts from the rest of the tank system, site-specific information, and improvements gained from the initial effort and will be issued by September 2006. Further full revisions will be added as needed, but probably on a several year cycle.

Partial revisions will be issued more regularly. Revision of inventory estimates and the associate impacts will occur after significant updates to the inventory data base. Experience will define significant, but reasonable expectations would be that the following would cause a significant update:

- laboratory analyses of contaminant concentrations in residual wastes after a component has had its waste retrieved
- laboratory analyses of leaked waste (from past releases, from retrieval releases, or other release events)
- New estimates (differing by more than 25%) of residual or leaked waste volumes.

Because of the overlapping of various inventory activities, it is expected that such inventory updates would not occur more frequently than 4 times a year.

In addition, the Department of Energy requires an "Annual Summary" each year that a full revision is not issued. Therefore, a partial revision providing all changes since the last full revision would be issued each year.

3.1.11 Types of Analyses

The master performance assessment will analyze all long-term impacts to the environment, including impacts to ground water, surface water, air, and the inadvertent intruder. It should include any analysis needed by a subsidiary document.

3.1.12 Sources of Contaminants

The master performance assessment will analyze all sources of contaminants, including

- Past leaks from tanks, pipelines, spills, and other events
- Potential leaks during retrievals
- Residual waste in tanks
- Residual waste in other facilities.

All contaminants (both radioactive and chemical) will be considered. Screening analyses may be used to reduce the number of simulations. In addition, such screening may be used to reduce the number of contaminants for which results are provided so only those providing most of the impact are provided.

3.1.13 Types of Data Needed

Since the master performance assessment is the most complete of the performance analyses, it will require the most data. Major categories of data needed are

- Inventory (concentration, amount, distribution, chemical form)
- Surface engineered barriers (type, timing of installation, degradation)
- Engineered barriers in and around components (type, timing of installation, degradation)
- Moisture infiltration
- Contaminant release (models and parameters)
- Vadose zone data (geology, hydrology, chemistry)
- Groundwater flow
- Dosimetry.

The best available data will be used and is expected to improve with time. Strong coordinated with other tank farm organizations, with Hanford Site staff, and with other DOE scientists will be maintained. Following the practice of the Tank Farm Vadose Zone Project and the Integrated Disposal Facility Performance Assessment activity, data packages will be documented and all data used will be justified.

3.1.14 Numeric Calculations Performed

Calculations will fall into 3 classifications:

- Base case
- Sensitivity cases exploring limits of technical knowledge
- Sensitivity cases exploring engineering alternatives.

In some cases, calculations will serve multiple purposes.

The base case will analyze the currently established base line for tank operations. It will reflect regulatory requirements as well as chosen engineered options.

The sensitivity cases exploring the limits of technical knowledge will determine the impacts of imperfect knowledge of data and processes. Past experience (Knepp 2002a, Knepp 2002b, Mann 2001) have shown that results are very sensitive to inventory data, release data and processes, moisture infiltration, and groundwater flow.

The sensitivity cases exploring engineering alternatives will determine the impacts of various decisions yet to be made. Examples are retrieval efficiency, the timing of barrier placement, and type of tank fill. As decisions are made, such cases will become less important.

3.1.15 Analysis

The areas of analysis will focus on understanding the tank system. Decision-specific analyses will be in the documents that use the master performance assessment as a source of information.

3.1.16 Quality

Since the master performance assessment is the root document for all analyses dealing with long-term environmental consequences from the tank system, its quality must be as high as possible. However, it is recognized that the quality of the report will improve rapidly as better data and understanding is obtained concerning past leaks, waste retrieval, and facility closure. Initially, the quality of the report should assume approval would be by ORP staff and by the Ecology management at the Kennewick office. Within a few years, the approval level for analyses supported by the master performance assessment will increase to DOE and Ecology headquarters.

3.1.17 Relationship with Other Categories

The master performance assessment is root document on which other documents are based. Activities supporting the other documents will be incorporated into the master performance assessment as appropriate in order to provide a single source for information on the environmental impacts of the tank waste system.

3.2 REQUIREMENTS FOR FIELD INVESTIGATION REPORTS

3.2.1 Overview

The Field Investigation Reports (FIRs) are secondary documents under the *Hanford Federal Facility Agreement and Consent Order* or Tri-Party Agreement (TPA, Ecology 1989) Milestone M45-55. They are part of the RCRA Corrective Action Program. They document:

- Existing data on existing contamination in a WMA from past tank leak events,
- New field, laboratory, and analysis information obtained during the effort,
- Numerical simulations of such past leak events on groundwater,
- Corrective actions (known as interim measures) taken to mitigate impacts on groundwater, and
- Recommendations for additional data collections, analyses, or interim measures.

The requirements for FIRs are specified in the *Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan for Single-Shell Tank Waste Management Areas* (known as the Master Work Plan) (DOE/RL-99-36).

3.2.2 Decisions Supported

The tank farm contractor (TFC, presently CH2M Hill Hanford Group, Inc.), ORP, and Ecology use the FIR information to determine whether any additional data collections, analyses, or interim measures are needed. The TFC or ORP can implement such actions on their own. The information is also used during later phases of the RCRA Corrective Action program (i.e., during the Corrective Measures phase) to determine whether more extensive activities are needed. The baseline data and information will also support Tier-1, -2, and –3 closure plans (RPP-13744).

3.2.3 Scope

The FIRs are part of the RCRA Corrective Action Program dealing with past tank leak events. They analyze the impacts to groundwater to determine whether corrective actions are needed to mitigate the impacts.

3.2.4 When Submitted

Dates are established in the TPA and are independent of retrieval/closure decisions. The *Field Investigation Report for Waste Management Area S-SX* (Knepp 2002a) was submitted to Ecology in January 2002. The *Field Investigation Report for Waste Management Area B-BX-BY* (Knepp 2002b) was submitted to Ecology in January 2003. The FIR for T and TX/TY WMAs is scheduled for submission to Ecology in January 2005, while the FIRs for WMA A/AX and C and for WMA U are scheduled for 2006 and 2007.

3.2.5 Types of Analyses

The FIRs investigate only the long-term impact to groundwater from past tank leaks. Impacts from tank residuals or from waste left in ancillary equipment are not investigated. There are no short-term analyses, nor are other transport pathways investigated.

3.2.6 Sources of Contaminants

The FIRs only investigate past tank leaks (actual leaks, tank spills). They do not investigate other sources of contaminants. Only those contaminants that are thought to be the major contributors to groundwater impact shall be analyzed. A discussion of how these contaminants were chosen shall be provided.

3.2.7 Types of Data Needed

Most of the focus of the field investigations is on the amount and distribution of the leaked contaminants. Other data is collected to support transport calculations. The data from the Science and Technology Project of the Groundwater Protection Program, a collaboration of various National Laboratories that uses the soil samples obtained during the effort, has provided important insights.

A significant effort is to determine the information already known about the specific WMA. Such data is summarized and referenced in the following Subsurface Conditions Descriptions Reports: *Subsurface Conditions Description for the S-SX Waste Management Area, Subsurface Conditions Description of the B-BX-BY Waste Management Area, and Subsurface Conditions Description of the T and TX-TY Waste Management Areas;* (Wood et al. 1999, Wood et al. 2000, Wood et al. 2001) and in the following inventory reports: *Inventory Estimates for Single-Shell Tank Leaks in S and SX Tank Farms, Inventory Estimate for Single-Shell Tank Leaks in T, TX and TY Tank Farms, and Preliminary Inventory Estimates for Single-Shell Tank Leaks in B, BX ,and BY Tank Farms, and Groundwater/Vadose Zone Integration Project: Hanford Soil Inventory Model* (Jones et al. 2000a, Jones et al. 2000b, Jones et al. 2001, and Simpson et al. 2001). Through such reports, important data gaps are noted and discussed through a data quality objective (DQO) process. A formal data collection plan has historically been issued as appendices to the Master Work Plan (Henderson 1999, *Preliminary Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX;* Knepp and Rogers 2000, *Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX;* Rogers and Knepp 2000, *Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA B-BX-BY;* Crumpler 2002, *Site-Specific SST Phase 1 FRI/CMS Work Plan Addendum for WMAs T and TX-TY*).

Data collection has focused on the collection of contaminated soil samples in the highest area of contamination in the WMA. Soil samples are also collected from areas where significant contamination is expected. Also part of the field program is geophysical logging of the new soil penetrations and of existing boreholes.

Laboratory measurements of the soil samples consist of sets of experiments depending on the nature of contamination found. Auxiliary experiments have provided important data on chemical processes used at the Hanford Site as well as in-tank characterization. The work has been extensively documented in works such as *Characterization of Uncontaminated Sediments form the Hanford Reservation – RCRA Borehole Core Samples and Composite Samples; Geologic and Geochemical Data Collected from Vadose Zone Sediments from Borehole 299-W23-19 [SX-115] in the S/SX Waste Management Area and Preliminary Interpretations; Geologic and Geochemical Data Collected from Vadose Zone Sediments from Borehole SX 41-09-39 in the S/SX Waste Management Area and Preliminary Interpretations; and Geologic and Geochemical Data Collected from Vadose Zone Sediments from Slant Borehole [SX-108] in the S/SX Waste Management Area and Preliminary Interpretations* (Serne et al. 2001a, Serne et al. 2001b, Serne et al 2001c, Serne et al 2001d).

3.2.8 Numeric Calculations Performed

The purpose of the numeric calculations is to estimate whether contamination already released will violate groundwater standards and whether corrective measures would mitigate this impact. A base analysis no action case is defined. Sensitivity cases examine the most important assumptions. Additionally, numeric cases are run to investigate the effect of various corrective actions.

Contaminants modeled are limited to those thought to be the most important based on previous modeling and on field/laboratory measurements. Other key parameters are defined in the Master Work Plan.

3.2.9 Analysis

Areas of analysis include improvements of the conceptual model for inventory amount and distribution from past leaks and for transport of contaminants, discussion of installation of corrective actions already performed and their expected impact, and recommendations for additional corrective actions.

3.2.10 Quality

The quality of the report should assume approval would be by ORP staff and by the Ecology management at the Kennewick office.

3.2.11 Relationship with Other Categories

The data collected and the conceptual models generated in the FIRs are expected to form the backbone of the data and models used in all the remaining categories. The numeric simulations used in the FIRs should form the transition into modeling of tank farm contaminants.

3.3 REQUQIRMENTS FOR PRE-RETRIEVAL FUNCTIONS AND REQUIREMENTS

3.3.1 Overview

Pre-Retrieval Functions and Requirements Documents (F&Rs) provide the function and requirements for the design of tank waste retrieval system. An important part of this information is the long-term environmental risk information. The reports will be based on the best available existing data to the maximum extent possible, with little new data collected for the creation of the document. The purpose of the performance analysis in the F&Rs is to provide Ecology information on environmental impacts of potential leaked waste and of residual waste as a function of retrieval efficiency so that Ecology can make rapid decisions if the a retrieval leak is discovered.

In previous Retrieval F&Rs, *Single-Shell Tank C-104 Full Scale Sludge/Hard Heel, Confined Sluicing and Robotics Technologies, Waste Retrieval Demonstration Functions and Requirements*; *Single-Shell Tank S-112 Full Scale Saltcake Waste Retrieval Demonstration Functions and Requirements*; and *S-102 Initial Waste Retrieval Demonstration Functions and Requirements* (Carpenter 2001, Crass 2001, Crass 2002), a full retrieval performance evaluation (RPE) was performed and included as an appendix to the F&Rs.

This new approach will provide needed design data in a clearer format and show the underlying assumptions more clearly. An example of this new approach is *Single-Shell Tank 241-U-107 Waste Retrieval Functions and Requirements* (Baide 2003).

3.3.2 Decisions Supported

Pre-Retrieval Functions and Requirements documents support the design of the tank waste retrieval system (RPP-13744). They are also used to provide Ecology information on environmental impacts of potential leaked waste and of residual waste as a function of retrieval efficiency so that Ecology can make rapid decisions if the a retrieval leak is discovered.

3.3.3 Scope

F&Rs provide figures and tables allowing designers and regulators to understand the long-term risk of leaving various amounts of an indicator contaminant (such as Tc-99) in the tank (including no action) and of having various amounts leak during retrieval.

3.3.4 When Submitted

Pre-Retrieval Functions and Requirements documents are submitted before final design of the retrieval method and leak detection monitoring is established.

F&Rs are listed as TPA milestones for selected tanks:

- M45-03-T03 S-112 completed
- M45-03-T04 C-104 completed
- M45-05-T16 S-102 completed

- M45-05-T17 S-105, S-106, and S-103 4/30/2005

Common features of these milestones as regards the performance analysis part of the milestones are

> *This document will … include a scoping level retrieval performance evaluation (RPE). The Functions and Requirements document and its associated RPE will provide environmental and human health risk information associated with estimated waste volumes to be retrieved, the maximum volume which could leak during retrieval, and risk from residual waste. This document will detail known and estimated radionuclide contamination and contaminant migration within the vadose zone as bases of calculation.*

3.3.5 Types of Analyses

The reports will cover long-term groundwater impacts for the various retrieval options being studied. The results of the tank being studied will be put into context of all tanks in the farm or WMA.

Incremental lifetime cancer risk (ILCR) has been chosen as the metric. This metric is recommended (EPA 1999) by the Environmental Protection Agency as the metric of choice for cleaning sites regulated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). It can be used for chemical or radioactive contaminants.

3.3.6 Sources of Contaminants

The sources of contamination to be included are past leaks, waste presumed to be left in the tank(s), and potential retrieval leaks. One indicator contaminant will be chosen that represents the largest expected contribution. In past documents, Tc-99 was chosen as this indicator contaminant based on earlier tank waste studies (Knepp 2002a; Knepp 2002b; and Mann et al. 2001, *Hanford Immobilized Low-Activity Tank Waste Performance Assessment*) as well as on Hanford Site work *Composite Analysis for Low-Level Waste Disposal in the 200-Area Plateau of the Hanford Site*, and *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability* (Kincaid et al. 1998 and Bryce et al. 2002).

3.3.7 Types of Data Needed

Present inventory values will be taken from best available existing data, such as the Best Basis Inventory (BBI) and published soils inventory data. As no transport calculations will be performed, data supporting such calculations are not needed.

3.3.8 Numeric Calculations Performed

Contaminant transport calculations will not be performed. Rather the effect of release and transport will be taken from previous studies that are the most relevant to the case being studied. For initial analyses, these are previous RPEs for the impacts from residual waste and previous FIRs for past leaks and potential retrieval leaks. For later analyses, it is expected that detailed contaminant transport calculations from retrieval and closure performance analyses will be available, as documented in the master performance assessment. There will be no short-term risk analysis of worker or general public exposure since these are design requirements that include the mandate to minimize such exposures.

3.3.9 Types of Analyses

The analysis will provide long-term groundwater risk in the format of graphs and tables. At a minimum, graphs showing:

- Incremental lifetime cancer risk (ILCR) as a function of the amount of the indicator contaminant left in the tank
- ILCR as a function of the amount of indicator contaminant leaked from the tank, including the effects of past leaks
- ILCR as a function of both the amount of the indicator contaminant left in residual waste and the amount leaked from the tank.

Since the amount of the indicator contaminant left or potentially leaked is strongly influenced by design decisions, it is premature to express metrics in terms of residual volume or potential leak lost volumes.

Tables will be provided to put such risks into prospective given the other tanks in the tank farm or WMA. Assumptions for the analysis will be clearly stated.

3.3.10 Quality

The quality of the Pre-Retrieval Functions and Requirements should assume approval would be by ORP staff and by the Ecology management at the Kennewick office.

3.3.11 Relationship with Other Categories

The Pre-Retrieval Functions and Requirements are expected to build on the data and methods of other categories.

3.4 REQUIREMENTS FOR POST-RETRIEVAL TANK PERFORMANCE ANALYSIS

3.4.1 Overview

Post retrieval documents are part of the Appendix H process of the TPA. They are part of the information to determine whether additional retrieval of tank waste is needed. Such documents will consider all sources of contamination and put the information in context of the tank farm, WMA, and Hanford Site.

3.4.2 Decisions Supported

The Post Retrieval Tank Performance Analyses support the decision on whether additional retrieval from a particular tank or facility is needed.

3.4.3 Scope

The Post Retrieval Tank Performance Analyses provide the human health and environmental impact of not retrieving additional waste. An analysis of short-term risks will be separately documented if additional waste is to be retrieved or if interim closure actions (such as installation of a stabilization layer) are to be performed. Appendix H of the TPA requires that DOE provide the following (among other items) if DOE believes that retrieval requirements of TPA M45-00 cannot be met for a specific tank:

5. *Expected impacts to human health and the environment if the residual waste is left in place*
6. *Additional information as required by RPA and/or Ecology.*

3.4.4 When Submitted

The Post Retrieval Tank Performance Analyses shall be submitted after retrieval for a particular tank is thought to have been completed and supporting information from analyses of residual waste and potential tank leak inventory and volume is available. Appendix H of the TPA states

> *The above information* [see section 3.5.3] *shall be submitted within 120 days of the decision by DOE that continued retrieval actions will not result in further waste removal.*

3.4.5 Types of Analyses

The following type of analyses will be covered

- Long-term human health and environment analysis of groundwater pathway (include impacts on surface waters)
- Long-term human health and environmental analysis of the air pathway
- Long-term human health analysis assuming inadvertent intrusion

Long-term ecological risk analysis is not required. Short-term risk analyses will be required for any additional retrieval to be done or for interim closure activities to be performed, but will be separately documented.

The three types of analyses are selected because the decision is whether further retrieval of waste from a tank or other facility component is necessary. The impacts to be studied are strongly determined in the long-term by the amount of inventory left. Although engineered features can affect the amount of impacts, the specifications of those engineered features will not have been determined. Ecological impacts will be much more impacted by the engineered features (for example, surface barriers, fill materials) and thus ecological studies are premature for this decision. Short-tem risk studies (for example, impacts to workers) may be important in determining how much and what type of further retrieval effort should be implemented.

3.4.6 Sources of Contaminants

All sources of contamination will be considered. These shall include waste remaining in tanks, waste remaining in tank farm auxiliary facilities, tank waste in the soils, and tank waste in the groundwater. Impacts from sources in the tank farm or WMA shall be compared with the impacts from all Hanford Site sources.

All significant contaminants (whether radiological or chemical) will be analyzed. A screening analysis (in the manner of that performed for the ILAW PA [Mann et al. 2001]) will be part of the document. Contaminants are not considered significant if they are part of the set of contaminants that provide less than 10% of the expected response to the analyzed metric.

3.4.7 Types of Data Needed

All data (inventory, facility design, geology, hydraulic, geochemical, and dosimetry) used in a contaminant fate and transport calculation are needed. Data will be kept under configuration control. Based on past Hanford Site assessments (FIRs [2001 and 2002b] and ILAW PA [Mann et al. 2001]), the most important data are:

- The inventory of key contaminants,
- The release rate of such contaminants,
- The rate at which moisture enters the system,
- The sorptive interactions between waste and soil particles. and
- The groundwater flow rate.

The last three data items, as well as other needed transport data, are expected to be obtained from the FIRs and from other Hanford Site programs.

Data on the inventory and release rate of key contaminants for the tank of interest (whether residual in the tank or leaked from the tank) will come from measurements from samples taken after the retrieval is complete or based on measurements on samples taken during retrieval. Data for other tanks, for auxiliary equipment, and for soil contamination from other tanks will be based on the best available data, which is expected to be previous sampling campaigns, BBI, and soil inventory data.

3.4.8 Numeric Calculations Performed

Numeric simulations will be performed for the no further action case (i.e., the simulations for residual waste will assume no impact from tank filler material as such design choices will occur later). Other cases (e.g., barrier installation, tank fill) will also be performed for information. No credit or debit will be taken for the tank itself, unless credible information on tank degradation is available.

Key contaminants, as determined from screening calculations, will be explicitly modeled. Other contaminants will be grouped with key contaminants having similar physical and chemical properties. Sensitivity cases will be performed to determine the sensitivity of assumptions and the values of key data.

3.4.9 Analysis

The analysis should provide a "reasonable expectation" of whether the amount of residual waste and associated leaks existing after retrieval protects human health and the environment would require additional retrieval. For those data, processes, and assumptions that have the greatest influence on the results, sensitivity analyses will be performed to establish the reasonable expectation. The analyses will put all results in context with other tanks/systems in the tank farm or the WMA as well as in context of other past and expected releases from the Hanford Site Central Plateau.

3.4.10 Quality

The quality of the Post-Retrieval Performance Analyses should assume approval would be by senior ORP management and by the Head of the Nuclear Waste Division of Ecology.

3.4.11 Relationship with Other Categories

The Post-Retrieval Performance Analyses will build on the data, process, models, and insights gained in the FIRs for the transport of contaminants once they have left the tank. The following performance analyses will build on the inventory and release rates for residual materials estimated in this category of documents

It is expected that as experience grows, the Post Retrieval Performance Analysis and the Pre-Closure Tank Performance Analysis will merge into one document.

3.5 REQUIREMENTS FOR PRE-CLOSURE TANK PERFORMANCE ANALYSIS

3.5.1 Overview

These reports document the design and methods to perform component closure of the tank. These reports should fulfill requirements under RCRA and under the DOE order 435.1, *Radioactive Waste Management*.

3.5.2 Decisions Supported

The Pre-Closure Tank Performance Analyses support the decision to perform component closure on a tank. These documents should also serve to fulfill the performance assessment requirements under DOE O 435.1 (High-Level Waste Facility Closure Plan Risk Assessment and Low-Level Waste Radiological Performance Assessment).

3.5.3 SCOPE

The Pre-Closure Tank Performance Analyses cover all long-term risk information needed by the regulators to allow tank component closure to proceed. Separate analyses will be performed for short-term risks.

3.5.4 When Submitted

The Pre-Closure Tank Performance Analyses shall be submitted after retrieval for a particular tank is completed and enough information is available to estimate with reasonable expectation the long-term risk associated with tank closure. This analysis for a particular tank assumes that the post-retrieval tank performance analysis has been approved or is part of this document.

3.5.5 Types of Analyses

The following type of analyses will be covered:

- Long-term human health and environment analysis of groundwater pathway (include impacts on surface waters)
- Long-term human health and environmental analysis of the air pathway
- Long-term human health analysis assuming inadvertent intrusion

Long-term ecological risk analysis is not required. Short-term risk analyses will be required for all closure activities under consideration, but will be documented separately.

The three types of analyses are selected because the decision is how to fill the interior of a tank or other facility component. Although the impacts to be studied are strongly determined in the long-term by the amount of inventory left, this amount has already been determined by the post-retrieval performance analysis (Section 3.5). Engineered features particular to the tank or component (for example, fill materials) will affect the amount of impacts and thus their effects on the environment must be determined. Ecological impacts will be much more impacted by the engineered features for the entire tank farm or waste management area, and thus ecological studies are premature for this decision. Short-tem risk studies (for example, impacts to workers) may be important in determining how component closure should be implemented.

3.5.6 Sources of Contaminants

All sources of contamination will be considered. These shall include waste remaining in tanks, waste remaining in tank farm auxiliary facilities, tank waste in the soils, and tank waste in the groundwater. Impacts from sources in the tank farm or WMA shall be compared with the impacts from all Hanford Site sources.

All significant contaminants (whether radiological or chemical) will be analyzed. A screening analysis (in the manner of that performed for the ILAW PA [Mann et al. 2001]) will be part of the document. Contaminants are not considered significant if they are part of the set of contaminants that provide less than 10% of the expected response to the analyzed metric.

3.5.7 Types of Data Needed

Inventory and contaminant transport data will be obtained from the corresponding Post-retrieval Tank Performance Analysis (Section 3.5). Additional information needed is release rates from any grouted materials, hydraulic properties of the fill material as well as degradation rates for man-made structures (such as the proposed surface barrier, the tank, and man-made fill materials).

3.5.8 Numeric Calculations Performed

Numeric simulations will be performed for the residual waste in tank and for waste released from the tank. The simulations for residual waste will include the effects of tank degradation as well as effects from tank filler material.

Key contaminants, as determined from screening calculations, will be explicitly modeled. Other contaminants will be grouped with key contaminants having similar physical and chemical properties. Sensitivity cases will be performed to determine the sensitivity of assumptions and the values of key data.

3.5.9 Analysis

The analysis should provide a "reasonable expectation" of whether tank component closure as planned protects human health and the environment. For those data, processes, and assumptions that are most significant to the results, sensitivity and uncertainty analyses will be performed to establish the reasonable expectation.

The analysis will put all results in context with other tanks/systems in the tank farm or the WMA as well as in context of other past and expected releases from the Hanford Site Central Plateau.

3.5.10 Quality

The quality of the Pre-Closure Tank Performance Analyses should assume approval would be by DOE/headquarters and by the Head of the Nuclear Waste Division of Ecology.

3.5.11 Relationship with Other Categories

The Pre-Closure Tank Performance Analyses will build on the data, process, models, and insights gained in the FIRs and the Post-Retrieval Performance Analyses. Following performance analyses will build on the release rates for residual materials in closed tanks estimated in this category of documents.

It is expected that as experience grows, the Post-Retrieval Performance Analysis and the Pre-Closure Tank Performance Analysis will merge into one document. After most of the tanks in a farm are closed, it is possible that the Pre-Closure Risk Tank Analyses for the remaining tanks will be combined with the Tank Farm Feasibility Study.

3.6 REQUIREMENTS FOR TANK FARM FEASIBILITY STUDY

3.6.1 Overview

These reports assess the impact of additional remediation work after the tanks in the tank farm or WMA have been component closed. It is expected to mainly affect tank farm soils and auxiliary equipment. Most of the data and numeric simulations should have been gathered or performed by earlier analyses.

Depending on the amount and source of contamination, there may be interim tank farm feasibility studies to address the contamination. These reports will build on the Field Investigation Reports described in Section 3.3 and the pre-closure performance analyses described in Section 3.6.

3.6.2 Decisions Supported

The Tank Farm Feasibility Studies support the decision on what additional remediation is needed after tanks in the tank farm or WMA have been component closed. It is expected to mainly affect tank farm soils and auxiliary equipment.

3.6.3 Scope

The Tank Farm Feasibility Studies cover all long-term risk information needed for the regulators to allow closure of the tank farm or WMA. Short-term risks will be documented separately.

3.6.4 When Submitted

The reports should be submitted after all tanks in the tank farm or WMA have been filled and isolated from the rest of the tank far system (component closed).

3.6.5 Types of Analyses

The following type of analyses will be covered

- Long-term human health and environment analysis of groundwater pathway (include impacts on surface waters)
- Long-term human health and environmental analysis of the air pathway
- Long-term human health analysis assuming inadvertent intrusion
- Ecological risk analysis

Short-term risk analyses will be required for all activities under consideration, but will be documented separately.

3.6.6 Sources of Contaminants

All sources of contamination will be considered. These shall include waste remaining in tanks, waste remaining in tank farm auxiliary facilities, tank waste in the soils, and tank waste in the groundwater. Impacts from sources in the tank farm or WMA shall be compared with the impacts from all Hanford Site sources.

All significant contaminants (whether radiological or chemical) will be analyzed. A screening analysis (in the manner of that performed for the ILAW PA [Mann et al. 2001]) will be part of the document. Contaminants are not considered significant if they are part of the set of contaminants that provide less than 10% of the expected response to the analyzed metric.

3.6.7 Types of Data Needed

Inventory, contaminant transport parameters, and other data needed for the numeric calculations are assumed to be available from previous work. Further work to determine inventory data for tank farm soils and/or auxiliary facilities may be needed. Information about engineering options (for example, soil removal efficiency, barrier placement and performance) will be required.

3.6.8 Numeric Calculations Performed

Numeric simulations will be performed for all residual waste in the tank farm or waste management area. The simulations for residual waste will include the effects of material degradation as well as effects from tank filler material.

Key contaminants, based on screening calculations, will be explicitly modeled. Other contaminants will be grouped with key contaminants having similar physical and chemical properties. Sensitivity cases will be performed to determine the sensitivity of assumptions and the values of key data.

3.6.9 Analysis

The analysis should provide a “reasonable expectation” of whether tank farm or WMA closure as planned protects human health and the environment would require additional retrieval. For those data, processes, and assumptions that are most significant to the results, sensitivity and uncertainty analyses will be performed to establish the reasonable expectation.

The analysis will put all results in context with other tanks/systems in the tank farm or the WMA as well as in context of other past and expected releases from the Hanford Site Central Plateau.

3.6.10 Quality

The quality of the Tank Farm Feasibility Studies should assume approval would be by DOE/headquarters and by the Head of the Nuclear Waste Division of Ecology.

3.6.11 Relationship with Other Categories

The Tank Farm Feasibility Study will build on the data, process, models, and insights gained in the earlier performance analyses. The Tank Farm Closure Performance Analysis will validate the closure efforts proposed in this category of documents based on the actual closure implementation.

After most of the tanks in a farm are closed, it is possible that the Pre-Closure Risk Tank Analyses for the remaining tanks will be combined with the Tank Farm Feasibility Study.

3.7 REQUIREMENTS FOR TANK FARM CLOSURE PERFORMANCE ANALYSIS

3.7.1 Overview

These reports assess whether the closure activities specified in earlier documents (tank closure performance analysis, and tank farm feasibility study) have been sufficient to remediate the tank farm or WMA. It is expected that this will be the last performance analysis dealing explicitly with the tank farm and WMA, and that its results will feed the performance assessment supporting final Hanford Site closure. This performance analysis is also expected to meet the DOE requirements under DOE O 435.1 for a closure performance assessment.

It is expected that data collection and numeric analyses will be minor, as previous documents should have provided the information.

3.7.2 Decisions Supported

The Tank Farm Closure Performance Analyses support the decision on whether additional remediation is necessary to close the tank farm or WMA and enter into the post-closure monitoring phase.

3.7.3 Scope

These reports cover all long-term risk information necessary to make the decision that remediation has been completed. Short-term risks will be documented separately. Information provided should be sufficient to satisfy RCRA, Comprehensive Environmental Response, Compensation, and Liability Act, and DOE Order requirements.

3.7.4 When Submitted

The Tank Farm Closure Performance Analyses should be submitted after all remediation in the tank farm or WMA (with the possible exception of placement of the final closure barrier) is complete.

3.7.5 Types of Analyses

The following type of analyses will be covered:

- Long-term human health and environment analysis of groundwater pathway (include impacts on surface waters).
- Long-term human health and environmental analysis of the air pathway.
- Long-term human health analysis assuming inadvertent intrusion.
- Long-term ecological risk analysis.
- Short-term risk analysis of remediation options considered.

Additional types of risk analysis may be needed as more experience is obtained in closing tank farm systems.

3.7.6 Sources of Contaminants

All sources of contamination will be considered. These shall include waste remaining in tanks, waste remaining in tank farm auxiliary facilities, tank waste in the soils, and tank waste in the groundwater. Impacts from sources in the tank farm or WMA shall be compared with the impacts from all Hanford Site sources. All significant contaminants (whether radiological or chemical) will be analyzed. Contaminants are not considered significant if they are part of the set of contaminants that provide less than 10% of the expected response to the analyzed metric.

3.7.7 Types of Data Needed

It is expected that data and numeric analyses needed will have been gathered or performed previously. If conditions (e.g., new data, different designs, and different implantations) have changed to make previous work unreliable, then new data and/or numeric simulations will have to be collected or run. It is expected that where the inventory and/or release of such contaminants are significant to the impacts estimated, the values used will be based on measurement.

3.7.8 Numeric Calculations Performed

It is expected that data and numeric analyses needed will have been gathered or performed previously. If conditions (e.g., new data, different designs, and different implantations) have changed to make previous work unreliable, then new data and/or numeric simulations will have to be collected or run.

3.7.9 Analysis

The analysis should show whether a "reasonable expectation" exists that no further remediation activities are needed. For those data, processes, and assumptions that are most significant to the results, sensitivity and uncertainty analyses will be performed to establish the reasonable expectation.

3.7.10 Quality

The quality of the Tank Farm Closure Performance Analyses should assume approval would be by DOE headquarter, Environmental Protection Agency (EPA) Regional 10 office, and by the Head of the Nuclear Waste Division of Ecology.

3.7.11 Relationship with Other Categories

This is the final performance analysis for the tank farm or WMA.

4.0 CONTENTS OF MASTER PERFORMANCE ASSESSMENT

The contents of the master performance assessment are based on the guidance for DOE's low level waste performance assessments: *Format and Content Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses* (DOE 1999). However, changes have been made to enhance rapid updates and to meet additional requirements of the Washington State Department of Ecology. The Basic Structure is displayed in Table 3.

Table 3. Major Sections of Master Performance Assessment

Chapter Label	Section Description
-	Executive Summary
1.	Introduction
2.	Background
3.	Analyses of Performance
4.	Results of Analyses (Groundwater, Surface Water, Air)
5.	Other Analyses (Intruder Risk, Worker Risk)
6.	Interpretation of Results
7.	Performance Evaluation
8.	Preparers and Major Reviewers
9.	References
Appendices	Appendix Label
A	Current Inventory Estimates
B	Other Changes Since Last Major Revision
C	Current Impact Estimates
D	Governing Equations Used in Major Codes
E	Dosimetry Factors
F	Quality Assurance
G	Detailed Results
H	Other Information

4.1 EXECUTIVE SUMMARY

This section should contain a summary of the master performance assessment, highlighting the features of each section of the document that are important to an understanding of the performance assessment and its results. The summary should also include a summary comparison of the assessment results to applicable performance measures and discussion of uncertainties, resulting constraints on performance (e.g., which pathways are significant to operational controls on waste receipts), and conditions, as appropriate.

4.2 CHAPTER 1 - INTRODUCTION

This chapter should establish the purpose and scope of the master performance assessment. The information included in this section should provide an overview of the approach taken in the assessment, including a summary of the contents of the assessment, and the relationship of the tank farm system to existing programs at the DOE site. The relationship of the assessment with other relevant documents associated with the tank farm system should be provided. Major assumptions regarding the tank farm system facility that are critical to the analysis of performance should be identified along with the performance criteria used in the performance assessment for demonstrating compliance with DOE O 435.1, RCRA, and CERCLA. The sections of Chapter 1 are

- 1.1 Purpose (This section of the assessment should explain the approach taken in preparation of the document, including citations or references to any relevant background material and previously published documents which contributed to defining the scope of the performance assessment.)
- 1.2 Tank System Description (This section should present a general description of the facility and its location. This section should provide a basic overall description of the facility and waste operations, without referring to other sections of the assessment, which is sufficient to understand the following sections of the introduction. This section should also contain a brief description of the chronology for the operating life cycle of the facility that is relevant to the analyses in the assessment.)
- 1.4 Tank Farm Program (This section should provide a brief description of the various parts of the Tank Waste System and their responsibilities. A chronology of future actions should also be provided.)
- 1.5 Related Documents (This section of the assessment should present a discussion of all applicable relationships between the waste management assessments, plans, and evaluations at the DOE site to provide the site-specific regulatory context within which the performance assessment has been prepared (e.g., closure, monitoring, and land-use plans, site treatment plans, environmental impact statements, ground water protection management plans). This section should also describe any institutional relationships, agreements, or commitments that may affect the performance criteria for the disposal facility.)
- 1.6 Performance Objectives (This section should describe each performance criteria used to assess the performance of the facility. These criteria include the performance measures in DOE O 435.1, as well as the appropriate RCRA (as implemented by the State of Washington) and CERCLA requirements. This section should include an explicit listing of all applicable performance criteria for the facility.)
- 1.7 Approach and Major Data Sources (This section should highlight key assumptions used in the assessment that are most critical to the analysis of performance. The significance of these assumptions should be put into context by explaining their relevance to the controlling pathways or scenarios analyzed. Certain key assumptions may be associated with

uncertainties or data gaps. These assumptions should be presented in such a way that the implications of the uncertainty and the actions needed to reduce the uncertainty are clearly understood.

1.8 Structure of the Assessment

4.3 CHAPTER 2 – SYSTEM DESCRIPTION

This chapter should provide descriptive information and data for the Hanford site, environment, tank waste system, and waste characteristics to provide the basis for the conceptual model of the facility and site, and to support a thorough understanding of the method of analysis. The information in this section comprises a much more detailed description than that presented in Section 1.2. The emphasis of information in this section should be on those characteristics that are important to the performance of the system, the source term models, the transport models, and the dose analysis. The sections of Chapter 2 are

2.1 Overview

2.2 Hanford Site Characteristics (This section of the assessment should present the relevant natural and demographic characteristics and data for the site and surrounding area. The level of detail included in this section should be sufficient to provide a basis for the conceptual model of the site and facility behavior, and the modeling assumptions made in the performance analysis. The assessment shall address reasonably foreseeable natural processes than might disrupt barriers against release and transport of radioactive materials. These processes, including such events as severe storms, tornados, and seismic events, should be discussed as appropriate. Appropriate subsections of Section 2.2 are

- 2.2.1 Geography and Demography (Consisting of 2.2.1.1 Disposal Site Location, 2.2.1.2 Disposal Site Description, 2.2.1.3 Population Distribution, and 2.2.1.4 Uses of Adjacent Lands)
- 2.2.2 Meteorology and Climatology
- 2.2.3 Ecology
- 2.2.4 Geology, Seismology, and Volcanology (Consisting of 2.2.4.1 Regional and Site-Specific Geology / Topography, 2.2.4.2 Seismology, and 2.2.4.3 Volcanology)
- 2.2.5 Hydrology (Consisting of 2.2.5.1 Surface Water and 2.2.5.2 Groundwater)
- 2.2.6 Geochemistry
- 2.2.7 Natural Resources (Consisting of 2.2.7.1 Geologic Resources and 2.2.7.2 Water Resources)
- 2.2.8 Natural Background Radiation

2.3 Physical Description of Tank Farms (This section should provide sufficient description of the tank farms and their design features to provide a basis for evaluating long-term performance of the facility. Detailed descriptions and data should be provided, as necessary, for all design features of the facility directly related to the conceptual model for the facility and the analysis of performance. The information included should address the principal design features of the facility that contribute to the long-term isolation of the waste to the extent necessary to justify any design information used in the conceptual model of the facility, or associated with key assumptions or parameters in the assessment of performance. Appropriate subsections of Section 2.3 are

2.3.1 Summary
2.3.2 Generalized History of Tank Farms
2.3.3 Generalized description of tank farm components
2.3.4 Detailed description of farm (History/Size/Components)
Water Infiltration
2.3.2 Disposal Unit Cover Integrity
2.3.3 Structural Stability
2.3.4 Inadvertent Intruder Barrier

2.4 Tank Waste Characteristics (This section should provide information and data of the inventory considered in the assessment that includes waste volumes, concentrations and inventories of radionuclides, and chemical and physical characteristics of the waste forms that affect the source term calculations. The focus of this discussion should be on those characteristics that are included in the conceptual model of the closed facility and the modeling of the facility performance. Waste characteristics excluded from the conceptual model of the facility or the detailed analysis of the performance of the facility should be justified as contributing to the conservatism of the analyses or having an insignificant effect on the results of the analysis. This section should provide sufficient information for a reader to conclude the wastes analyzed in the assessment are complete, logically determined, technically correct, rigorous, and defensible. Appropriate subsections of 2.4 are

- 2.4.1 Summary
- 2.4.2 Processing (Overview/Bismuth Phosphate/ REDOX/ PUREX/Uranium Recovery/Isotope Separation/ Special Campaigns)
- 2.4.3 Sources of Information (Tank Sampling/BBI/Field Investigations)
- 2.4.4 Waste by farm

2.5 Retrieval/Closure Plans (This section should provide sufficient description of the planned retrieval and closure activities and their design features to provide a basis for evaluating long-term performance of the closed facility. Detailed descriptions and data should be provided, as necessary, for all design features of the facility directly related to the conceptual model for the closed facility and the analysis of performance. Appropriate subsections of Section 2.5 are

2.5.1 Summary
2.5.2 Retrieval (Methods/Plans)
2.5.3 Closure (Overview/Plans/Tank Fill/Soil remediation/ Other remediation/ Surface Barriers)

4.4 CHAPTER 3 - ANALYSIS OF PERFORMANCE

The purpose of this chapter is to provide the technical basis for the determination of a reasonable expectation of acceptable performance of the facility over time, based on the total radionuclide and chemical inventory of the waste. The analysis should be directed toward providing results to demonstrate the performance criteria for the all-pathways, air pathways, and water resource impact assessment are met. The analysis may also provide results which calculate allowable concentration or inventory limits in waste that meet the performance criteria for the disposal facility. The sections of Chapter 3 are

3.1 Overview (A brief overview of the method of analysis for the LLW disposal facility should be provided in this section. This overview should be an abstract of the detailed analysis which follows. Most importantly, this overview should provide an integration of the data presented in Chapter 2 concerning the site, facility, and waste characteristics that is the basis of the conceptual model for the disposal facility. This section should provide the scope and framework for the conceptual model, and the detailed method of analysis which follows.)

3.2 Inventory (This section should provide the conceptual model for inventory. Uncertainties in the various process included in the conceptual inventory model that are associated with gaps in knowledge should also be identified, and the potential significance of the uncertainties discussed. The conceptual inventory model discussion should provide the reader with sufficient information to understand the relationship between the detailed elements of the analysis of performance, and to clearly understand the basis, logic and rigor of the method of analysis. Appropriate subsections of Section 3.2 are

- o 3.2.1 Overview
- o 3.2.2 Selection of Contaminants of Concern
- o 3.2.3 What Inventories are Determined for This Analysis
- o 3.2.4 Conceptual Models for Release Rates

3.3 Pathways and Scenarios (This section should present the conceptual model of the performance of the site and the facility. The conceptual model should present all of the elements of the detailed analysis of performance from geology to the exposed individuals. The conceptual model discussion should include references and citations to geochemical, geologic, meteorologic and hydrologic data, and to other analyses or investigations that justify the conceptual model as being technically correct and rigorous. Uncertainties in the behavior of the site or the facility included in the conceptual model that are associated with gaps in knowledge should also be identified, and the potential significance of the uncertainties discussed. The conceptual model discussion should provide the reader with sufficient information to understand the relationship between the detailed elements of the analysis of performance, and to clearly understand the basis, logic and rigor of the method of analysis. Appropriate subsections of Section 3.3 are

- o 3.3.1 Selection Criteria
- o 3.3.2 Pathways
- o 3.3.3 Contaminant Release Scenario
- o 3.3.4 Contaminant Transport
- o 3.3.5 Exposure Scenarios

3.4 Values and Assumptions (This section provides the detailed discussion of the method of analysis. This section should provide a clear description of any mathematical models used for the source term. The description of the mathematical models and their structure, and the basis for selecting the mathematical models should be presented, with supporting information presented in the appendices. Models selected for the analysis of the source term should be documented and verified in referenced publications or in the appendices. The mathematical models used should be justified and provide a reasonable representation of the mechanisms identified in the conceptual model. The complexity of the models selected should be commensurate with the available data associated with the wastes and the facility. The models should have the capability of providing results that will support the analysis of the transport of radionuclides for evaluating the selected performance objectives. The method of analysis should include a description and justification of any credits for engineered features, waste forms, or waste packaging included in the modeling. Any additional assumptions included in the development of the model, inputs to the model, or linkages to other models used to analyze the performance of the facility should be identified, justified, and consistent with the conceptual model. Verification of the mathematical models for the source term for the site-specific application should be presented, and include comparisons to existing data or related investigations. The initial conditions, boundary conditions, and changes of properties with time should be justified, and derived from existing site data or information. Parametric representations in the mathematical models of natural processes should be discussed. The parametric values used in the modeling should be identified and justified, and based on site data, laboratory data, or referenced literature sources that are applicable to the site. Any uncertainties associated with parameters or parameter values should be identified. Appropriate subsections of Section 3.4 are

- o 3.4.1 Selection Criteria
- o 3.4.2 Key Assumptions
- o 3.4.3 Source Term [Appendix A provides the final listing of inventories to be evaluated in the assessment.]
- o 3.4.4 Environmental Transport of Radionuclides
- o 3.4.5 Impacts Analysis

3.5 Performance Assessment Methodology (This section defines the base analysis cases and other cases needed to understand the performance of the facility. Justification should be provided for the selection of the base analysis case. Justification should also be provided for the inclusion and exclusion of the sensitivity cases.) Appropriate subsections of Section 3.5 are

- o 3.5.1 Integration
- o 3.5.2 Computer Codes
- o 3.5.3 Computer models
- o 3.5.4 Input Data for Base Analysis Case
- o 3.5.5 Sensitivity Cases

4.5 CHAPTER 4 - RESULTS OF ANALYSES

This chapter of the assessment should present the results of the method of analysis described in Chapter 3. The results should include the presentation of intermediate results from the various models in the analysis, and the results of the dose analysis for the exposure pathways and scenarios selected for demonstrating compliance with the performance criteria. This section should also include an analysis of the sensitivity and uncertainty of the results, which addresses the sensitivity and uncertainty of the models used and their application in the analysis. Tabular and graphical presentations of the summary of the calculations for the various source term calculations should be presented with references to the appendices for additional detailed listings of inputs and outputs of the analysis, if necessary. Explanations of the results should be included to provide an understanding of the linkage of these results with the other results presented in this chapter. The discussion should demonstrate the results are consistent with available site monitoring data and supporting field investigations that have been completed. The discussion of the results should demonstrate the results are defensible and conservative representations of performance. The sections of Chapter 4 are

4.1 Introduction
4.2 Comments on Calculations
4.3 Results of Groundwater Scenarios: Base Analysis Case
4.4 Sensitivity Cases: Moisture Flow into the Facility
4.5 Sensitivity Cases: Contaminant Release
4.6 Sensitivity Cases: Vadose Zone Moisture Flow and Contaminant Transport
4.7 Sensitivity Cases: Groundwater Flow and Contaminant Transport
4.8 Sensitivity Cases: Other Factors
4.9 Sensitivity Cases: Extreme Cases
4.10 Cumulative Impacts from Hanford Site Activities
4.11 Summary of Groundwater Pathway Cases
4.12 Effects of Releases to Air
4.13 Effects from Biotic Pathways
4.14 Effects of Catastrophic Events
4.15 ALARA Analysis

4.6 CHAPTER 5 - RESULTS FOR OTHER ANALYSES

This chapter presents the results of other analyses. One such analysis has so far been established:

- Inadvertent Intruder Analysis for Radionuclides

Other analyses may be identified in the future.

This chapter should present the analyses of the doses to a hypothetical individual who inadvertently intrudes into the facility, assuming a temporary lapse of institutional control. The purpose of the inadvertent intruder analysis is to provide a surrogate for the determination of that the radioactive waste is acceptable for near-surface disposal. The inadvertent intruder analysis does not have the purpose of protecting future members of the public. As a result, the ingestion of contaminated water need not be considered as part of the inadvertent intruder analysis, because the protection of water resources is considered explicitly as one of the performance objectives for the assessment. This section should present the method for performing the inadvertent intruder analysis, and the results of that analysis. Any credits for the long-term performance of barriers that would discourage intrusion and are included in the analysis of intrusion should also be identified and justified (e.g., historical examples of longevity for similar materials, analysis of degradation rates). Models and exposure scenarios to be used in the analysis should be described and justified. The basis for selecting any numerical models used for analysis should be presented. The documentation for the models should be referenced or included, and verification of the model should be provided. The exposure scenarios considered for inadvertent intrusion should be consistent with conservative representations of potential exposures to individuals to average concentrations of radionuclides in wastes, and consider direct intrusion into the closed facility and exhumation of accessible wastes. Relevant chronic exposure scenarios to be considered include agricultural, residential, and post drilling that incorporates ingestion of foodstuffs, ingestion of soil, external exposure, and inhalation of resuspended particles. Relevant acute exposure scenarios to be considered include discovery, construction and drilling that incorporate external exposure, inhalation of resuspended particles, and ingestion of particles.

4.7 CHAPTER 6 - INTERPRETATION OF RESULTS

This chapter should provide an interpretation of results presented in Chapters 4 and 5. The many different results presented in these sections should be reviewed and consolidated to provide a reasoned basis for evaluating the performance of the facility. The interpretation of results should address the findings of the sensitivity and uncertainty analyses to provide an overall estimate of the expected performance of the facility that is defensible for each of the performance criteria for the time of compliance at the points of compliance. The interpretation of results should provide a rational basis to conclude the performance of the facility has been completely addressed, the analysis is logically interpreted, the results are correct representations of the facility performance, and the results are sufficiently rigorous. Sections of Chapter 6 are

6.1 Overview
6.2 Integration of Results
6.3 Verification of Assessment Results
6.4 Basis for Waste Limits

4.8 CHAPTER 7 - PERFORMANCE EVALUATION

This chapter provides an evaluation of the assessment results with respect to the performance objectives. The implications and applications of the results of the assessment for site characterization, monitoring, operations, and other regulatory related issues as necessary or appropriate should be discussed. Sections of Chapter 7 are

7.1 Overview
7.2 Comparison of Estimated Impacts to Performance
7.3 Performance Sensitivity to Key Parameter Uncertainties
7.4 Conservatisms and Caveats
7.5 Requirements Set by Performance Assessment
7.6 Summary of the Impact of Differences between Previous Assessments and This Document
7.7 Further Work
7.8 Conclusions

4.9 CHAPTER 8 - PREPARERS AND MAJOR REVIEWERS

This section should list the preparers of the performance assessment, including their qualifications.

4.10 CHAPTER 9 -REFERENCES

This section should contain the complete citations for references cited in the assessment.

4.11 APPENDIX A - CURRENT INVENTORY ESTIMATES

This appendix provides the current estimates for each tank farm for the following sources:

- Inventories and distributions resulting from past leaks
- Inventories resulting from potential future leaks (e.g., retrieval leaks)
- Inventories left in facilities (including tanks, pipelines, and other facilities).

The methods for obtaining these estimates will be described in the main text. However, this appendix will provide details not presented in the main text that are necessary to understand how the numeric estimates were derived.

The purpose of this appendix is to have a readily identified section of the assessment that has the current estimates of inventories as it is likely that such estimates will undergo the most rapid change of the parameters used in the assessment. Section A.1 will contain tables having the currently estimated inventories.

The following sections in Appendix A will summarize the reasons for changes in the estimates. Such changes are expected to occur because of

- Retrieval actions (pans and implementations)
- Laboratory measurements of residual inventory samples
- Field investigations of soils
- Updates to the Best Basis Inventory.

Each subsection of Appendix A will describe the changes from the previous update, with Section A.2 describing the changes from the last full revision of the assessment.

4.12 APPENDIX B – OTHER CHANGES SINCE LAST MAJOR REVISION

This appendix describes other changes in data or methods that impact the results. Such changes are expected to occur more slowly than changes in inventory. The sections of Appendix B are structured based on the subject matter:

B.1 Moisture Infiltration

B.2 Near-Field Moisture Flow

B.3 Contaminant Release

B.4 Near-Field Contaminant Transport

B.5 Vadose Zone Moisture Flow and Contaminant Transport (Geology, Hydrology, Geochemistry)

B.6 Groundwater Flow and Transport

B.7 Dosimetry

Each section would be subdivided into subsections that provide a chronological update of the changes made in the discipline since the last full revision of the assessment.

4.13 APPENDIX C – CURRENT IMPACT ESTIMATES

This appendix provides the current estimates for the various metrics calculated. The purpose of this appendix is to have a readily identified section of the assessment that displays the current estimates of impacts. Section C.1 will contain tables having the currently estimated impacts.

The following sections in Appendix C will summarize the reasons for changes in the estimates. Each subsection of Appendix C will describe the changes from the previous update, with Section C.2 describing the changes from the last full revision of the assessment.

4.14 APPENDIX D – GOVERNING EQUATIONS USED IN MAJOR CODES

This appendix provides the major equations used in the analysis, the reasons such equations were chosen, and a description of the parameters in the equations. The appendix should be divided by subject matter.

4.15 APPENDIX E – DOSIMETRY FACTORS

This appendix provides the detailed data in tables supporting the conversion of contaminant concentrations in various media (water, soil, air) into various impacts (doses, ILCR, etc.).

4.16 APPENDIX F – QUALITY ASSURANCE

This appendix describes the quality assurance program for the assessment. Included in this appendix or in the main should be quality assurance activities for computer codes and the simulations created using them.

4.17 APPENDIX G - DETAILED RESULTS

This appendix should contain detailed results useful for the reader, but if placed in the main text would divert from the readability of the document.

4.18 APPENDIX H – OTHER INFORMATION

This appendix should provide other information useful for the reader to know but is not needed to understand the results. Examples could be

- Reviews of the previous full revision
- New requirements
- Background information

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