Summary

This Hanford Site environmental report is prepared annually to summarize environmental data and information, to describe environmental management performance, to demonstrate the status of compliance with environmental regulations, and to highlight major environmental programs and efforts.

The report is written to meet requirements and guidelines of the U.S. Department of Energy (DOE) and to meet the needs of the public. This summary has been written with a minimum of technical terminology.

Individual sections of the report are designed to

- describe the Hanford Site and its mission
- summarize the status of compliance with environmental regulations
- describe the environmental programs at the Hanford Site
- discuss the estimated radionuclide exposure to the public from 1999 Hanford Site activities
- present the effluent monitoring, environmental surveillance, and groundwater protection and monitoring information
- discuss the activities to ensure quality.

More detailed information can be found in the body of the report, the cited references, and the appendixes.

The Hanford Site and its Mission

The Hanford Site in southcentral Washington State is ~1,517 square kilometers (586 square miles) of semiarid shrub and grasslands located just north of the confluence of the Snake and Yakima Rivers with the Columbia River. This land, with restricted public access, provides a buffer for the smaller areas historically used for the production of nuclear materials, waste storage, and waste disposal. Approximately 6% of the land area has been disturbed, is actively used, and is divided into operational areas:

- the 100-B,C, 100-D, 100-F, 100-H, 100-K, and 100-N Areas, which lie along the south shore of the Columbia River in the northern portion of the Hanford Site (containing reactors used primarily for plutonium production; now all shut down)
- the 200-East and 200-West Areas, which lie in the center of the Hanford Site near the basalt outcrops of Gable Mountain and Gable Butte (formerly used for plutonium processing; now focused on waste management)
- the 300 Area, near the southern border of the Hanford Site (containing laboratories, support facilities, and former reactor fuel manufacturing facilities)
- the 400 Area, between the 300 and 200 Areas (home of the Fast Flux Test Facility)
- the Richland North Area, in the northern part of the city of Richland (includes leased office buildings for DOE and its contractors).

The 600 Area is the land between the operational areas. Areas off the Hanford Site used for research and technology development and administrative functions can be found in Richland, Kennewick, and Pasco, the nearest cities.

The Hanford Site was acquired by the federal government in 1943 and, until 1989, was dedicated primarily to the production of plutonium for national defense and the management of the resulting wastes. With the shutdown of the production facilities in the 1970s and 1980s, DOE ended the production of nuclear materials for weapons at the Hanford Site. The current mission being implemented by DOE is now:

- waste management, environmental restoration, and facilities stabilization
- research and technology development.

Current waste management at the Hanford Site focuses primarily on managing wastes with high and low levels of radioactivity (from the nuclear materials production activities) in the 200-East and 200-West Areas. Key waste management facilities include the underground waste storage tanks, Environmental Restoration Disposal Facility, Central Waste Complex, low-level burial grounds, 200 Areas Effluent Treatment Facility, Waste Receiving and Processing Facility, 242-A Evaporator, State-Approved Land Disposal Site, Liquid Effluent Retention Facility, and 200 Areas Treated Effluent Disposal Facility. In addition, irradiated nuclear fuel is stored in the 100-K Area in fuel storage basins.

Environmental restoration includes activities to decontaminate and decommission facilities and to clean up or restore inactive waste sites. The Hanford surplus facilities program conducts surveillance and maintenance of such facilities; the cleanup and disposal of more than 100 facilities have begun.

Development of research and technology capabilities is intended to improve the techniques and reduce the costs of waste management, environmental protection, and site restoration.

DOE manages operations on the Hanford Site through six prime contractors and numerous subcontractors. Each contractor is responsible for the safe, environmentally sound maintenance and management of its facilities and operations, management of its wastes, and monitoring of its operations and effluents for environmental compliance.

The principal contractors include the following:

- Fluor Hanford, Inc.
- Battelle Memorial Institute
- Bechtel Hanford, Inc.
- Hanford Environmental Health Foundation
- CH2M HILL Hanford Group, Inc.
- MACTEC-ERS.

Non-DOE operations and activities include commercial power production by Energy Northwest (formerly known as the Washington Public Power Supply System) at its WNP-2 Reactor and operation of a commercial low-level radioactive waste burial site by US Ecology, Inc. Kaiser Aluminum and Chemical Corporation leases the 313 Building to operate a formerly DOE-owned extrusion press. The National Science Foundation built the Laser Interferometer Gravitational-Wave Observatory facility near Rattlesnake Mountain. R. H. Smith Distributing operates vehicle fueling stations in the former 1100 Area and the 200 Areas. Washington State University at Tri-Cities operates three laboratories in the 300 Area. Livingston Rebuild Center, Inc. leases the former 1171 Building in the former 1100 Area to rebuild train locomotives. Johnson Controls, Inc. operates 42 diesel and natural gas package boilers to produce steam in the 200 and 300 Areas and also has compressors that supply compressed air to the site. Immediately adjacent to the southern boundary of the Hanford Site, Siemens Power Corporation operates a commercial nuclear fuel fabrication facility and Allied Technology Group Corporation operates a low-level radioactive waste decontamination, supercompaction, and packaging disposal facility.

Compliance with Environmental Regulations

DOE Order 5400.1, "General Environmental Protection Program," describes the environmental standards and regulations applicable at DOE facilities. These standards and regulations fall into three categories: 1) DOE directives; 2) federal legislation and executive orders; and 3) state and local statutes, regulations, and requirements. The following summarizes the status of Hanford's compliance with applicable regulations.

A key element in Hanford's compliance program is the Hanford federal facility agreement and consent order (also known as the Tri-Party Agreement; Ecology et al. 1998). The Tri-Party Agreement is an agreement among the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology, and DOE for achieving compliance with the remedial action provisions of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) and with treatment, storage, and disposal unit regulation and corrective action provisions of the *Resource Conservation and Recovery Act* (RCRA). From 1989 through 1999, a total of 636 enforceable Tri-Party Agreement milestones and 253 unenforceable target dates were completed on or ahead of schedule. Forty-one milestones scheduled for 1998 were completed.

Comprehensive Environmental Response, Compensation, and Liability Act

This act established a program to ensure that responsible parties or the government cleans up sites contaminated by hazardous substances. The act primarily covers waste cleanup of inactive sites.

Preliminary assessments conducted for the Hanford Site revealed ~2,200 known individual waste sites where hazardous substances may have been disposed of in a manner that requires further evaluation to determine impact to the environment.

DOE is actively pursuing the remedial investigation/feasibility study process at some operable units on the Hanford Site. The operable units currently being studied were selected as a result of Tri-Party Agreement negotiations.

In 1999, the Hanford Site was in compliance with requirements of the act. Cleanup is under way at various areas on the site. Full-scale remediation of waste sites continued in the 100 and 300 Areas in 1999.

Emergency Planning and Community Right-To-Know Act

This act requires that the public be provided with information about hazardous chemicals in the community and establishes emergency planning and notification procedures to protect the public from a release. The act calls for creation of state emergency response commissions to guide planning for chemical emergencies. State commissions have also created local emergency planning committees to ensure community participation and planning.

To provide the public with the basis for emergency planning, the act contains requirements to report periodically on hazardous chemicals stored and/or used near the community. An updated material safety data sheet listing was issued in April 1999 to the State Emergency Response Commission, local county emergency management committees, and local fire departments. The listing consisted of 33 hazardous chemicals present in quantities exceeding minimum threshold levels, including three extremely hazardous substances. No subsequent updates to the listing were required during 1999. The 1999 Hanford Site Tier Two Emergency and Hazardous Chemical Inventory was issued in February 2000. During 1999, the Hanford Site was in compliance with the reporting and notification requirements contained in this act.

Resource Conservation and Recovery Act

This act establishes regulatory standards for the generation, transportation, storage, treatment, and disposal of hazardous wastes. The Washington State Department of Ecology has been authorized by EPA to implement its dangerous waste program except for some provisions of the Hazardous and Solid Waste Amendments of 1984. The Washington State Department of Ecology implements the state's regulations, which are often more stringent. The act primarily covers ongoing waste management at active facilities.

The Hanford Site is considered a single facility with over 70 treatment, storage, and disposal units. The Tri-Party Agreement recognized that all of these units could not be issued permits simultaneously, and a schedule was established for submitting unit-specific permit applications and closure plans to the Washington State Department of Ecology. During 1999, five Part A revisions and one new Part A application were submitted to the Washington State Department of Ecology. Two Part B applications were also submitted, and three closure-related documents were filed.

Subtitle I of the act deals with regulation of underground storage tank systems. The Hazardous and Solid Waste Amendments of 1984 added these regulations to the act. EPA developed regulations to implement technical standards for tank performance and management, including standards governing the cleanup and closure of leaking tanks. However, these regulations do not apply to the single- and double-shell waste tanks at Hanford, which are regulated as treatment, storage, and disposal facilities.

DOE and its contractors are working to resolve several outstanding notices of violation and warning letters of noncompliance from the Washington State Department of Ecology that were received following inspections in 1999. Each of the notices lists specific violations.

Clean Air Act

The purpose of the *Clean Air Act* is to protect public health and welfare by safeguarding air quality, bringing polluted air into compliance, and protecting clean air from degradation. In Washington State, EPA, Washington State Department of Ecology, Washington State Department of Health, and local air authorities implements the provisions of the act.

Washington State regulations require applicable controls and annual reporting of all radioactive air emissions. The Hanford Site operates under a license for such emissions. The conditions specified in the license will be incorporated into the Hanford Site air operating permit, scheduled to be issued in 2000.

Revisions to the act for radioactive air emissions were issued in December 1989. Emissions from the Hanford Site are within the state and EPA offsite emissions standard of 10 mrem/yr. Nearly all Hanford Site sources currently meet the procedural requirements for flow measurement, emissions measurement, quality assurance, and sampling documentation.

The local air authority (the Benton Clean Air Authority) regulations pertain to detrimental effects, open burning, odor, opacity, and asbestos handling. The authority has also been delegated responsibility to enforce the EPA asbestos regulations under the revised act.

There were several compliance findings following inspections by the Washington State Department of Health and the Washington State Department of Ecology in 1999. All but one were resolved by the end of calendar year 1999.

Clean Water Act

The *Clean Water Act* applies to point discharges to waters of the United States. At the Hanford Site, the regulations are applied through National Pollutant Discharge Elimination System permits that govern effluent discharges to the Columbia River. The permits specify discharge points (called outfalls), effluent limitations, and monitoring requirements. The National Pollutant Discharge Elimination System permits for the Hanford Site were revised and combined into a single permit in April 1999. The single permit covers all three active outfalls: one for the 300 Area Treated Effluent Disposal Facility and two at the 100-K Area. All other former outfalls are inactive. Several permit violations occurred at the

300 Area Treated Effluent Disposal Facility in 1999 despite the use of best available technology.

Safe Drinking Water Act

The National Primary Drinking Water Regulations of the *Safe Drinking Water Act* apply to the drinking water supplies at the Hanford Site and are enforced by the Washington State Department of Health. In 1999, all Hanford Site water systems were in compliance with requirements and agreements.

Toxic Substances Control Act

The requirements of the *Toxic Substances Control Act* are applied to regulate Hanford Site chemicals called polychlorinated biphenyls. The site is currently in compliance with an agreement to store these wastes beyond the regulatory limit. All radioactive polychlorinated biphenyl wastes are being stored pending development of treatment and disposal technologies and capabilities.

The EPA issued one Federal Facility Notice of Significant Noncompliance in early 1999 following inspections of the Hanford Site in 1998. The findings included 16 corrective actions. DOE Richland Operations Office submitted the required responses to the notice 16 days after the notice was issued.

Federal Insecticide, Fungicide, and Rodenticide Act

EPA is responsible for ensuring that a chemical, when used according to label instructions, will not present unreasonable risks to human health or the environment. This act and specific chapters of the Revised Code of Washington apply to storage and use of pesticides. In 1999, the Hanford Site was in compliance with these requirements.

Endangered Species Act

Many rare species of native plants and animals are known to occur on the Hanford Site. Two of these (bald eagle and the peregrine falcon) are listed by the U.S. Fish and Wildlife Service as endangered or threatened. Steelhead trout and spring chinook salmon are listed by the National Marine Fisheries Service. Other species are listed by the Washington State Department of Fish and Wildlife as endangered, threatened, or sensitive. Hanford Site activities complied with the requirements of this act in 1999.

National Historic Preservation Act, Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, Historic Sites Buildings and Antiquities Act, Archeological and Historic Preservation Act, and American Antiquities Preservation Act

Cultural resources on the Hanford Site are subject to the provisions of these acts. In 1999, the Hanford Site was in compliance with these acts.

National Environmental Policy Act

The *National Environmental Policy Act* establishes environmental policy to prevent or eliminate damage to the environment and to enrich our understanding of ecological systems and natural resources. This act requires that major federal projects that may significantly impact the environment be carefully reviewed and reported to the public in environmental impact statements. Other documents such as environmental assessments are also prepared in accordance with requirements of the act.

Several environmental impact statements related to programs or activities on the Hanford Site are in process or in the planning stage.

Environmental Occurrences

Onsite and offsite environmental occurrences (spills, leaks) of radioactive and nonradioactive effluent materials during 1999 were reported to DOE and other federal and state agencies as required by law. All emergency, unusual, and off-normal occurrence reports, including event descriptions and corrective actions, are available for review in the DOE Hanford Reading Room located on the campus of Washington State University at Tri-Cities, Richland, Washington. There were no emergency occurrence reports and one environmentally significant unusual occurrence report filed in 1999. There were several off-normal environmental release-related occurrence reports filed during 1999.

Environmental Management Services

Major contractors have issued Integrated Environment, Health, and Safety Management Systems plans at the Hanford Site. These programs, contractually mandated by DOE, are intended to protect the worker, public, and environment by integrating environment, health, and safety into the way work is planned and performed. An international voluntary consensus standard and DOE policy form the bases of the systems.

Waste Management and Chemical Inventories

Radioactive, hazardous, and mixed waste is generated at approximately 200 facilities on the Hanford Site. These wastes are handled and prepared for safe storage on the site or shipped off the site for treatment and disposal. In addition to newly generated waste, significant quantities of waste remain from over 50 years of nuclear material production. This waste from past operations at the Hanford Site resides in waste sites or is stored in several places awaiting cleanup and ultimate safe storage or disposal. Examples are high-level radioactive waste stored in single- and double-shell tanks and transuranic waste stored in vaults and on storage pads. Most of the environmental monitoring performed at the Hanford Site is focused on protecting the public from exposure to this waste and waste handling activities. See Section 2.5, “Waste Management and Chemical Inventories,” for details.

Environmental Monitoring Information

Environmental monitoring of the Hanford Site consists of effluent monitoring, environmental surveillance, and groundwater and vadose zone monitoring. Effluent monitoring is performed as appropriate by the operators at the facility or at the point of release to the environment. Additional monitoring is conducted in the environment near facilities that discharge, or have discharged, effluents. Environmental surveillance consists of sampling and analyzing environmental media on and off the site to detect and quantify potential contaminants and to assess their environmental and human health significance.

The overall objectives of the monitoring and surveillance programs are to demonstrate compliance with applicable federal, state, and local regulations; confirm adherence to DOE environmental protection policies; and support environmental management decisions.

Effluent Monitoring

Effluent monitoring includes facility effluent monitoring (monitoring effluents at the point of release to the environment) and near-facility environmental monitoring (monitoring the environment near operating facilities).

Facility Effluent Monitoring. Liquid and gaseous effluents that may contain radioactive and/or hazardous constituents are continually monitored at the Hanford Site. The monitoring is done mainly by collecting effluent samples near points where the effluent is released into the environment. These samples are analyzed for selected constituents and the results evaluated against federal, state, and local regulatory standards and permit requirements.

Effluent stream flows are determined mostly through the use of measuring instruments, with a lesser number calculated using process information. Effluents with the potential of containing radioactivity that may reach prescribed threshold levels are monitored for gross alpha and gross beta levels and, as warranted, specific gamma-emitting radionuclides. When warranted, nonradioactive hazardous constituents are also monitored.

The radioactivity in effluents released from most Hanford facilities is at or near levels practically indistinguishable from naturally occurring radioactivity present everywhere in the world. Cumulatively, these low levels contribute very little to the radiation dose received by people living in areas surrounding the site.

Near-Facility Environmental Monitoring. The near-facility environmental monitoring program is designed to protect the environment adjacent to Hanford facilities and to ensure compliance with federal, state, and local regulations. Specifically, this program monitored new and existing sites, processes, and facilities for potential impacts and releases; fugitive emissions and diffuse sources from contaminated areas; and surplus facilities before decontamination or decommissioning. Air, surface water, springs, surface contamination, soil, vegetation, external radiation, and investigative sampling (which can include wildlife) were sampled. Some of the parameters typically monitored are pH, radionuclide activities, radiation exposure levels, and concentrations of selected hazardous chemicals. Samples are collected from known or expected effluent pathways. These pathways are generally downwind of potential or actual airborne releases and downgradient of liquid discharges.

Near-Facility Air Monitoring. Radioactivity in air was sampled by a network of continuously operating samplers at 85 locations near nuclear facilities. Air samplers were primarily located within ~500 meters (1,500 feet) of sites and/or facilities having the potential for, or history of, environmental releases, with an emphasis on the prevailing downwind directions. Of the radionuclide analyses performed, strontium-90, cesium-137, plutonium-239/240, and uranium were consistently detected in the 100-K, 100-N, and 200 Areas. Cobalt-60 was consistently detected in the 100-N Area. Air levels for these radionuclides were elevated near facilities and compared to levels measured off the site.

100-N Springs Monitoring. Groundwater springs along the 100-N Area shoreline are sampled annually to verify the reported radionuclide releases to the Columbia River from past N Reactor operations. By characterizing the radionuclide concentrations in the springs along the shoreline, the results can be compared to the concentrations measured at the effluent monitoring well. In 1999, the radionuclide levels detected in samples from shoreline springs were highest in springs nearest the effluent monitoring well.

Near-Facility Radiological Surveys. In 1999, there were ~3,628 hectares (8,964 acres) of posted outdoor contamination areas and 594 hectares (1,468 acres) of posted underground radioactive materials areas, not including active facilities, at the Hanford Site. These areas were typically associated with burial grounds, covered ditches, cribs, and tank farms. The posted contamination areas vary between years because of an ongoing effort to clean, stabilize, and remediate areas of known contamination. During this time, new areas of contamination were being identified. It was estimated that the external dose rate at 80% of the identified outdoor contamination areas was less than 1 mrem/h measured at 1 meter (3.28 feet), though direct dose rate readings from isolated radioactive specks (a diameter of less than 0.6 centimeter [0.25 inch]) could have been considerably higher. Contamination levels of this magnitude did not significantly add to dose rates for the public or Hanford Site workers in 1999.

Soil and Vegetation Sampling from Operational Areas. Soil and vegetation samples were collected on or adjacent to waste disposal units and from locations downwind and near or within the boundaries of the operating facilities. Samples were collected to detect potential migration and deposition of facility effluents. Special samples were also taken where physical or biological transport problems were identified. Migration can occur as the result of resuspension from radioactively contaminated surface areas, absorption of radionuclides by the roots of vegetation growing on or near underground and surface-water disposal units, or by waste site intrusion by animals. Some radionuclide concentrations in soil and vegetation samples from near facilities were elevated when compared to concentrations measured off the site. The levels show a large degree of variance; in general, samples collected on or adjacent to waste disposal facilities had significantly higher radionuclide concentrations than those collected farther away.

Near-Facility External Radiation. External radiation fields were measured near facilities and waste handling, storage, and disposal sites to measure, assess, and control the impacts of operations.

Three new thermoluminescent dosimeter monitoring sites were established in the 100-H Area during late 1999 to evaluate environmental restoration activities at the 116-H-7 Water Retention Basin and the 116-H-1 Liquid Waste Disposal Trench. The 1999 average was comparable to offsite background levels.

Five thermoluminescent dosimeter locations in the 100-D,DR Area evaluated environmental restoration activities at the 116-D-7 and 116-DR-9 water retention basins. The 1999 readings were comparable to offsite background levels.

Thermoluminescent dosimeters are placed in the 100-K Area, surrounding the 105-K East and 105-K West Fuel Storage Basins (K Basins) and adjacent reactor buildings. Dose rates decreased noticeably in 1999 as the result of the removal of stored radioactive waste.

At the 100-N Area, the 1999 thermoluminescent dosimeter results indicate that direct radiation levels were again highest near facilities that had contained or received liquid effluent from N Reactor. These facilities primarily include the 1301-N and 1325-N Liquid Waste Disposal Facilities. The results for these two facilities were noticeably higher than those for other 100-N Area thermoluminescent dosimeter locations, and they were ~5% higher than exposure levels measured at these locations in 1998.

The highest dose rates in the 200/600 Areas were measured near waste handling facilities such as tank farms. The highest dose rate was measured at tank farm A (200-East Area). The average annual dose rate in the 200 Areas measured in 1999 was 110 mrem/yr, ~6% higher than the dose rate measured in 1998.

Ten thermoluminescent dosimeter locations around the perimeter of the Tank Waste Remediation System, Phase I demonstration project indicated that the 1999 dose rates were comparable to those observed in 1998, as well as offsite levels.

One new thermoluminescent dosimeter site was established in the 200 North Area in 1999. This location is at the 212-R (contaminated) Railroad Car Disposition Area. Results were, as expected, noticeably elevated.

Two thermoluminescent dosimeter locations at the Environmental Restoration Disposal Facility evaluate the disposal activities in progress. Readings in 1999 were comparable to offsite background levels.

The highest dose rates in the 300 Area were measured at the 316 process trench. The average annual dose rate measured in the 300 Area in 1999 was 110 mrem/yr, equal to the average measured in 1998. The average annual dose rate at the 300 Area Treated Effluent Disposal Facility in 1999 was 82 mrem/yr, a slight increase (1%) relative to the average dose rate measured in 1998.

The average annual dose rate measured in the 400 Area in 1999 was 87 mrem/yr, a decrease of 1% compared to the average dose rate measured in 1998.

Investigative Sampling. To confirm the absence or presence of radioactive or hazardous contaminants, or to verify radiological conditions at specific project sites, investigative samples were collected from across the Hanford Site in 1999.

Generally, the predominant radionuclides discovered during these efforts were activation products in the 100 and 200 Areas, and uranium in the 300 Area. Hazardous chemicals generally have not been identified above background levels in preoperational environmental monitoring samples.

Investigative samples in 1999 included soil, vegetation, nests, mammal feces, insects, and wildlife. The samples were collected where known or suspected radioactive contamination was present or to verify radiological conditions at project sites. In 1999, samples were analyzed for radionuclides and showed some level of contamination. In addition, samples were collected and disposed of without isotopic analyses, though field instrument readings were recorded.

Environmental Surveillance

Environmental surveillance at the Hanford Site includes monitoring environmental media on and off the Hanford Site for potential chemical and radiological contaminants originating from site operations. The media monitored included air, surface water and sediment, drinking water, food and farm products, fish, wildlife, soil, vegetation, and external radiation.

Air Surveillance. Radioactive materials in air were sampled continuously at 44 onsite locations, at the site perimeter, and in nearby and distant communities. Nine of these locations were community-operated environmental surveillance stations that were managed and operated by local school teachers. At all locations, particulates were filtered from the air and analyzed for radionuclides. Air was sampled and analyzed for selected gaseous radionuclides at key locations. Several radionuclides released at the site are also found worldwide from two other sources: naturally occurring radionuclides and radioactive fallout from historical nuclear activities not associated with Hanford. The potential influence of emissions from site activities on local radionuclide concentrations was evaluated by comparing differences between concentrations measured at distant locations within the region and concentrations measured at the site perimeter.

For 1999, no differences were observed between the annual average gross alpha air concentrations measured at the site perimeter and those measured at distant community locations concentrations. The site perimeter annual average gross beta air concentration was slightly higher than the distant community concentrations. Quarterly composite samples were analyzed for numerous specific gamma-emitting radionuclides; however, no radionuclides of Hanford origin were detected.

Annual average tritium concentrations for 1999 at the Hanford Site perimeter were not significantly different than annual average concentrations at the distant community locations. As a result of tritium studies in selected 300 Area facilities, 300 Area annual average concentrations in air were elevated when compared to other onsite locations. However, this effect did not increase annual average levels at site perimeter locations.

Iodine-129 concentrations were statistically elevated at the site perimeter compared to the distant locations, indicating a measurable Hanford source; however, the average concentration at the site perimeter was only 0.000001% of the DOE derived concentration guide of 70 pCi/m^3. The DOE derived concentration guide is the air concentration that would result in a radiation dose equal to the DOE public dose limit (100 mrem/yr).

The annual average strontium-90 concentrations at the Hanford Site perimeter were not significantly higher than the annual average levels at the distant community locations. The maximum level was 0.004% of the DOE derived concentration guide of 9 pCi/m^3.

Plutonium-239/240 concentrations were not significantly different for air samples collected at the site perimeter compared to the distant locations. The average concentration at the perimeter locations was less than 0.002% of the DOE derived concentration guide of 0.02 pCi/m^3.

Uranium isotopic concentrations (uranium-234, uranium-235, and uranium-238) were similar on the site, at the perimeter, and at the distant locations for 1999. The annual average uranium concentration at the site perimeter was 0.03% of the 0.1-pCi/m^3 DOE derived concentration guide.

No air samples were collected in 1999 to test for chemical contaminants.

Surface-Water and Sediment Surveillance. The Columbia River was one of the primary environmental exposure pathways to the public during 1999 as a result of past operations at the Hanford Site. Radiological and chemical contaminants entered the river along the Hanford Reach primarily through seepage of contaminated groundwater. Water samples were collected from the river at various locations throughout the year to determine compliance with applicable standards.

Although radionuclides associated with Hanford operations continued to be identified routinely in Columbia River water during the year, concentrations remained extremely low at all locations and were well below standards. The concentrations of tritium and iodine-129 were significantly higher (5% significance level) at the Richland Pumphouse (downstream from the site) than at Priest Rapids Dam (upstream from the site), indicating contribution along the Hanford Reach. Transect (multiple samples collected across the river) and near-shore sampling in 1999 revealed elevated tritium levels along the Benton County shoreline near the 100-N Area, Old Hanford Townsite, 300 Area, and Richland Pumphouse. Total uranium concentrations were elevated along the Franklin County shoreline near the 300 Area and the Richland Pumphouse and likely resulted from groundwater seepage and water from irrigation return canals on the east shore of the river that contained naturally occurring uranium.

Several metals and anions were detected in transect samples collected upstream and downstream of the site. Nitrate concentrations were slightly elevated along both the Benton County and Franklin County shoreline of the 300 Area and Richland Pumphouse transects. With the exception of nitrate, sulfate, and chloride, no consistent differences were found between average quarterly metal and anion contaminant concentrations in the Vernita Bridge and Richland Pumphouse transect samples. All metal and anion concentrations in Columbia River water collected in 1999 were less than the Washington State ambient surface-water quality criteria levels for both acute and chronic toxicity. Arsenic concentrations exceeded EPA standards; however, similar concentrations were found at Vernita Bridge (background location) and Richland Pumphouse.

In 1999, samples of Columbia River surface sediment were collected from monitoring sites above McNary Dam (downstream of the site), Priest Rapids Dam (upstream of the site), and from sediment deposited along the Hanford Reach (including some riverbank springs). In addition, sediment samples were collected behind Ice Harbor Dam on the Snake River. Strontium-90 was the only radionuclide to exhibit consistently higher median concentrations at McNary Dam compared to the other locations. In 1999, no other radionuclides measured in sediment exhibited appreciable differences in concentration between locations. The concentrations of radionuclides in sediment collected from riverbank springs were similar and were comparable to levels observed in 1999 river sediment. Detectable amounts of most metals were found in all river sediment samples with similar levels in riverbank springs sediment. River sediment was also analyzed for simultaneously extracted metals and acid volatile sulfide (SEM/AVS). The SEM/AVS ratios are typically a better indicator of sediment toxicity than traditional total metals concentrations. When the amount of sulfide exceeds the amount of the metals (SEM/AVS ratio is below 1), the metal concentration in the sediment porewater will be low because of the limited solubility of the metal sulfides. For 1999, the SEM/AVS molar ratios were close to one for Priest Rapids Dam and Hanford Reach sediment, with zinc as the dominant metal. The molar ratios for sediment from McNary Dam were above one, indicating a potential for some metals to be present in the sediment porewater, with zinc as the primary metal present. Ice Harbor Dam had similar concentrations of acid volatile sulfide as McNary Dam, but zinc concentrations were lower.

Water samples were collected from eight Columbia River shoreline springs in 1999. All concentrations of radiological contaminants measured in water from riverbank springs in 1999 were less than DOE derived concentration guides. However, the spring at the 100-N Area that has historically exceeded the DOE derived concentration guide for strontium-90 was not flowing during the 1999 sample collection visit. Tritium concentrations at the Old Hanford Townsite and gross alpha concentrations at the 300 Area riverbank springs exceeded the applicable Washington State ambient surface-water quality criteria. Gross beta concentrations at the Old Hanford Townsite and 300 Area riverbank springs were close to the state criteria. There are currently no ambient surface-water quality criteria levels directly applicable to uranium; however, total uranium exceeded the site-specific proposed EPA drinking water standard in the 300 Area riverbank spring. All other radionuclides were below the Washington State ambient surface-water quality criteria levels.

Nonradiological contaminants measured in riverbank springs located on the Hanford shoreline in 1999 were below Washington State ambient surface-water acute toxicity levels, except for chromium at the 100-B, 100-D, 100-K, 100-F, 100-H Area, and 300 Area riverbank springs and for copper, lead, and zinc at the 300 Area. Arsenic concentrations in water from riverbank springs were well below the applicable ambient surface water chronic toxicity levels, but concentrations in all samples exceeded the federal limit (including upriver Columbia River water samples). Nitrate concentrations at all locations were below the EPA drinking water standard.

Water was collected from two onsite ponds located near operational areas in 1999. Although the ponds were not accessible to the public and did not constitute a direct offsite environmental impact during the year, they were accessible to migratory waterfowl and other animals. As a result, a potential biological pathway existed for the removal and dispersal of onsite pond contaminants. With the exception of uranium-234 and uranium-238 in water samples from West Lake, radionuclide concentrations in the onsite pond water were below DOE derived concentration guides. The median gross alpha, gross beta, and total uranium concentrations in West Lake exceeded the applicable ambient surface-water quality criteria levels. Concentrations of most radionuclides in water collected from both ponds during 1999 were similar to those observed during past years.

Irrigation water from the Riverview canal near Pasco was sampled three times in 1999 to determine radionuclide levels. Radionuclide concentrations in offsite irrigation water were below both the DOE derived concentration guides and ambient surface-water quality criteria levels and were similar to those observed in Columbia River water.

Drinking Water Surveillance. Surveillance of Hanford Site drinking water was conducted to verify the quality of water supplied by site drinking water systems and to comply with regulatory requirements. Radiological monitoring was performed by the Pacific Northwest National Laboratory; nonradiological monitoring was conducted by DynCorp Tri-Cities Services, Inc. Radiological results are discussed in this report; nonradiological results are reported directly to the Washington State Department of Health.

During 1999, radionuclide concentrations in Hanford Site drinking water were similar to those observed in recent years and were in compliance with Washington State Department of Health and EPA drinking water standards.

Food and Farm Product Surveillance. The Hanford Site is situated in a large agricultural area that produces a wide variety of food products and alfalfa. In 1999, milk, vegetables, fruit, and wine were collected from areas around the site and were analyzed for cobalt-60, strontium-90, iodine-129, cesium-137, and tritium.

Most farm products sampled did not contain measurable levels of cobalt-60 or cesium-137. Iodine-129 was measured in milk at levels equivalent to those seen at the downwind location. Levels of iodine-129 in milk collected at downwind locations have remained relatively stable for the past 5 years. Strontium-90 was detected in only 1 of 12 milk samples analyzed in 1999. The one positive result was close to the analytical detection limit. Tritium was also measured in milk samples and concentrations were believed to be influenced by the source of water used by the dairies. Tritium levels were low in all samples but were higher in the Sagemoor area than in the Wahluke and Sunnyside areas. Tritium levels in wine were low and the Yakima Valley wines were lower than the Columbia Basin wines. Measurable levels of most man-made radioactivity were not detected in vegetable and fruit samples collected in 1999. Strontium-90 was detected in two leafy vegetable samples at levels approaching the analytical detection limit. The sample with the highest concentration was re-analyzed and the result was below the analytical detection limit. Cesium-137 and other man-made gamma-emitting radionuclides were not detected in alfalfa in 1999. Strontium-90 was found above the detection limit in three of the four samples analyzed and levels were consistent with measurements in alfalfa over the past 5 years.

Fish and Wildlife Surveillance. Bass, whitefish, and large-scale suckers were collected from the Columbia River in 1999. Cesium-137 was not detected in any of the muscle samples analyzed. Strontium-90 was found in 7 of 16 carcass samples but levels were similar to those observed in Hanford Reach and background area fish.

Wildlife sampled and analyzed in 1999 for radioactive constituents included elk, geese, and rabbits. Radionuclide levels in Hanford-resident geese and elk were similar to levels in wildlife collected at reference background locations. Cesium-137 was not detected in any of the goose and elk samples analyzed and the highest strontium-90 levels were seen in elk collected in Idaho. Levels of cesium-137 and strontium-90 were low in most rabbit samples also but levels in one rabbit collected in the 100-N Area was high enough to suggest some onsite exposure to Hanford Site contaminants.

Soil and Vegetation Surveillance. Routine soil and vegetation samples were not collected by Pacific Northwest National Laboratory on and around the Hanford Site in 1999, but two special studies were conducted. Reed canary grass and mulberry trees were sampled along the Columbia River, and soil samples were collected in and near the former 1100 Area. Plants collected on the Hanford Site by the Wanapum People were also analyzed. Elevated tritium levels were seen in mulberry trees growing in the 100-B,C Area where a groundwater tritium plume is known to exist. The highest strontium-90 concentrations were seen in vegetation collected in the 100-N Area with levels in vegetation from other reactor areas being slightly lower. Soil samples collected in the former 1100 Area in July 1999 were analyzed for potential radiological contaminants from prior DOE activities in the area and from airborne deposition from both DOE and private facilities on and around the site. All concentrations were similar to concentrations measured at Hanford Site perimeter locations between 1992 and 1997.

External Radiation Surveillance. Using thermoluminescent dosimeters, radiological dose rates were measured at both onsite and offsite locations during 1999. Radioactive substances contributing to the measured dose rates were of either natural or man-made origin. The dose rates did not change significantly from the dose rates measured in previous years. The 1999 annual average background dose rate measured in communities distant from the Hanford Site was 74 ± 2 mrem/yr; in 1998, the average background was 70 ± 2. The 1999 annual average perimeter dose rate was 90 ± 4 mrem/yr; in 1998, the average measured dose rate was 88 ± 7 mrem/yr. All onsite thermoluminescent dosimeters averaged 88 ± 3 mrem/yr, which compares favorably with the average of 85 ± 9 mrem/yr measured in 1998. Columbia River shoreline dosimeters had a 1999 average of 91 ± 6 mrem/yr; in 1998, the average was 90 ± 6 mrem/yr. The average dose rate along the 100-N Area shoreline (120 ± 26 mrem/yr) was ~50% higher than the typical shoreline dose rate (87 ± 3 mrem/yr).

Groundwater Monitoring

Monitoring of radiological and chemical constituents in groundwater at the Hanford Site was performed to characterize physical and chemical trends in the flow system, to establish groundwater quality baselines, to assess groundwater remediation, and to identify new or existing groundwater problems. Groundwater monitoring was also performed to verify compliance with applicable environmental laws and regulations and to fulfill commitments made in official DOE documents. Samples were collected from over 600 wells to determine the distribution of radiological and chemical constituents in Hanford Site groundwater. In addition, hydrogeologic characterization and modeling of the groundwater flow system were used to assess the monitoring network and to evaluate the potential impact of groundwater contaminants. Modeling of Hanford Site groundwater was also used to assess performance of waste disposal facilities and evaluate remediation strategies.

Groundwater Protection and Monitoring. The Hanford Groundwater Monitoring Project was responsible for groundwater surveillance and monitoring activities at the Hanford Site. This project incorporates sitewide groundwater monitoring mandated by DOE orders with near-field groundwater monitoring conducted to ensure that operations in and around specific waste-disposal facilities comply with applicable regulations. Groundwater monitoring was required by RCRA at 26 waste treatment, storage, and disposal units. Monitoring status and results for each of these units are summarized in this report.

To assess the quality of groundwater, measured sample concentrations were compared with the EPA drinking water standards and the DOE derived concentration guides. Groundwater is used for drinking at three locations on the Hanford Site. In addition, water supply wells for the city of Richland are located near the southern boundary of the Hanford Site. Radiological constituents detected at levels greater than their respective EPA drinking water standards in one or more wells included tritium, iodine-129, technetium-99, uranium, strontium-90, carbon-14, gross alpha, and gross beta. Tritium, uranium, and strontium-90 were detected at levels greater than their respective DOE derived concentration guides.

Extensive tritium plumes extend from the 200-East and 200-West Areas into the 600 Area. The plume from the 200-East Area extends east and southeast, discharging to the Columbia River between the Old Hanford Townsite and the 300 Area. This plume has affected tritium concentrations in the 300 Area, located in the southern part of the Hanford Site, at levels of more than one-half the EPA drinking water standard. The spread of this plume farther south than the 300 Area is restricted by the groundwater flow away from the Yakima River, recharge from agricultural irrigation, and the recharge basins associated with the north Richland well field. A much smaller tritium plume from the 200-West Area extends east to the US Ecology facility. Groundwater with tritium at levels above the EPA drinking water standard also discharges to the Columbia River near the 100-N Area. A small but high-level tritium plume in the 100-K Area also may discharge to the river. Tritium in groundwater at levels greater than the EPA drinking water standard were also found in the 100-B,C, 100-D, and 100-F Areas and at the State-Approved Land Disposal Site north of the 200-West Area. Tritium occurred at levels equal to or greater than the DOE derived concentration guide in small areas in the 100-K, 200, and 600 Areas. Tritium was detected above the guide for the first time near the 618-11 burial ground in the eastern 600 Area.

Iodine-129 was detected at levels greater than the EPA drinking water standard in the 200-East Area and in part of the 600 Area to the east and southeast. Iodine-129 contamination extends as far to the east as the Columbia River but at levels less than the EPA standard. The iodine-129 and tritium plumes share common sources. Iodine-129 at levels greater than the EPA standard also extends into the 600 Area to the northwest of the 200-East Area, into the 600 Area in the southern part of the 200-West Area, and to the northeast in the north-central part of the 200-West Area.

Technetium-99 concentrations greater than the EPA drinking water standard were found in the northwestern part of the 200-East Area and adjacent 600 Area. Technetium-99 was also detected at levels greater than the EPA standard in the 200-West Area and adjacent 600 Area to the east. Approximately 357 million liters (99 million gallons) of groundwater have been treated and ~61.7 grams (2.2 ounces) of technetium-99 have been removed from groundwater since a pump-and-treat system began operating in the 200-West Area in 1994.

Uranium was detected at levels greater than the EPA drinking water standard in groundwater in the 100-F, 100-H, 200, 300, and 600 Areas. Wells near U Plant in the 200-West Area showed concentrations greater than the DOE derived concentration guide. A pump-and-treat system has removed 101.1 kilograms (223 pounds) of uranium from groundwater in the 200-West Area since 1994. Groundwater with uranium levels greater than the EPA standard is discharging to the Columbia River in the 300 Area.

The strontium-90 plume in the 100-N Area contains levels greater than the EPA drinking water standard and the DOE derived concentration guide. Strontium-90 at these levels is discharging to the Columbia River. Strontium-90 entering the river could potentially reach an ecological receptor. A pump-and-treat method to reduce the amount of strontium-90 entering the river removed ~0.2 curie from extracted groundwater in fiscal year 1999. Strontium-90 at levels greater than the DOE derived concentration guide also occurred in localized areas in the 100-K and 200-East Areas. Strontium-90 was detected at levels greater than the EPA drinking water standard in the 100, 200, and 600 Areas.

Carbon-14 exceeded the EPA drinking water standard in two small plumes near each of the 100-K Area reactors.

Cesium-137 occurs at levels above the EPA drinking water standard in a localized area associated with a former injection well in the 200-East Area. Plutonium also occurs in this localized area at levels greater than the 100-mrem/yr dose equivalent guideline.

Cobalt-60 was detected in the 200-East Area and adjacent 600 Area but at levels less than the EPA drinking water standard.

Several nonradioactive chemicals regulated by EPA and Washington State were also present in Hanford Site groundwater. These were nitrate, chromium, carbon tetrachloride, chloroform, trichloroethylene, cis-1,2-dichloroethylene, cyanide, and fluoride. Of these chemicals, nitrate, chromium, and carbon tetrachloride are the most widely distributed in Hanford Site groundwater.

Nitrate concentrations exceeded the EPA drinking water standard in all areas, except the 400 Area. The nitrate plumes in the 100 Areas discharge to the Columbia River. Nitrate from sources in the northwestern part of the 200-East Area is present in the adjacent 600 Area at levels greater than the EPA drinking water standard. Nitrate levels greater than the EPA standard occur in two areas of the 200-West Area and adjoining 600 Area. A pump-and-treat system in the 200-West Area has removed 12,770 kilograms (28,153 pounds) of nitrate from groundwater. Nitrate is widely distributed in groundwater in the 100-F and adjoining 600 Area. A wide area of nitrate contamination occurs along part of the southern boundary of the Hanford Site. This contamination is affected by agricultural and industrial nitrate sources off the Hanford Site.

Chromium was detected above the EPA drinking water standard in the 100-D, 100-H, and 100-K Areas and in localized sites in the 100-B,C, 100-K, 200, and 600 Areas. Plume boundaries were defined better in the 100-D Area because new monitoring wells were installed. Since pump-and-treat systems began operating in the 100-D, 100-H, and 100-K Areas in 1997, 136 kilograms (300 pounds) of chromium has been removed from groundwater.

An extensive plume of carbon tetrachloride at levels greater than the EPA drinking water standard occurs in groundwater in the 200-West Area and adjoining 600 Area. Two pump-and-treat systems operating in the 200-West Area have treated 1,312 million liters (351 million gallons), resulting in the removal of ~3,402 kilograms (7,500 pounds) of carbon tetrachloride. At the pump-and-treat system near the Plutonium Finishing Plant, the portion of the carbon tetrachloride plume with the highest concentrations has increased in size because of the effects of pumping from the extraction wells.

Trichloroethylene and chloroform levels were above the EPA drinking water standard in the 200-West Area. Trichloroethylene was found at levels greater than the EPA standard in small areas in the 100-F Area and nearby 600 Area, 100-K Area, 300 Area, and near the former Horn Rapids Landfill near the southern boundary of the Hanford Site.

Cis-1,2-dichloroethylene concentrations were above the EPA drinking water standard in one well in the 300 Area. Cyanide was detected at levels above the EPA drinking water standard in the 200-East Area. Fluoride was detected above the EPA drinking water standard in the 200-West Area.

Vadose Zone Monitoring

The vadose zone is the region in the subsurface between the ground surface and the top of the water table. Radioactive and hazardous wastes in the soil column from past intentional disposal of liquid waste, unplanned leaks, solid waste burial grounds, and underground tanks at the Hanford Site are potential sources of continuing and future vadose zone and groundwater contamination. In 1999, subsurface source characterization and vadose zone monitoring, soil-vapor monitoring, sediment sampling and characterization, and vadose zone remediation were conducted to better understand and alleviate the spread of subsurface contamination.

Vadose Zone Characterization and Monitoring at Tank Farms. Several vadose zone characterization activities occurred at the single-shell tank farms in 1999. At the SX tank farm, in the 200-West Area, samples were collected and characterized from the decommissioning of one borehole drilled to characterize deep vadose zone contamination. Analytical results from the samples showed very high concentrations of cesium-137. The region between 18.6 and 25.3 meters (61 and 83 feet) had the highest concentrations of cesium-137 reaching 1.759 x 10^7 pCi/g at 25 meters (82 feet) depth. Levels were the highest obtained from under leaking tanks in the past 35 years. Very little cesium-137 was leached by a water extraction procedure, indicating that most cesium-137 in the sediment from the borehole is not soluble and is bound to the sediment.

The multiyear vadose zone baseline characterization project at the single-shell tank farms was completed by the end of 1999. During 1999, tank summary data reports were completed for the remaining tanks in T and B tank farms and the report for T tank farm was completed. Tank summary data reports were issued for a total of 133 single-shell tanks. Also, by the end of 1999, 11 of 12 tank farm reports had been issued; only the B tank farm report remained to be completed. During 1999, repeat logging was completed and a high-count rate logging system was deployed to measure radionuclide concentrations in borehole intervals where high gamma flux led to saturation of the spectral gamma logging system. It is anticipated that the final tank farm report will be issued by the end of March 2000. Work is underway to prepare a series of addenda for earlier tank farm reports that will present additional data from high rate and repeat logging, as well as modifications to the visualizations based on re-evaluation of existing data.

Vadose Zone Characterization and Monitoring at Liquid Waste Disposal Facilities. The 116-C-1 process effluent trench, in the 100-B, C Area was remediated in 1997, and a test pit was dug to groundwater in early 1998 by Bechtel Hanford, Inc. to evaluate the remediation effort. Analyses of the soil samples showed that most remaining contamination in the vadose zone was within ~5 meters (16 feet) of the base of the remedial action excavation. However, the more mobile contaminants, such as strontium-90, were slighter deeper in the soil column. The most mobile contaminants, such as hexavalent chromium, were flushed through the vadose zone to groundwater. Remediation of the 116-C-1 trench met cleanup standards and the site was reclassified as closed in accordance with the Tri-Party Agreement (Ecology et al. 1998).

Important decisions affecting the cost and extent of remedial actions in the 100 Areas are currently based on the predictions of the very conservative computer model RESRAD. To date, the RESRAD code has used on the distribution coefficient (K_d), and not leachability, to evaluate the effect to groundwater. (K_d is a measure of the relative concentration of contaminant sorbed on the sediment to that dissolved in solution; the smaller the K_d, the amore contaminant is in solution.) Experiments were done in 1999 to measure both the leach rate and K_d for hexavalent chromium using sediment samples from the 100-D Area. The findings of the study suggest that there is very little soluble chromium in the vadose zone of the 100-D Area. This is contrary to the existence of high chromium concentrations in groundwater from some 100-D locations. The apparent incongruity may be an artifact of sampling (i.e., samples were collected outside areas of chromium contamination) or of an, as yet, unidentified geochemical process.

Soil vapor extraction is being used to remove carbon tetrachloride from the vadose zone in the 200-West Area. The EPA and the Washington State Department of Ecology authorized DOE to initiate this remediation in 1992 as a CERCLA expedited response action. Between March 29 and September 30, 1999, 832 kilograms (1,800 pounds) of carbon tetrachloride were removed from the vadose zone in the 200-West Area. As of September 1999, ~76,500 kilograms (168,700 pounds) of carbon tetrachloride had been removed from the vadose zone since extraction operations started in 1992.

The Hanford Groundwater Monitoring Project monitored 25 inactive liquid waste disposal facilities in the 200-East Area of the Hanford Site in 1999. The facilities consisted of 6 cribs and 19 specific retention facilities. Specific retention facilities were liquid waste disposal sites designed to use the moisture retention capability of the soil to retain contaminants. These facilities were chosen for monitoring because they are among the highest priority sites as determined by an evaluation of past-practice, liquid waste disposal facilities (PNNL-11958, Rev. 2). These sites represent potential sources for future contamination of groundwater at the Hanford Site. Monitoring of the past practice sites consisted of spectral gamma-ray and neutron moisture logging of 28 wells and boreholes.

Only four of the boreholes logged in 1999 had previous spectral gamma logs for comparison. Two of those logs showed that changes in the subsurface distribution of man-made radioisotopes had occurred since 1992. Although the changes are not great, they do point to continued movement of contaminants in the vadose zone. None of the facilities monitored in 1999 have been used for at least 30 years and some for 40 years. Thus, the driving force for the changes is not known for certain but must be either natural recharge, residual moisture from past facility operations, or moisture from adjacent facilities. The radionuclides that were observed to have moved since 1992 are cesium-137 and cobalt-60. Given the amount of movement and the half-lives of the isotopes, it is expected that they will decay to insignificant amounts before reaching groundwater.

In 1999, the Hanford Groundwater Monitoring Project sampled and analyzed soil gas and soil moisture to 1) demonstrate the adaptability of soil gas sampling techniques to the measurement of tritium and helium-3 concentrations in Hanford Site soil, 2) determine tritium and helium-3 concentrations in soil gas at two locations on the Hanford Site, and 3) attempt to extrapolate tritium and helium-3 concentrations in the soil to tritium concentrations in groundwater at the 100-K Area.

Measurements of tritium in soil moisture do not appear to be useful for delineating tritium groundwater plumes or estimating concentrations of tritium in groundwater. The major source of moisture in the vadose zone at the two investigated sites appears to be natural precipitation and not upward migration of moisture from groundwater into the vadose zone.

Analyses of soil gas from samples collected at the Old Hanford Townsite area show that the gas is enriched in helium-3. This enrichment is due to decay of tritium in the groundwater beneath the site. The amount of enrichment appears to vary with time, most likely because of atmospheric influences. Nevertheless, helium-3 can be a useful tracer for either vadose zone or groundwater sources of tritium.

Potential Radiological Doses from 1999 Hanford Operations

In 1999, potential radiological doses to the public, resulting from exposure to Hanford Site liquid and gaseous effluents, were evaluated to determine compliance with pertinent regulations and limits. These doses were calculated using reported effluent releases and environmental surveillance data using version 1.485 of the GENII computer code and Hanford-specific parameters. The potential dose to the maximally exposed individual in 1999 from site operations was 0.008 mrem (0.08 µSv) compared to 0.02 mrem (0.2 µSv) calculated for 1998. The radiological dose to the population within 80 kilometers (50 miles) of the site, estimated to be 380,000 persons, from 1999 site operations was 0.25 person-rem (0.0025 person-Sv), which is a slight increase of the population dose calculated for 1998 (0.2 person-rem [0.002 person-Sv]). The average per-capita dose from 1999 site operations was 0.0007 mrem (0.007 µSv). The national average dose from background sources, according to the National Council on Radiation Protection, is ~300 mrem/yr (3 mSv/yr), and the current DOE radiological dose limit for a member of the public is 100 mrem/yr (1 mSv/yr). Therefore, the average individual potentially received 0.0007% of the DOE limit and 0.0002% of the national average background. Special exposure scenarios not included in the dose estimate above included the hunting and consumption of game animals residing on the Hanford Site and exposure to radiation at a publicly accessible location with the maximum exposure rate. Doses from these scenarios would have been small compared to the DOE dose limit. Radiological dose through the air pathway was 0.03% of the EPA limit of 10 mrem/yr (0.1 mSv/yr).

Other Hanford Site Environmental Programs

Climate and Meteorology

Meteorological measurements are taken to support Hanford Site emergency preparedness, site operations, and atmospheric dispersion calculations. Weather forecasting and maintenance and distribution of climatological data are provided.

The Hanford Meteorology Station is located on the 200 Areas plateau, where the prevailing wind direction is from the northwest during all months. The secondary wind direction is from the southwest. The average speed for 1999 was 14.2 km/h (11.1 mi/h), which was 1.8 km/h (1.1 mi/h) above normal and was the windiest year on record. The peak gust for the year was 105 km/h (65 mi/h).

Precipitation for 1999 totaled 9.6 centimeters (3.75 inches), 60% of normal, with 1.5 centimeters (0.6 inch) of snow recorded.

Temperatures for 1999 ranged from -7.8° Celsius (18° Fahrenheit) in January to 40.6° Celsius (105° Fahrenheit) in July.

Cultural Resources

Management of archaeological, historical, and traditional cultural resources at the Hanford Site is provided in compliance with the *National Historic Preservation Act*, *Archaeological Resources Protection Act*, *Native American Graves Protection and Repatriation Act*, *American Indian Religious Freedom Act*, *Historic Sites Buildings and Antiquities Act*, *Archeological and Historic Preservation Act*, and *American Antiquities Preservation Act*. During 1999, 176 proposed projects were reviewed to consider their potential effect on significant cultural resources. Other activities included the continuation of a multiyear monitoring study of cutbank erosion and the associated impact to National Register archaeological sites at Locke Island, a large channel island located in the northern extent of the Hanford Reach of the Columbia River. Mitigation of historic buildings and structures continued in 1999 as required by the programmatic agreement for the built environment and the historic district treatment plan.

Public involvement activities are important components of a cultural resources management program. To accomplish this goal, DOE developed mechanisms that allow the public access to cultural resources information and the ability to comment and make recommendations concerning the management of cultural resources on the Hanford Site. In 1999, these mechanisms were woven into a draft involvement plan that includes input provided by the public and Hanford Site staff over the past several years. Native American involvement included the completion of several field surveys, construction monitoring, and monthly cultural issues meetings.

Community-Operated Environmental Surveillance Program

This program was initiated in 1990 to increase the public's involvement in and awareness of Hanford's surveillance program. Nine citizen-operated radiological surveillance stations were operating in 1999.

Biological Control Program

The Biological Control Program was established at the Hanford Site in 1999 to control the spread of radiological contamination by plants and animals (including insects) and to control pests (including noxious weeds) that may affect the workplace or the environment. Program efforts focused on controlling plants and animals, locating and cleaning up both new and old areas of contamination, and post-cleanup remediation. Remediation was performed when there was a potential for recurrence of the problem, with the objective of preventing the recurrence.

All reported incidents of radiological contamination spread by plants and animals in 1999 were confined to the site and were either cleaned up or scheduled for clean up. In 1999, three contaminated house flies were collected at a transfer facility in the 200-East Area, 86 incidents of contaminated vegetation were identified, and 14 contaminated animals were detected.

The noxious weed control program on the Hanford Site was developed in response to federal, state, and local laws requiring eradication or control of noxious weeds. A noxious weed is defined as any plant that, when established, is highly destructive, competitive, or difficult to control by cultural or chemical practices. Typically, noxious weeds are non-native species that invade and displace native species, reduce habitat for fish and wildlife, and contribute to the extinction of sensitive species. Nine plants are on the high-priority list for control at the Hanford Site. These include yellow starthistle, rush skeletonweed, babysbreath, dalmation toadflax, spotted knapweed, diffuse knapweed, Russian knapweed, saltcedar, and purple loosestrife. All these plants were monitored in 1999, but control measures focused on the more invasive species. In 1999, ~4,617 hectares (11,400 acres) of the site were treated with herbicide to control undesirable vegetation and ~2 hectares (5 acres) were re-seeded with native vegetation to prevent the growth of tumbleweeds.

Quality Assurance

Comprehensive quality assurance programs, which include various quality control practices and methods to verify data, are maintained to ensure data quality. The programs are implemented through quality assurance plans designed to meet requirements of the American National Standards Institute/American Society of Mechanical Engineers and DOE Orders. Quality assurance plans are maintained for all activities, and auditors verify conformance. Quality control methods include, but are not limited to, replicate sampling and analysis, analysis of field blanks and blind reference standards, participation in interlaboratory crosscheck studies, and splitting samples with other laboratories. Sample collection and laboratory analyses are conducted using documented and approved procedures. When sample results are received, they are screened for anomalous values by comparing them to recent results and historical data. Analytical laboratory performance on the submitted double blind samples, the EPA Laboratory Intercomparison Studies Program, and the national DOE Quality Assessment Program indicated that laboratory performance was adequate overall, was excellent in some areas, and needed improvement in others.