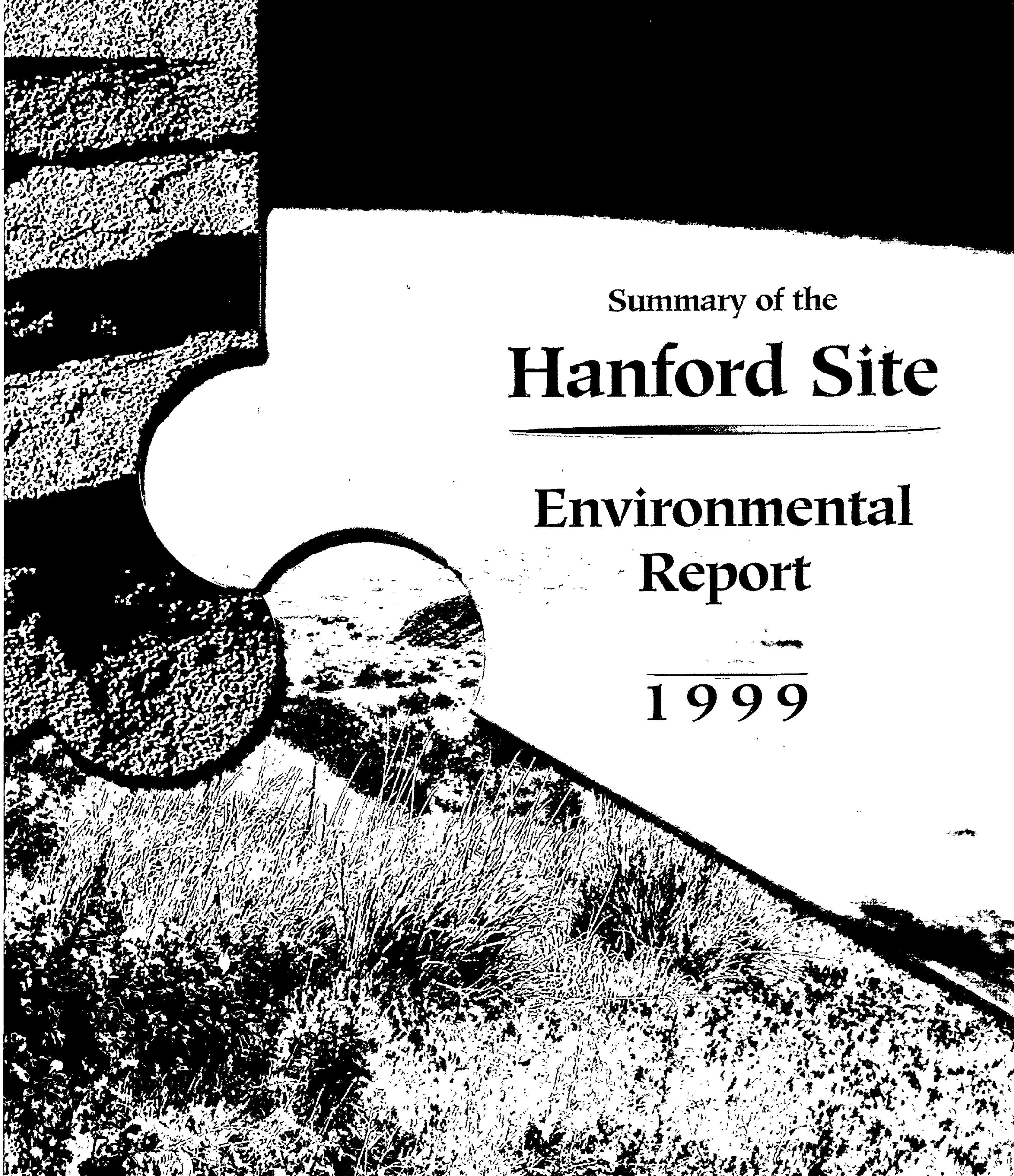

Summary of the

Hanford Site Environmental Report

1999

PNNL-13230

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

PNNL-13230-SUM

Summary of the
Hanford Site Environmental Report
for Calendar Year 1999

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September 2000

This report was prepared for the U.S. Department of Energy by Pacific Northwest National Laboratory under contract DE-AC06-76RLO 1830, with contributions from Fluor Hanford, Inc. and its affiliate companies, Bechtel Hanford, Inc. and its subcontractors, CH2M HILL Hanford Group, Inc., and MACTEC-ERS

Pacific Northwest National Laboratory
Richland, Washington 99352

Disclaimer

Cover Design

This report cover shows photos of world weather patterns, the shrub-steppe ecosystem as viewed from the Rattlesnake Hills on the Hanford Site, and sandstone stratification. The images are intended to represent climatology, environmental surveillance, and groundwater monitoring activities conducted on the Site. The sandstone photo helps illustrate the concept of groundwater, although groundwater on the Hanford Site is found in a cobble/sand strata, not in layered sedimentary rock as shown.

Pacific Northwest National Laboratory

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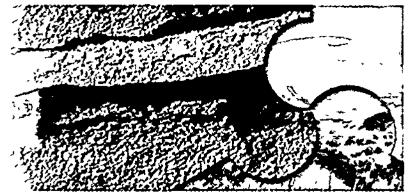
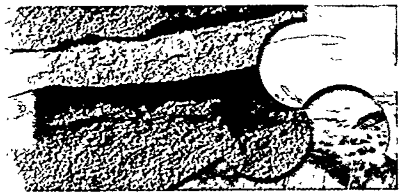


Contents



Introduction

This booklet summarizes the *Hanford Site Environmental Report for Calendar Year 1999*. The Hanford Site environmental report is prepared annually to summarize environmental data and information, describe environmental management performance, demonstrate the status of compliance with environmental regulations, and highlight major environmental programs and efforts. The document is written to meet requirements and guidelines of the U.S. Department of Energy (DOE) and the needs of the public.

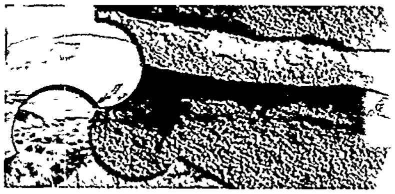
This summary booklet is designed to briefly

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

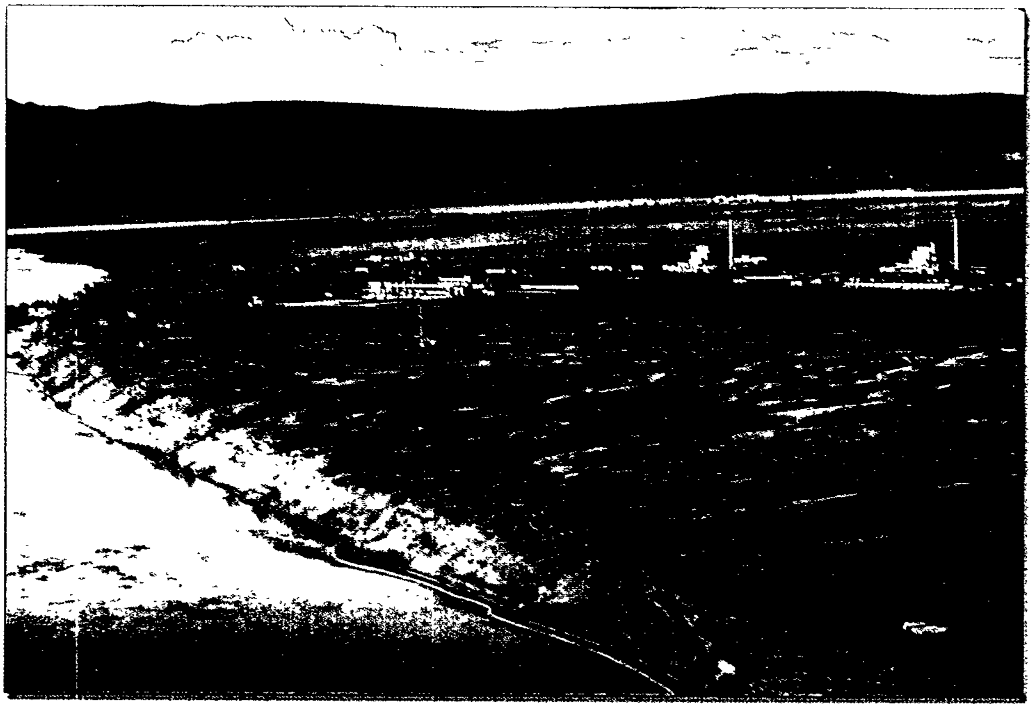
This booklet was written with a minimum of technical terminology. Readers interested in more detailed information can consult the 1999 report or the technical documents cited and listed in that report.

Inquiries about this booklet or comments and suggestions about its content may be directed to Mr. D. C. (Dana) Ward, DOE Richland Operations Office, Office of Site Services, P.O. Box 550, Richland, Washington 99352 (Dana_C_Ward@rl.gov) or to Mr. T. M. (Ted) Poston, K6-75, Pacific Northwest National Laboratory, P.O. Box 999, Richland, Washington 99352 (ted.poston@pnl.gov).

Copies of this summary booklet and the 1999 report have been provided to many public libraries in communities around the Hanford Site and to several university libraries in Washington and Oregon. Copies also can be found at DOE's Public Reading Room located in the Consolidated Information Center, Room 101L, on the campus of Washington State University-Tri-Cities. Copies of the 1999 report can be obtained from Mr. R. W. (Bill) Hanf, K6-75, Pacific Northwest National Laboratory, P.O. Box 999, Richland, Washington 99352 (RW_hanf@pnl.gov) while supplies last or can be purchased from the National Technical Information Center, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, Virginia 22161. **The reports can be accessed on the Internet at http://hanford.pnl.gov/envreport/1999.**



Overview of the Hanford Site and its Mission



The Columbia River flows through the northern portion of the U.S. Department of Energy's Hanford Site.

The Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State. The site occupies an area of approximately 1,517 square kilometers (approximately 586 square miles) (68 square kilometers [26 square miles] larger this year to include DOE-owned portions of the Columbia River) located north of the city of Richland and the confluence of the Yakima and Columbia rivers.

This large area has restricted public access and provides a buffer for the smaller areas on the site that historically were used for production of nuclear materials, waste storage, and waste disposal. Only approximately 6% of the land area has been disturbed and actively used. The Columbia River flows eastward through the northern part of the Hanford Site and then turns south, forming part of the eastern site boundary. The Yakima River flows near a portion of the southern boundary and joins the Columbia River at the city of Richland. Portions of the site are managed by the U.S. Fish and Wildlife Service as part of the Arid Lands National Wildlife Refuge complex.

The cities of Richland, Kennewick, and Pasco (Tri-Cities) constitute the nearest population center and are located southeast of the site. Land in the surrounding environs is used for urban and industrial development, irrigated and dry-land farming, and grazing.

Site Description

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 resulting waste.

The entire site has been designated a National Environmental Research Park (one of four nationally) by the former U.S. Energy Research and Development Administration, a precursor to DOE. The site is a relatively large, undisturbed area of shrub-steppe that contains a rich, natural diversity of plant and animal species adapted to the region's semiarid environment. Terrestrial vegetation on the site consists of ten major plant communities: 1) sagebrush/bluebunch wheatgrass, 2) sagebrush/cheatgrass or sagebrush/Sandberg's bluegrass, 3) sagebrush-bitterbrush/cheatgrass, 4) grease wood/cheatgrass-saltgrass, 5) winterfat/Sandberg's bluegrass, 6) thyme buckwheat/Sandberg's bluegrass, 7) cheatgrass-tumble mustard, 8) willow or riparian, 9) spiny hopsage, and 10) sand dunes. Over 600 species of plants have been identified on the site, and recent work by The Nature Conservancy of Washington has further delineated 30 distinct plant community types from within 10 major communities.

There are two types of natural aquatic habitats on the Hanford Site. One is the Columbia River and associated wetlands, and the second is upland aquatic sites. The upland sites include small spring streams and seeps located mainly on the Fitzner/Eberhardt Arid Lands Ecology Reserve on Rattlesnake Mountain (e.g., Rattlesnake Springs, Dry Creek, Snively Springs) and West Lake, a small, natural pond near the 200 Areas.

More than 1,000 species of insects, 3 species of reptiles and amphibians, 44 species of fish, 214 species of birds, and 39 species of mammals have been found on the Hanford Site. Deer and elk are the major large mammals; coyotes are plentiful, and the Great Basin pocket mouse is the most abundant mammal. Waterfowl are numerous on the Columbia River, and the bald eagle is a regular winter visitor along the river. Salmon and steelhead are the fish species of most interest to sport fishermen and are commonly consumed by local Native American tribes.

Although no Hanford Site plant species have been identified from the federal list of threatened and endangered species, biodiversity inventory work conducted in collaboration with The Nature Conservancy of Washington identified more than 100 populations of 31 different rare plant taxa. The U.S. Fish and Wildlife Service lists the bald eagle as threatened. The bald eagle is a common winter resident and has initiated nesting on the site but has never successfully produced offspring. Several species of mammals, birds, molluscs, reptiles, and invertebrates occurring on the site are candidates for formal listing under the Endangered Species Act.

Operational Areas

For security, safety, and functional reasons, the site is divided into operational areas (Figure 1):

- The 100 Areas, on the south shore of the Columbia River, are the sites of nine retired plutonium production reactors (100-B, 100-C, 100-D, 100-DR, 100-F, 100-H, 100-KW, 100-KE, 100-N) that occupy 11 square kilometers (4 square miles).
- The 200-West and 200-East Areas are located on a plateau and are approximately 8 and 11 kilometers (5 and 7 miles) south and west of the Columbia River. The 200 Areas cover 16 square kilometers (6 square miles).
- The 300 Area is located just north of Richland. This area covers 1.5 square kilometers (0.6 square mile).
- The 400 Area is approximately 8 kilometers (5 miles) northwest of the 300 Area.
- The 600 Area includes all the Hanford Site not occupied by the 100, 200, 300, and 400 Areas.
- The former 311-hectare (768-acre) 1100 Area

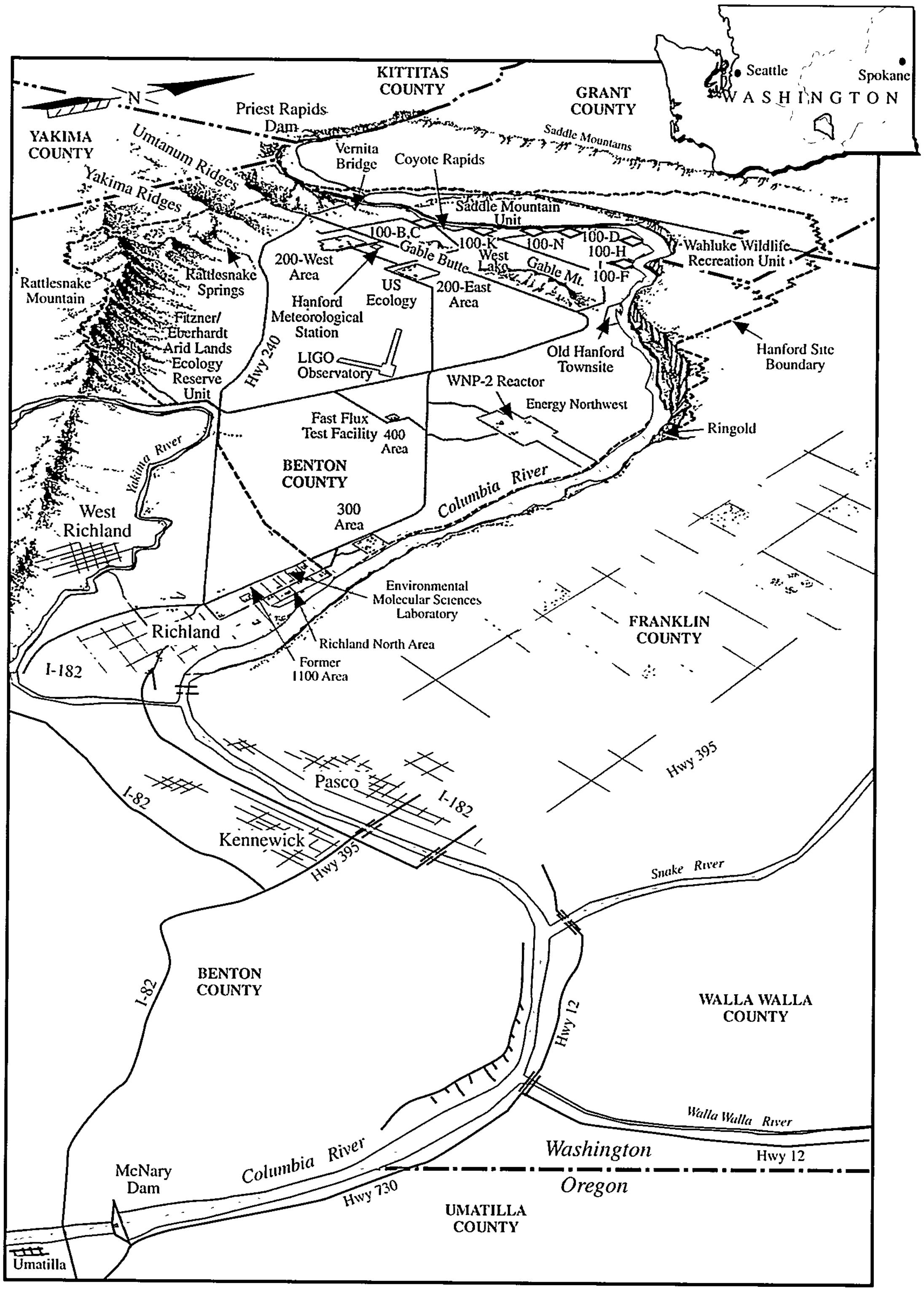


Figure 1. The Hanford Site is located along the Columbia River in southeastern Washington.

is located between the 300 Area and Richland and included site support services such as general stores and transportation maintenance. This area was transferred to the Port of Benton and is no longer part of the site. DOE contractors continue to lease facilities in this area.

- The Richland North Area (off the site) includes DOE and its contractor facilities, mostly leased office buildings, generally located in the northern part of the city of Richland.

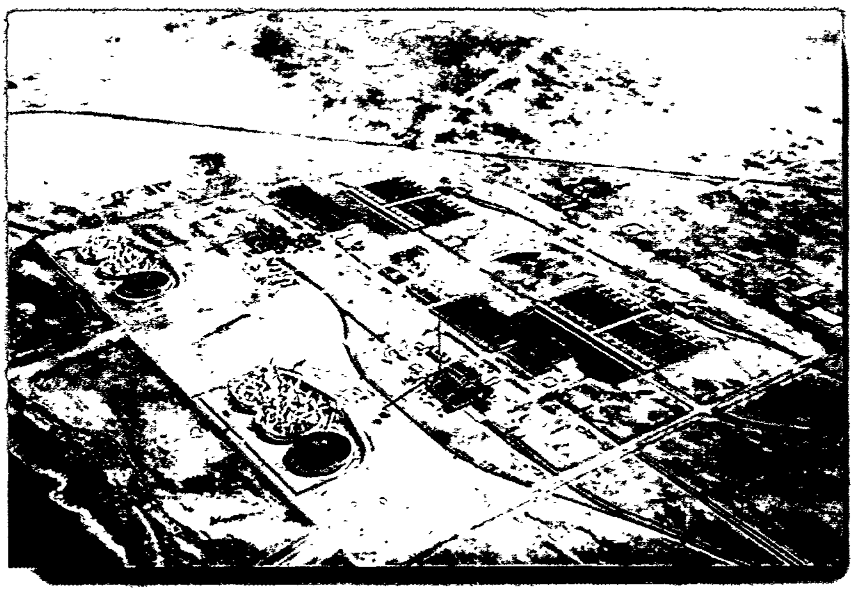
Several areas of the site, totaling 665 square kilometers (257 square miles), have special designations. These include the Fitzner/Eberhardt Arid Lands Ecology Reserve (310 square kilometers [120 square miles]), the U.S. Fish and Wildlife Service Saddle Mountain National Wildlife Refuge (approximately 130 square kilometers [50 square miles]), and the Washington State Department of Fish and Wildlife Reserve Area (Wahluke Slope Wildlife Recreation Area) (225 square kilometers [87 square miles]). Together these make up the U.S. Fish and Wildlife Service-Managed Arid Lands National Wildlife Refuge complex.

The Fitzner/Eberhardt Arid Lands Ecology Reserve was established in 1967 by the U.S. Atomic Energy Commission to preserve shrub-steppe habitat and vegetation. In 1971, the reserve was classified a Research Natural Area as a result of a federal interagency cooperative agreement. In June 1997, DOE transferred management, including access management, of the reserve from Pacific Northwest National Laboratory to the U.S. Fish and Wildlife Service, which will continue to operate the reserve using the in-place policy until a new management plan can be written.

Secretary of Energy Bill Richardson announced in April 1999 the proposal to manage the entire Wahluke Slope area as a national wildlife refuge. The recreation area and the Saddle Mountain National Wildlife Refuge were renamed the Wahluke Wildlife Recreation and Saddle Mountain Units, respectively, and are managed by the U.S. Fish and Wildlife Service. The Wahluke Slope is a prime example of a shrub-steppe habitat that is quickly disappearing in the Pacific Northwest. This land has served as a safety and security buffer zone for Hanford Site operations since 1943, resulting in an ecosystem that has been relatively untouched.

Historical Operations

The Hanford Site was established in 1943 to use technology developed at the University of Chicago and the Clinton Laboratory in Oak Ridge, Tennessee, to produce plutonium for some of the nuclear weapons tested and used in World War II. Hanford was the first plutonium production facility in the world. The U.S. Army Corps of Engineers selected the site because it was remote from major populated areas and



This historical photo shows 1965 Hanford Site operations in the 100-KE and 100-KW Areas.

had 1) ample electrical power from Grand Coulee Dam, 2) a functional railroad, 3) clean water from the nearby Columbia River, and 4) sand and gravel that could be used for constructing large concrete structures.

Hanford Site operations have produced liquid, solid, and gaseous waste. Most waste resulting from site operations has had at least the potential to contain radioactive materials. Radioactive waste originally was categorized as "high level," "intermediate level," or "low level," which referred to the level of radioactivity present.

Some high-level solid waste, such as large pieces of machinery and equipment, were placed onto railroad flatcars and stored in underground tunnels. Both intermediate- and low-level solid waste, consisting of tools, machinery, paper, and wood were placed into covered trenches at storage and disposal sites known as "burial grounds."

High-level liquid waste was stored in large underground tanks. Intermediate-level liquid waste streams were usually routed to underground structures of various types called "cribs." Occasionally, trenches were filled with the liquid waste and then covered with soil after the waste had soaked into the ground. Low-level liquid waste streams were usually routed to ditches and ponds. Some liquid waste was discharged to the Columbia River.

Hanford at a Glance

Location	The U.S. Department of Energy's Hanford Site is located in southeastern Washington State near the city of Richland.
Dominant Feature	Rattlesnake Mountain on the Fitzner/Eberhardt Arid Lands Ecology (ALE) Reserve rises 1,074 meters (3,525 feet) above the Columbia River Plain.
Size	The site covers approximately 1,517 kilometers (586 square miles).
Employees	DOE and its contractors employed 10,400 workers in fiscal year 1999.
Mission	Hanford's mission is to safely clean up and manage the site's legacy wastes and develop and deploy science and technology.
Budget	The annual budget is approximately $1.6 billion.
History	Hanford was established in secrecy during World War II to produce plutonium for America's nuclear weapons. Peak production years were reached in the 1960s when nine production reactors were operating at the site. All weapons material production was halted in the late 1980s, and the site is now engaged in the world's largest environmental cleanup project.
Prime Contractors	Fluor Hanford, Inc. (nuclear legacy cleanup), Battelle Memorial Institute operates Pacific Northwest National Laboratory (research and development), Bechtel Hanford, Inc. (environmental restoration), Hanford Environmental Health Foundation (occupational and environmental health services), CH2M HILL Hanford Group, Inc. (storing, retrieving and characterizing waste stored in 170 underground tanks), and MACTEC-ERS (tank farm vadose zone characterization).

Mission and Major Activities

For more than 50 years, Hanford Site facilities were dedicated primarily to producing plutonium for national defense and managing the resulting waste. In recent years, efforts at the site have focused on developing new waste treatment and disposal technologies and cleaning up contamination left over from historical operations.

The environmental management mission includes the following:

- **managing waste** and handling, storing, treating, and disposing of radioactive, hazardous, mixed, or sanitary waste from past and current operations
- **stabilizing facilities** by transitioning them from an operating mode to a long-term surveillance and maintenance mode
- **maintaining the Fast Flux Test Facility reactor** and its associated support facilities while alternative future missions for the reactor are explored (e.g., medical isotope production)
- **maintaining and cleaning up** several hundred inactive radioactive, hazardous, and mixed waste disposal sites; **remediating** contaminated groundwater; and **surveillance, maintenance,** and **decommissioning** of inactive facilities.

The science and technology mission includes the following:

- **conducting research and development** in energy, health, safety, environmental sciences, molecular sciences, environmental restoration, waste management, and national security
- **developing new technologies** for environmental restoration and waste management, including site characterization and assessment methods; waste minimization, treatment, and remediation technology.

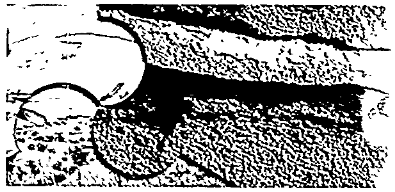
Hanford - The War Years

One month after Enrico Fermi and his team conducted the first controlled nuclear chain reaction, the leaders of the top secret Manhattan Project chose a place to build the world's first, full-scale plutonium production plants. It was a remote, arid site near the farming village of Hanford in southeastern Washington.

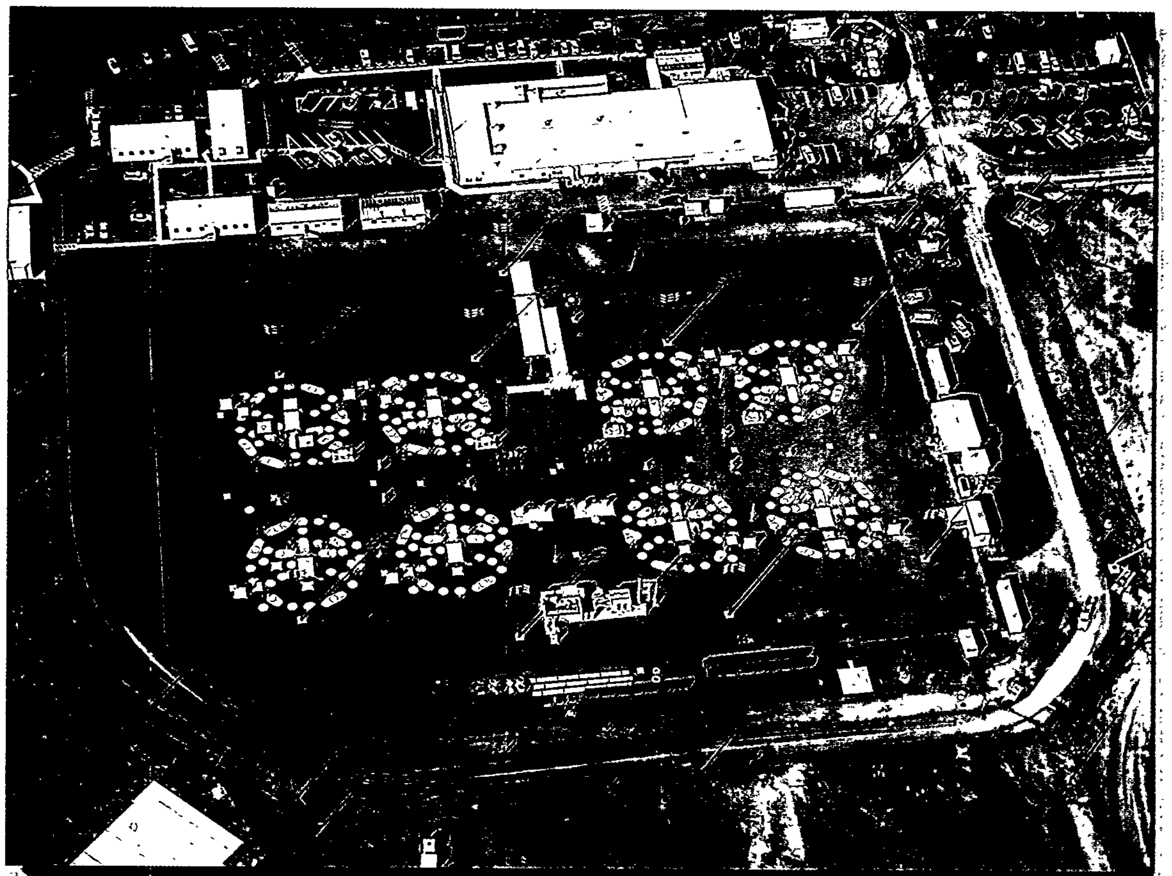
Three plutonium production reactors quickly took shape along the banks of the Columbia River, 35 miles north of the town of Richland. Fuel fabrication, chemical processing, waste management, research, and other support facilities sprang up in other parts of the site.

Thirty months later, Hanford produced the plutonium used for the world's first nuclear detonation. Soon after, U.S. planes dropped two nuclear bombs on Japan to end World War II. One bomb included plutonium made at Hanford.

The unexpected onset of the Cold War and the nuclear arms race brought an urgent demand for plutonium that led to major expansions of Hanford throughout the 1950s. By the end of 1963, nine production reactors and a variety of facilities spanning the nuclear production cycle were operating at the site.



Environmental Management



This photo shows an aerial view of a tank farm in the 200 Areas. Eighteen tank farms contain from 2 to 16 tanks each.

A major focus of DOE's environmental management mission at Hanford is cleanup of the site's Cold War legacy of more than 50 years of nuclear weapons production. Managing this legacy waste—as well other waste from past and current operations—involves safe storage, treatment, and final disposal of a large amount and variety of radioactive and chemical materials. It also involves remediating several hundred inactive waste disposal sites and stabilizing inactive facilities and the material inside them to prevent leaks or avoidable radiation exposures. Environmental restoration and pollution prevention are key parts of the environmental management mission. An agreement between DOE, Washington State Department of Ecology, and the U.S. Environmental Protection Agency (EPA), known as the Tri-Party Agreement, provides the legal and procedural basis for cleanup of waste sites at Hanford. This section describes some current issues and actions related to environmental management at Hanford in 1999.

Waste Storage, Treatment, and Disposal

Waste management at Hanford includes designing, building, and operating a variety of facilities to store, treat, and prepare the waste for disposal. At Hanford, a large part of this process involves safely managing 177 underground storage tanks (149 single-shell tanks and 28 double-shell tanks) that contain 204 million liters (54 million gallons) of high-level liquid waste, enough liquid to fill nearly 2,700 railroad tanker cars. These tanks contain approximately half of all the radioactive and chemical waste at Hanford.

Waste Tanks

The tanks were built in groups called tank farms in the 200-East and 200-West Areas. The farms contain underground pipes so waste can be pumped between tanks.

Since the 1950s, waste leaks from 67 single-shell tanks have been detected, and some of this waste has reached groundwater underlying the 200 Areas. To date, scientists estimate that 2.3 to 3.4 million liters (600,000 to 900,000 gallons) of radioactive waste have leaked from single-shell tanks.

Liquid waste in single-shell tanks is being pumped into the newer, more durable double-shell tanks. All single-shell tanks have exceeded their design life by about 30 years.

Cleanup of the waste stored in the tanks and groundwater remediation are key parts of the site's cleanup activities. Hanford's tanks contain some 40 different kinds of waste that were created from nuclear fuel reprocessing and recovery. The DOE's goal is to safely remove the liquid waste from the tanks, separate the radioactive elements from nonradioactive chemicals, and create a solid form of waste that can be disposed. The approach selected to solidify the waste is called vitrification, a process that turns the liquid into a rocklike glass.

In 1998, Congress established the DOE Office of River Protection to manage storage, treatment, and disposal of the high-level liquid waste stored in the underground tanks. The status of the waste tanks as of December 1999 is as follows:

Waste stored in underground tanks at Hanford can be solid, liquid, or sludge like. This photo shows the surface of waste stored in a double-shell tank.

- number of tanks assumed to have leaked
  - 67 single-shell tanks
  - 0 double-shell tanks
- chronology of single-shell tank leaks
  - 1956: first tank reported as suspected of leaking (tank 241-U-104)
  - 1973: largest estimated leak reported (tank 241-T-106; 435,000 liters [115,000 gallons])
  - 1988: tanks 241-AX-102, -C-201, -C-202, -C-204, and -SX-104 confirmed as having leaked
  - 1992: latest tank (241-T-101) added to list of tanks assumed to have leaked, bringing total to 67 single-shell tanks
  - 1994: tank 241-T-111 was declared to have leaked again
- number of flammable gas tanks (of concern because of the possibility of the generation, retention, and potential release of flammable gases by the tank waste)
  - 19 single-shell tanks

- 6 double-shell tanks

- number of organic tanks (of concern because of the potential for uncontrolled reactions of organic solvents present in some tanks)
  - 2 single-shell tanks (18 tanks were removed from the watch list in December 1998)

During 1999, waste was pumped from 10 single-shell tanks to the double-shell tank system. Portions of waste in tanks numbered 241-SX-104, SX-106, T-104, T-110, S-102, S-103, S-106, U-103, and U-109 (all in the 200-West Area) were removed, and the majority of waste in tank 241-C-106 (in 200-East Area) was removed.

So far, 120 single-shell tanks have been stabilized; the tank stabilization program is scheduled to be completed in 2004. At the end of 1999, 108 single-shell tanks had intrusion prevention devices completed, and 51 single-shell tanks were disconnected from the piping system and capped to avoid inadvertent liquid additions to the tanks.

Immobilization of Waste Contained in Underground Tanks

The DOE River Protection Program is currently upgrading facilities to deliver waste to a planned treatment facility. Treatment will separate the waste into a low-radioactivity fraction and a high-radioactivity and transuranic fraction. Both fractions will be vitrified in a process that will destroy or extract organic constituents, neutralize or deactivate dangerous waste, and immobilize toxic metals. The immobilized low-radioactivity portion will be disposed of in a facility on the Hanford Site. The immobilized high-radioactivity fraction will be stored onsite until a geologic repository is available offsite for permanent disposal. Tri-Party Agreement milestones specify December 2028 for completion of pretreatment and immobilization of the tank wastes.

At this time, work continues to design and obtain permits for the vitrification plant. DOE is seeking a new contractor to complete the design and construction of the plant and is trying to maintain the agreed upon schedule.

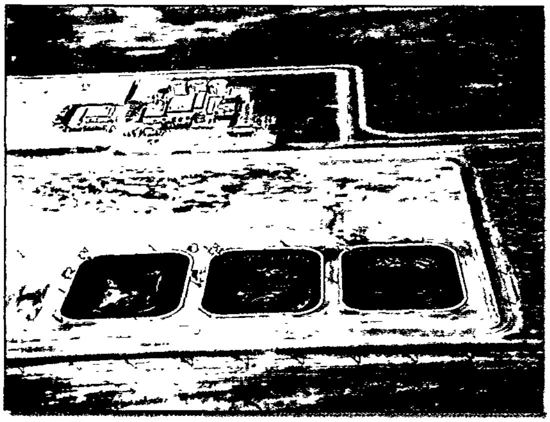
Defining Waste

Waste produced from Hanford Site cleanup operations is classified as either radioactive, nonradioactive, mixed, or hazardous. Radioactive waste is categorized as transuranic, high-level, and low-level.

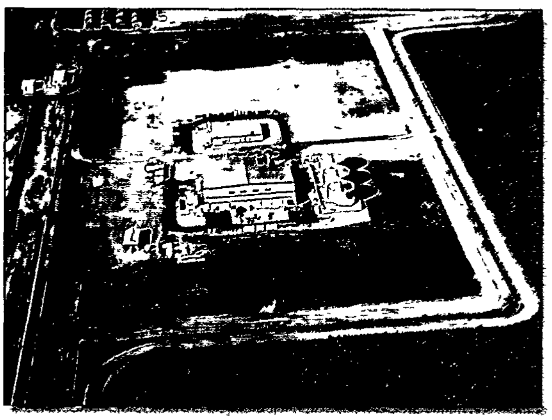
- **High-level waste** is waste that results from processing of highly radioactive material such as spent nuclear fuel.
- **Hazardous waste** is nonradioactive waste that is toxic, corrosive, flammable, or explosive and may pose a threat to human health or the environment. This type of waste may contain specific elements such as lead and mercury, pesticides such as DDT, or cancer-producing compounds such as PCBs and dioxin.
- **Mixed waste** contains both low-level radioactive material and hazardous nonradioactive substances.
- **Transuranic waste** is material (excluding high-level waste and certain other waste materials) contaminated with alpha-emitting isotopes that have atomic numbers greater than 92, have half-lives greater than 20 years, and occur in concentrations greater than 100 nanocuries per gram (100 billionths of a curie per gram).
- **Low-level waste** is waste that does not require shielding during handling or transportation. It can include such things as contaminated clothing, tools, or equipment.

Liquid Waste Management

Liquid waste, called effluent (any treated or untreated liquid discharge at a DOE site or facility), is managed in storage, treatment, and disposal facilities in compliance with Resource Conservation and Recovery Act (RCRA) and state regulations.



The three basins shown in the foreground of this photo of the Liquid Effluent Retention Facility are constructed of two, flexible, high-density polyethylene membrane liners.



The 200 Areas Treated Effluent Disposal Facility treats and stores radioactive waste.

The 300 Area Treated Effluent Disposal Facility treats wastewater from laboratories, research facilities, and former fuel fabrication facilities on the Hanford Site.

242-A Evaporator

The 242-A evaporator processes double-shell tank waste into a concentrate (that is returned to the tanks) and a process condensate stream. In 1999, the evaporator treated 3.83 million liters (1,012,000 gallons) of tank waste to produce 3.56 million liters (940,000 gallons) of liquid waste that were send to the Liquid Effluent Retention Facility.

Liquid Effluent Retention Facility

This facility consists of three surface basins that store and treat condensate from the 242-A evaporator and other liquid waste. Approximately 38.8 million liters (10.3 million gallons) of liquid waste were stored in the facility's basins at the end of 1999.

200 Areas Treated Effluent Disposal Facility

This facility is a collection and disposal system for non-RCRA-permitted waste that has been treated using "best available technology/all known and reasonable treatment." There are 14 waste generating facilities in the 200 Areas that send waste to the 200 Areas Treated Effluent Disposal Facility.

This facility began operation in April 1995 and has a capacity of 12,900 litres per minute (3,400 gallons per minute). Approximately 534 million liters (141 million gallons) of effluent were discharged to two 2-hectare (5-acre) disposal ponds located east of the 200-East Area. The discharge permit requires monitoring of the effluent and the groundwater to ensure that concentrations for certain constituents are not exceeded.

300 Area Treated Effluent Disposal Facility

Industrial wastewater generated throughout the Hanford Site is accepted and treated in the 300 Area Treated Effluent Disposal Facility. Laboratories, research facilities, office buildings, and former fuel fabrication facilities in the 300 Area constitute the primary sources of wastewater. Wastewater consists of cooling water, stream condensate, and other industrial wastewaters. The facility treated approximately 223 million liters (59 million gallons) of wastewater in 1999.

Solid Waste Management

Storage, treatment, and disposal of solid waste takes place at a number of locations on the Hanford Site, such as those described in the following paragraphs. Solid waste may be from work on the Hanford Site or from sources offsite that are authorized by DOE to ship waste to the site.

Central Waste Complex

Ongoing cleanup and research and development activities on the Hanford Site, as well as remediation activities, generate the waste received at the Central Waste Complex. Offsite waste comes primarily from DOE research facilities, other DOE sites, and Department of Defense facilities. The waste includes low-level, transuranic, mixed waste, and radioactively contaminated polychlorinated biphenyls.

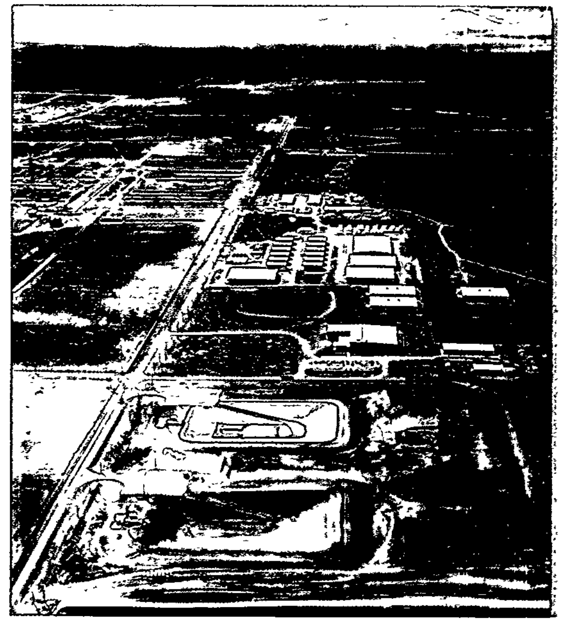
Waste Receiving and Processing Facility

The Waste Receiving and Processing Facility analyzes and characterizes waste resulting from plutonium operations at Hanford. Waste destined for the facility includes Hanford's legacy waste as well as materials generated from current and future site cleanup activities. The waste consists primarily of clothing, gloves, face masks, small tools, and particulates suspected of being contaminated with plutonium. Waste containers may also contain other radioactive materials and hazardous components.

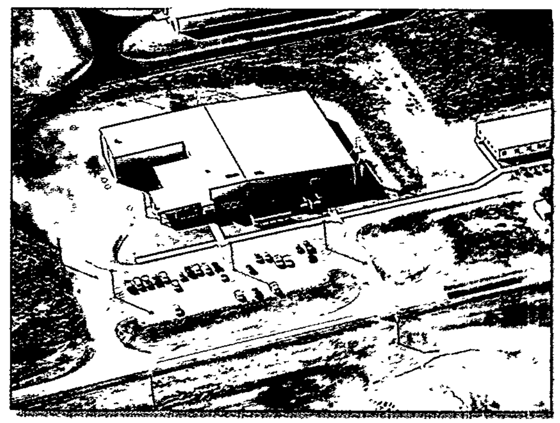
Navy Reactor Compartments

Nine disposal packages containing defueled U.S. Navy reactor compartments were received and placed in Trench 94 in the 200-East Area during 1999. Three reactor compartments were from submarines and six were from cruisers. This brings the total number of reactor compartments received to 86. All reactor compartments shipped to the Hanford Site for disposal have originated from decommissioned nuclear-powered submarines or cruisers.

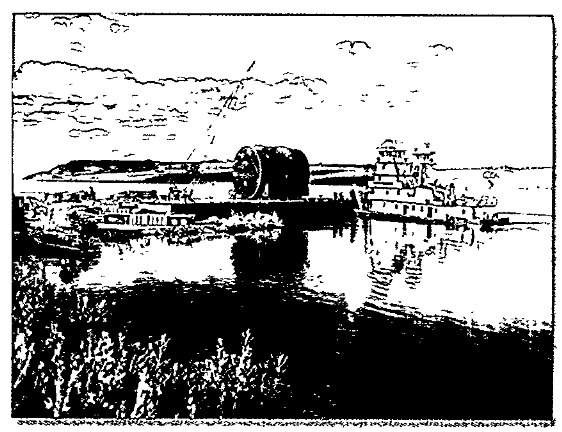
Washington State Department of Ecology regulates the disposal of reactor compartments as dangerous waste because lead is used as shielding. The reactor compartments are also managed as mixed waste because of their radioactivity.



The Central Waste Complex receives waste from Hanford Site cleanup activities and from other DOE and Defense Department Facilities.



Clothing, gloves, masks, and small tools suspected of being contaminated with plutonium are sent to the Waste Receiving and Processing Facility.



Defueled reactor components from nuclear-powered submarines and cruisers are barged to the Hanford Site and buried in a trench in the 200-East Area.

Environmental Restoration

Environmental restoration at Hanford involves stabilizing contaminated soil; remediating disposal sites; decontaminating, decommissioning, and demolishing former plutonium production process buildings, nuclear reactors, and separation plants; and mitigating effects to biological resources from site development and environmental cleanup and restoration activities. The following subsections briefly describe activities at Hanford related to these areas of the site mission.

Waste Site Remediation

Remediation of waste sites continued through 1999 at several liquid waste disposal sites in the 100-B/C and 100-D Areas. In March 1999, remediation work began in the 100-HR Area. Over 450,000 metric tons (500,000 tons) of contaminated soil has been removed and transported to the Environmental Restoration Disposal Facility.

In the 100-B/C Area, 51,700 metric tons (57,000 tons) of soil were removed in 1999 from 13 different waste sites. Through December 1999, 621,100 metric tons (685,000 tons) of contaminated soil have been removed and shipped to the Environmental Restoration Disposal Facility. Backfill activities were completed at five waste sites.

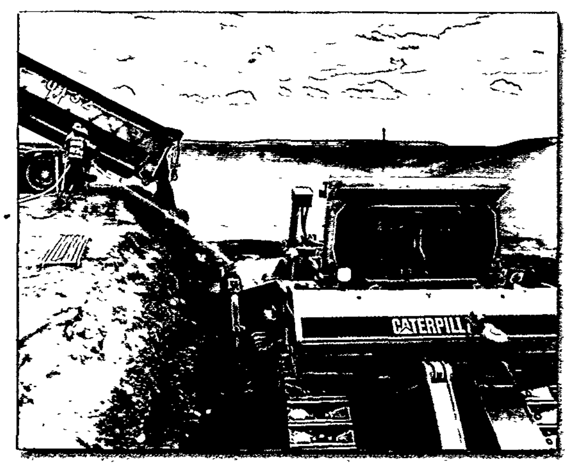
In the 100-DR Area, 112,200 metric tons (124,000 tons) of soil were removed from 15 waste sites. The removal of liquid discharge pipelines at 100-DR Area was the first significant removal of pipe at the reactors. Through December 1999, 549,000 metric tons (610,000 tons) of contaminated soil were removed and shipped to the Environmental Restoration Disposal Facility.

In the 100-HR Area, 200,000 metric tons (224,000 tons) of soil were removed from six waste sites and around effluent pipelines. The startup of remedial actions at 100-HR completed Tri-Party Agreement milestone M-16-26A.

Environmental Restoration Disposal Facility

This 918,000-cubic meter (1,200,000-cubic yard) earthen disposal facility is located near the 200-West Area. Constructed with double liners and a leachate collection system, the facility was designed to serve as the central disposal site for contaminated waste removed during cleanup operations conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) on the Hanford Site.

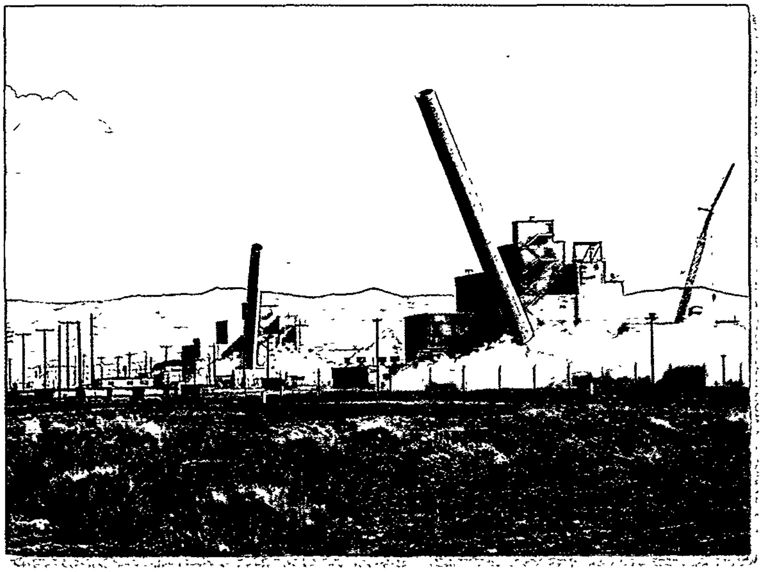
Cleanup materials may include soil, rubble, or other materials (excluding liquids) contaminated with hazardous, low-level radioactive or mixed (combined hazardous chemical radioactive) waste. In 1999, the facility was expanded to provide additional storage space for contaminated materials from ongoing cleanup work.



The Environmental Restoration Disposal Facility serves as a central disposal site for contaminated waste removed during Hanford cleanup operations.

Decommissioning Project

Decontamination and decommissioning continued in 1999 in the 100-DR and 100-F Areas. During the year, ancillary facilities that supported



In 1999, two 200-foot exhaust stacks were demolished at the 100-D/DR Area as part of site decontamination and decommissioning activities.

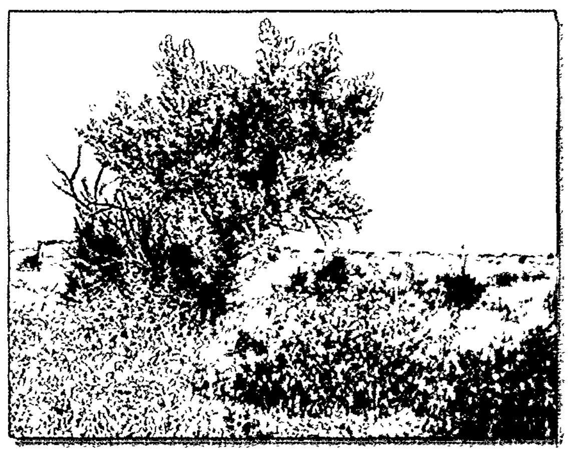
the DR and F reactors were removed and disposed. The activities support the interim safe storage of the reactor buildings. Other decontamination and decommissioning work was completed during the year at the 100-D/DR Area and 100-F Area. A four-story laboratory (108-F) located near the F Reactor was decontaminated and demolished. Two, 200-foot exhaust stacks were demolished by explosive demolition at the 100-D/DR Area. The stack rubble was packaged and shipped to the 200 Area Environmental Restoration Disposal Facility for final disposal.

Revegetation and Mitigation Planning

A DOE contractor planted 77 hectares (190 acres) of sagebrush in several small areas on the Fitzner/Eberhardt Arid Lands Ecology Reserve to mitigate the effects from new construction on the Environmental Restoration Disposal Facility in 1998. Representative plots of each area were selected, and sagebrush survival was estimated. Low survival was noted at two of the plots. In December 1999, an additional 250 sagebrush seedlings were planted to compensate for the low survival rates.

In 1997, bitterbrush plants were salvaged from the perimeter of the 618-4 burial ground (600 Area) and transplanted to the area surrounding the burial ground. An additional 293 container grown sagebrush seedlings were planted adjacent to the bitterbrush to make up for the loss of mature shrubs during remediation of the burial ground. Examination of the plantings showed that all the bitterbrush and 46% of the planted sagebrush died. In November 1999, the dead sagebrush plants were replaced with new sagebrush seedlings. In addition to planting 126 sagebrush seedlings, 50 bitterbrush seedlings were planted east of the 618-4 burial ground. All bitterbrush plants were protected with biodegradable plastic mesh tubes that were staked into the ground to prevent browsing by deer.

A second bat gate was installed at the DR Reactor building allowing access to both noncontaminated process water tunnels. These tunnels provide habitat for a Washington State pro-



Efforts are underway to protect sagebrush and restore it to damaged habitats.

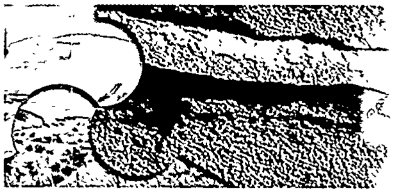
tected bat species that has been living in the reactor building. The bat gates were constructed to allow bats into the tunnels while preventing human intrusion. An existing structure at the DR Reactor building was used to preserve an important maternity roost that bats have used for many years.

Revegetation of 100-B,C liquid effluent disposal sites 116-C-5, 116-B-1, and 116-B-11 was completed as part of the CERCLA Remedial Action Project for the 100-B,C Area. The 5.27 hectares (13 acres) sites were replanted with Sandberg's bluegrass, needle-and-thread grass, sagebrush, snow buckwheat, Carey's Balsamroot, yarrow, and small amounts of cushion fleabane and Piper's daisy.

Pollution Prevention Program

The Hanford Site Pollution Prevention Program is an organized and continuing effort to reduce the quantity and toxicity of hazardous, radioactive, mixed, and sanitary wastes (mixed waste contains both hazardous chemical components and radioactive components).

In 1999, pollution prevention efforts on the Hanford Site helped reduce the amount of material disposed by using source reduction and by recycling an estimated 2.8 cubic meters (3.7 cubic yards) of radioactive mixed waste, 164 metric tons (362 tons) of RCRA hazardous/dangerous waste, 144 million liters (38 million gallons) of process wastewater, and 5,616 metric tons (12,380 tons) of sanitary waste. Estimated savings in waste disposal costs in 1999 exceeded $54 million.



Compliance with Environmental Regulations

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The foothills of Rattlesnake Mountain lie within the Fitzner/Eberhardt Arid Lands Ecology Reserve.

Environmental standards and regulations applicable at DOE facilities fall into three categories: 1) DOE directives; 2) federal legislation and executive orders; and 3) state and local statutes, regulations, and requirements.

Several federal, state, and local government agencies monitor and enforce compliance with applicable environmental regulations at the Hanford Site. Major agencies include the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology, Washington State Department of Health, and Benton Clean Air Authority. These agencies issue permits, review compliance reports, participate in joint monitoring programs, inspect facilities and operations, and/or oversee compliance with applicable regulations. DOE, through compliance audits and its directives to its field offices, initiates and assesses actions for compliance with environmental requirements.

Table 1 summarizes DOE's compliance with environmental regulations in 1999. Performance related to the Hanford Federal Facility Agreement and Consent Order and environmental occurrence reports are described in

Table 1. How Well did the Hanford Site Comply with Environmental Regulations in 1999?[a]

Act	Compliance Status
Comprehensive Environmental Response, Compensation, and Liability Act	In compliance
Emergency Planning an Community Right-to-Know Act	In compliance
Resource Conservation and Recovery Act	DOE and Hanford Site contractors are working to resolve several notices of violations and warning letters issued by the Washington State Department of Ecology in 1999.
Clean Air Act	There were several compliance findings following inspections by the Washington State Departments of Health and Ecology in 1999. Most were resolved but one was unresolved at the end of the calendar year.
Clean Water Act	NPDES permit violations occurred at the 300 Area Treated Effluent Disposal Facility. Metal concentrations in effluents slightly exceeded permit limits on six occasions, and sample analyses were not performed as they should have been on three occasions.
Safe Drinking Water Act	In compliance
Toxic Substances Control Act	The EPA issued one Federal Facility Notice of Significant Noncompliance in 1999 that included 16 corrective actions.
Federal Insecticide, Fungicide, and Rodenticide Act	In compliance
Endangered Species Act	In compliance
National Historic Preservation Act	In compliance
Archaeological Resources Protection Act	In compliance
Native American Graves Protection and Repatriation Act	In compliance
American Indian Religious Freedom Act	In compliance
Historic Sites Buildings and Antiquities Act	In compliance
Archaeological and Historic Preservation Act	In compliance
American Antiquities Preservation Act	In compliance
National Environmental Policy Act	In compliance

(a) See the *Hanford Site Environmental Report for Calendar Year 1999* for more information on these federal acts and related state and local regulations.
NPDES = National Pollutant Discharge Elimination System.

the following subsections. An environmental occurrence is any sudden or sustained deviation from a regulated or planned performance at a DOE operation that has environmental protection and compliance significance.

Hanford Federal Facility Agreement and Consent Order

This order (also known as the Tri-Party Agreement) is an agreement among the Washington State Department of Ecology, EPA, and DOE to achieve environmental compliance at the Hanford Site with CERCLA, including the Superfund Amendments and Reauthorization Act of 1986 remedial action provisions, and RCRA storage, treatment, and disposal unit regulation and corrective action provisions.

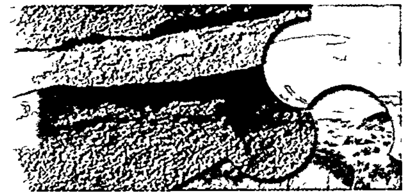
The Tri-Party Agreement 1) defines the RCRA and the CERCLA cleanup commitments, 2) establishes responsibilities, 3) provides a basis for budgeting, and 4) reflects a concerted goal to achieve regulatory compliance and remediation with enforceable milestones in an aggressive manner. Also, the Tri-Party Agreement contains requirements for how to involve the public.

The Tri-Party Agreement has continued to evolve as cleanup of the Hanford Site progresses. Significant changes to the agreement have been negotiated between the Washington State Department of Ecology, EPA, and DOE to meet the changing conditions and needs of the cleanup. The most complex changes were worked out in 1993 with further modifications each year since. All significant changes to the agreement undergo a process of public involvement that ensures communication and addresses the public's values prior to final approvals.

From 1989 through 1999, 636 enforceable milestones and 253 unenforceable target dates were completed on or ahead of schedule. In 1999, there were 44 specific cleanup milestones and target dates scheduled for completion: 41 were completed on or before their required due dates, 2 were delayed because of privatization issues, and 1 was delayed because of RCRA barrier concerns.

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 filed in 1999, but one environmentally significant unusual occurrence report was filed. Several off-normal environmental release-related occurrence reports were filed during 1999.

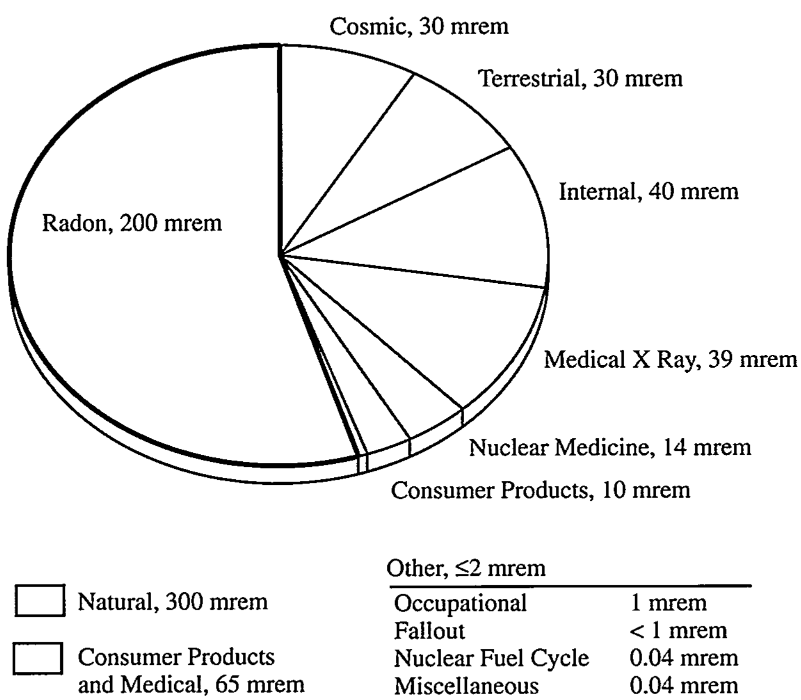


Potential Radiological Doses from 1999 Hanford Operations

In 1999, scientists evaluated potential radiological doses to the public resulting from exposure to Hanford Site liquid and airborne effluents to determine compliance with pertinent regulations and limits. These doses were calculated with Version 1.485 of the GENII computer code and Hanford-specific parameters using reported effluent releases and environmental surveillance data.

The potential dose to the maximally exposed individual in 1999 from site operations was 0.008 millirem (0.08 millisievert). Special exposure scenarios not included in this dose estimate include 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 were small compared to the DOE dose limit. Radiological dose through the air pathway was 0.03% of the EPA limit of 10 millirem per year (0.1 millisievert per year).

As Figure 2 shows, the national average dose from background sources, according to the National Council on Radiation Protection, is approximately 300 millirem per year (3 millisievert per year); the current DOE radiological dose limit for a member of the public is 100 millirem per year (1 millisievert per year). Therefore, the average individual potentially received 0.0007% of the DOE limit and 0.0002% of the national average background.



Other, ≤2 mrem	
Occupational	1 mrem
Fallout	< 1 mrem
Nuclear Fuel Cycle	0.04 mrem
Miscellaneous	0.04 mrem

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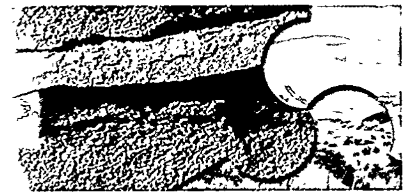
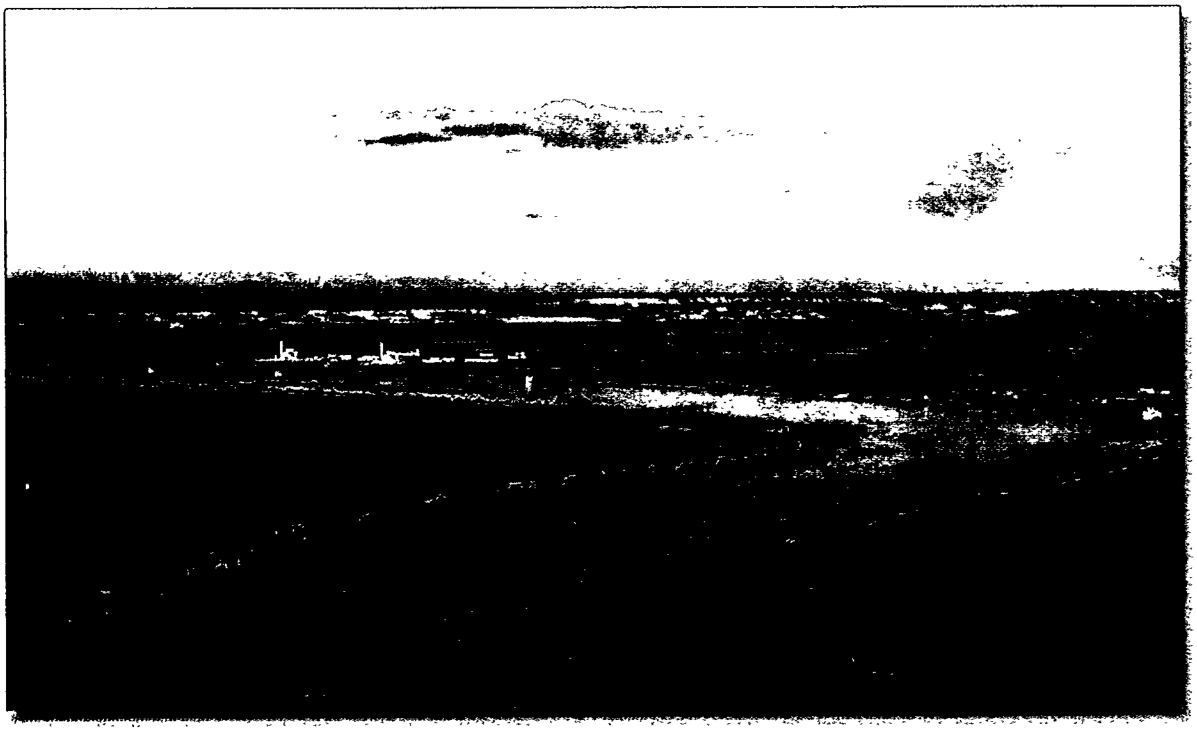
Figure 2. The National Council on Radiation Protection and Measurements estimates annual average radiological doses.

A Summary of Potential Radiological Doses from 1999 Hanford Operations

Radiological Dose Assessments	Dose Parameters	Dose
Annual DOE radiological dose limit for a member of the public	The dose limit includes air, drinking water, food, recreation and external radiation exposure pathways.	100 millirem
Maximally exposed individual	This individual's diet, dwelling place, and other factors were chosen to maximize the combined doses from all reasonable environmental pathways of exposure to radionuclides in Hanford Site effluents. In 1999, this individual was located at Sagemoor, 1.5 kilometers (1 mile) directly across the river from the 300 Area.	0.008 millirem
Average per capita dose	The average per capita dose is based on a population of 380,000 within 80 kilometers (50 miles) of the onsite operating areas.	0.0007 millirem
Maximum Hanford Site boundary dose	Boundary dose rates are not used to calculate annual doses to the general public because no one can actually reside at the boundary locations. The highest boundary location exposure rate in 1999 was measured along the 100-N Area shoreline of the Columbia River.	0.02 millirem per hour
Sportsman dose	The sportsman's dose is an estimate of the dose that could result if wildlife containing the maximum levels measured in onsite wildlife in 1999 were hunted and eaten. The rate is calculated for a person eating 1 kilogram (2.2 pounds) of rabbit contaminated with cesium-137 at 0.051 pico curies per gram (the maximum concentration measured in any rabbit collected at Hanford in 1999).	~0.003 millirem
	The dose from eating 1 kilogram (2.2 pounds) of goose flesh contaminated with 0.047 picocurie per gram (the maximum concentration measured in any goose collected at Hanford in 1999).	~0.002 millirem
Dose to people consuming Fast Flux Test Facility drinking water	The potential dose to Fast Flux Test Facility workers assumes a consumption of 1 liter of drinking water per day (0.26 gallon per day) for 240 days.	~0.02 millirem
Individual dose from non-DOE sources	Various non-DOE industrial sources of public radiation exposure exist at or near the Hanford Site.	~0.05 millirem



Environmental Monitoring



Samples of surface water are collected and analyzed on and around the Hanford Site to determine any potential impact to the public and the aquatic environment from Hanford-originated radiological or chemical contaminants.

Environmental monitoring at the Hanford Site consists of collecting and analyzing samples of air, surface water, drinking water, soil, natural vegetation, agricultural products, fish, and wildlife. In addition, external radiation levels in the environment are monitored, and radiological surveys are conducted to monitor and detect contamination. Air emissions and liquid discharges that may contain radioactive or hazardous materials are also monitored at and near site facilities.

The purpose of these monitoring programs is to measure chemical and radiological contaminants in the environment on and around the Hanford Site and assess the effects of these contaminants, if any, on the environment and the public. Information obtained from these efforts are provided to federal, state, county, and city agencies, regional Indian tribes, the general public and other stakeholders. The collected data are used to document Hanford Site compliance with applicable federal, state, and local regulations; confirm adherence to DOE environmental protection policies; and support environmental management decisions.

Radiological and chemical constituents in groundwater at the Hanford Site also are monitored to characterize physical and chemical trends in the groundwater flow system, establish groundwater quality baselines, assess groundwater remediation, and identify new or existing groundwater problems.

The following subsections briefly describe environmental monitoring activities on and near the Hanford Site in 1999. For further details, see the *Hanford Site Environmental Report for Calendar Year 1999*.

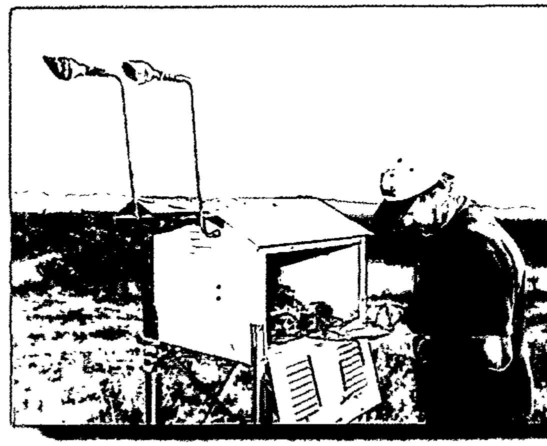
Air

Atmospheric releases of radioactive material from the Hanford Site to the surrounding region are a potential source of human exposure. Radioactive constituents in air are monitored at a number of locations on and around the Hanford Site.

Small quantities of tritium, cobalt-60, strontium-90, ruthenium-106, antimony-125, iodine-129, cesium-134, cesium-137, europium-154, plutonium-238, plutonium-239/240, plutonium-241, and americium-241 were released to the air at Hanford through state and federally permitted release points. These release points (usually a stack or a vent) are located in the 100, 200, 300, and 400 Areas.

In the 100 Areas, radioactive airborne emissions originated from five points: the deactivation of N Reactor, K-East and K-West fuel storage basins that contain irradiated fuel, the 1706-KE laboratory facility, and from sample preparation at the radiological counting facility. In the 200 Areas, 49 radioactive emission points were active in 1999. Primary sources of radionuclide emissions were the Plutonium-Uranium Extraction Plant, Plutonium Finishing Plant, T Plant, 222-S Laboratory, underground waste storage tanks, and waste evaporators.

In 1999, 23 radioactive emission discharge points were active in the 300 Area. Primary sources of radioactive emissions were the 324 Waste Technology Engineering Laboratory, 325 Applied Chemistry Laboratory, 327 Post-Irradiation Laboratory, and 340 Vault and Tanks. Radioactive emissions were from research and development work and waste handling operations. The 400 Area had five radioactive emission discharge points active during 1999 at the Fast Flux Test Facility, Maintenance and Storage Facility, and Fuels and Materials Examination Facility. The 600 Area had two radioactive emission points active during 1999.



Scientists monitor radioactive constituents in air at numerous locations on the Hanford Site and in nearby distant communities. Local teachers have managed and operated community-operated environmental monitoring stations at nine locations since 1990.

Sampling Near Facilities

Radioactivity in air was sampled by a network of continuously operating samplers at 85 locations near the facilities. Air samplers were primarily located within approximately 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 compared to the levels measured off the site.

Sampling Onsite and in Nearby/ Distant Communities

Radioactive materials in air were sampled at 44 operating locations on the Hanford Site, at the site perimeter, and in nearby and distant communities. Nine locations were community-operated environmental surveillance stations managed and operated, since 1990, by local teachers.

At all locations, particulates were filtered from the air and analyzed for radionuclides. Air was sampled and analyzed for selected airborne 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 operations. 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.

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

Annual average atmospheric 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, 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 Hanford Site perimeter compared to the distant locations, indicating a measurable Hanford source; however, the average level at the site perimeter was only 0.000001% of the DOE derived concentration guide of 70 picocuries per cubic meter. The DOE derived concentration guide is the air concentration that would result in a radiation dose equal to the DOE public dose limit (100 millirem per year). The derived concentration guide is defined as concentrations of radionuclides in air and water that an individual could continuously consume, inhale, or be immersed in at average annual rates, and not receive an effective dose equivalent of greater than 100 millirem per year.

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 0.003% of the DOE derived concentration guide of 9 picocuries per cubic meter.

Plutonium-239/240 annual average concentrations were not significantly different at distant community locations. The average concentration at the perimeter locations was less than 0.002% of the DOE derived concentration guide of 0.02 picocuries per cubic meter.

Uranium isotopic concentrations (uranium-234, -235, and -238) were similar on the site, at the perimeter, and at distant locations in 1999. The annual average uranium concentration at the site perimeter was 0.03% of the 0.1 picocuries per cubic meter DOE derived concentration guide.

Surface Water, Sediment, and Drinking Water

Samples of surface water and sediment on and around the Hanford Site are collected and analyzed to determine the potential impact to the public and the aquatic environment from Hanford-originated radiological and chemical contaminants. Surface water bodies include the Columbia River and associated riverbank springs, onsite ponds, and an offsite irrigation canal. The quality of drinking water at Hanford also is monitored routinely. Samples are collected, analyzed, and data are compared with established federal and state drinking water standards and guidelines.

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Scientists sample and analyze sediment from the Columbia River for radiological and chemical contaminants.

100-N Springs

Groundwater springs along the 100-N Area shoreline are sampled annually to monitor and quantify contaminants entering the Columbia River from past N Reactor operations. Spring samples were collected from shallow groundwater wells located along the river shoreline. One well was sampled monthly and ten others were sampled once during 1999. The highest tritium concentration detected was 3,200 picocuries per liter, and the highest strontium-90 concentration measured was 270 picocuries per liter. All gamma-emitting radionuclide concentrations were below analytical detection limits in 1999. The amount of spring water entering the river along the 100 N Area shoreline was estimated to be 43 liters per minute.

Columbia River

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 a contribution along the Hanford Reach.

Transect sampling (multiple samples collected across the river) 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 shorelines 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 Washington State ambient surface-water quality criteria levels. 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 also 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 concentrations 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 spring sediment. The highest maximum and median concentrations of chromium were found in riverbank springs sediment.

Riverbank Springs

Water samples were collected from eight Columbia River shoreline spring areas along the Hanford Site in 1999. All concentrations of radiological contaminants measured in riverbank spring water were less than the DOE derived concentration guides. However, the spring at the 100-N Area that historically has 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. Currently, there are 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, and 100-H Area and 300 Area riverbank springs. Arsenic concentrations in water from riverbank springs water were well below the applicable state ambient surface water chronic toxicity levels, but concentrations in all samples exceeded the federal limit. Nitrate concentrations at all locations were below the EPA drinking water standard.

Onsite Ponds

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.

With the exception of uranium-234 and uranium-238 in water samples from West Lake, radionuclide concentrations in the onsite pond water were below the DOE derived concentration guides. The median gross alpha, gross beta, and total uranium concentrations in West Lake exceeded applicable ambient surface-water quality criteria levels. Concentrations of most radionuclides in water collected from onsite ponds in 1999 were similar to those observed during past years.

Irrigation Canal

Irrigation water from the Riverview Canal near Pasco was sampled three times in 1999 to determine radionuclide levels. Water from this canal is obtained from the Columbia River downstream of the Hanford Site. 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

Radiological 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. 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.

Soil and Vegetation

Soil and perennial vegetation samples have been collected on and around the Hanford Site for more than 50 years. Because the current Hanford Site mission includes cleanup and environmental restoration, and because plutonium production operations have ceased, the need for annual soil and perennial vegetation surveillance has diminished. However, in 1999, samples were collected at waste disposal units, along the Columbia River shoreline, and in and around the former 1100 Area. Soil and vegetation samples were also collected from, or near, operating areas.

Waste Disposal Units

Soil and vegetation samples were collected on or adjacent to waste disposal units and from locations downwind and near or within the boundaries of Hanford Site operating facilities. Samples were collected to detect potential migration and deposition of facility effluents.

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 activities 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 activities than those collected farther away. In 1999, there were 42 instances of radiological contamination in soil samples and 85 instances of vegetation contamination. The number of contaminated vegetation incidents was the highest seen in recent years.

Vegetation samples are routinely collected on and around the Hanford Site.

Columbia River Shoreline and 1100 Area

Routine soil and vegetation samples were not collected 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.

Food and Farm Products

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, alfalfa, and wine were collected from several areas around the site. Samples were collected primarily from downwind directions (south and east of the site) where airborne effluents or fugitive dust from the Hanford Site could be deposited. Samples also were collected in generally upwind directions and at locations somewhat distant from the site to provide information on background radioactivity. Samples were analyzed for cobalt-60, strontium-90, iodine-129, cesium-137, and tritium.

In 1999, milk, vegetables, fruit, alfalfa, and wine samples were collected from several locations around the Hanford Site and analyzed for radioactive constituents.

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 downwind locations. Levels of iodine-129 in milk collected at downwind locations have remained relatively stable for the last 5 years.

Strontium-90 was detected in only 1 of 12 milk samples analyzed in 1999. That 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 man-made radioactivity were not detected in vegetable and fruit samples collected in 1999.

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A resident herd of more than 800 elk makes its home on the Hanford Site. Elk are one of 39 mammal species that occur on the site.

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 last 5 years.

Fish and Wildlife

Contaminants in fish and wildlife that inhabit the Columbia River and Hanford Site are monitored for several reasons. Wildlife have access to areas of the site containing radioactive or chemical contamination, and fish can be exposed to contamination entering the river along the shoreline. Fish and some wildlife species exposed to Hanford contaminants might be harvested for food and may potentially contribute to offsite public exposure.

Bass, whitefish, and large-scale suckers were collected from the Columbia River near Hanford 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 background area fish.

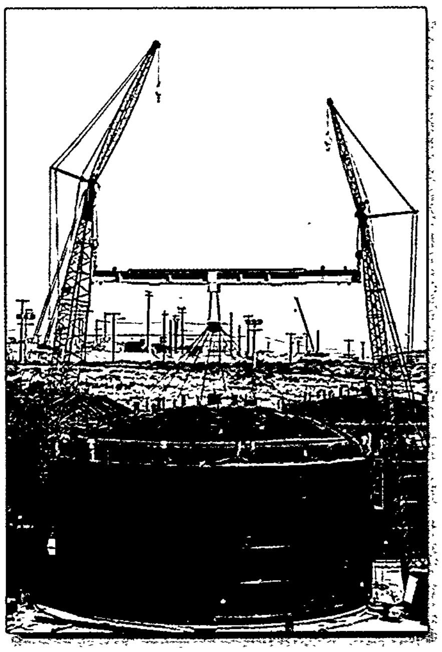
Wildlife sampled and analyzed in 1999 for radioactive constituents included elk, geese, and rabbits. Radionuclide levels in Hanford-resident geese and elk were similar to levels in wildlife collected at reference background locations. Cesium-137 was not detected in any of the goose and elk samples analyzed, and the highest strontium-

90 levels were seen in elk collected in Idaho. Levels of cesium-137 and strontium-90 also were low in most rabbit samples, but levels in one rabbit collected in the 100-N Area were high enough to suggest some onsite exposure to Hanford Site contaminants.

Wildlife samples were also collected directly from, or near, facilities to monitor the effectiveness of measures designed to deter animal intrusion. In 1999, nine wildlife and wildlife-related samples were submitted for analysis. Seven of the nine samples showed detectable levels of radiological contamination. The maximum concentrations were seen in mouse feces collected near the A tank farm in the 200 East Area. Contaminants included strontium-90 (394,000 picocuries per gram), cesium-137 (75,000 picocuries per gram), and total uranium (1,150,000 picocuries per gram).

Radiological Surveys and External Radiation

Radiological surveys conducted during 1999 showed that there were approximately 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 are associated with waste 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. Since 1998, new areas of contamination have been identified. It was estimated that the external dose rate at 80% of the identified outdoor contamination areas was less than 1 millirem per hour 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 workers in 1999.



The Hanford Site contains 177 cylindrical underground storage tanks with holding capacities ranging from 55,000 to 4.1 million liters (14,530 to 1.1 million gallons). These tanks contain 204 million liters (54 million gallons) of hazardous and radioactive wastes–enough to fill nearly 2,800 railroad tanker cars.

External radiation also is surveyed on the Hanford Site. External radiation is defined as radiation originating from a source external to the body. External radiation consists of a natural component and a man-made component, which includes radionuclides generated for or from nuclear medicine, power, research, waste management, and consumer products containing nuclear materials (such as home smoke detectors).

Near Facilities

External radiation fields were measured near facilities and waste handling, storage, and disposal sites to assess and control the impact 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.

Readings from five thermoluminescent dosimeter locations in the 100-D/DR Area at the 116-D-7 and 116-DR-9 water retention basins were comparable to offsite background levels.

Thermoluminescent dosimeters were 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 increased noticeably in 1999 as the result of activities associated with 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, including 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 approximately 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 millirem per year, approximately 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

The Environmental Restoration Disposal Facility, located near the 200-West Area was expanded in 1999 to provide additional storage space for contaminated materials from ongoing cleanup and remeditation work on the Hanford Site.

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.

Onsite and Offsite Locations

During 1999, thermoluminescent dosimeters were used to measure radiological dose rates at both onsite and offsite locations. 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 considered distant from the Hanford Site, was 74 ± 2 millirem per year. The

1999 annual average perimeter dose rate was 90 ± 4 millirem per year.

All onsite thermoluminescent dosimeters averaged 88 ± 3 millirem per year in 1999. Columbia River shoreline dosimeters had a 1999 average of 91 ± 6 millirem per year.

The average dose rate along the 100-N Area shoreline (120 ± 26 millirem per year) was approximately 50% higher than the typical shoreline dose rate (86 ± 5 millirem per year).

Groundwater and Vadose Zone

In 1999, samples were collected from over 600 monitoring 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 evaluate potential impacts of groundwater contaminants.

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 groundwater and vadose zone contamination. The vadose zone is the region between the ground surface and the top of the water table. 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.

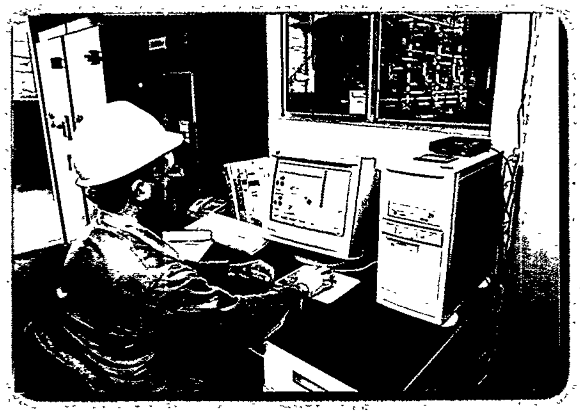
Groundwater Protection and Monitoring

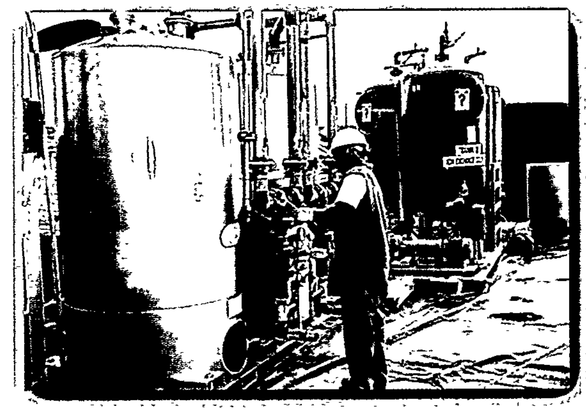
To assess the quality of groundwater, measured sample concentrations were compared with EPA drinking water standards and DOE derived concentration guides. Groundwater is used for drinking at three locations on the Hanford Site. In addition, water supply wells for the city of Richland are located near the southern boundary of the Hanford Site.

Radiological constituents detected at levels greater than their respective EPA drinking water standards in one or more onsite wells included tritium, iodine-129, technetium-99, uranium, strontium-90, cesium-137, 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 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 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 tritium plume of high contration in the 100-K Area also may discharge to the river. Tritium in groundwater at levels greater than the EPA drinking water standard was 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.





Pump-and-treat systems were constructed in the 100-D, 100-H, and 100-K Areas in the late 1990s. The systems are designed to remove contaminants from groundwater. Treated water is reinjected into the ground.

Iodine-129 was detected at levels greater than the EPA drinking water standard in the 200-East Area and in a part of the 600 Area (to the east and southeast of the 200-East Area). Iodine-129 contamination extends as far east as the Columbia River but at levels less than the EPA drinking water 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 near the southern part of the 200-West Area, and to the northeast in the northcentral 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.

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. Groundwater with uranium levels greater than the EPA standard is discharging to the Columbia River in the 300 Area.

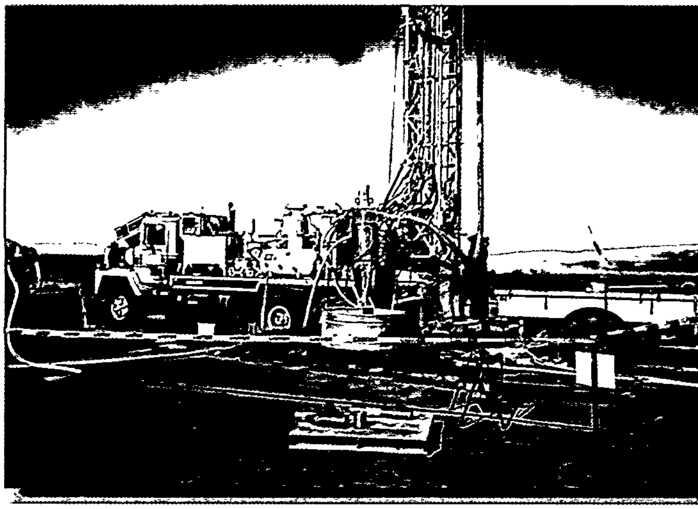
The strontium-90 plume in the 100-N Area contains levels more than the DOE derived concentration guide. Strontium-90 at these levels is discharging to the Columbia River. Strontium-90 entering the river could potentially reach an ecological receptor. A pump-and-treat system designed to reduce the amount of strontium-90 entering the river removed approximately 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 also were present in Hanford Site groundwater. These were carbon tetrachloride, chloroform, chromium, cyanide, fluoride, nitrate, tetrachloroethylene, cis-1,2-dichloroethylene, and trichloroethylene. Of these chemicals, nitrate, chromium, and carbon tetrachloride are the most widely distributed in Hanford Site groundwater.


Scientists sample over 600 wells annually to monitor groundwater beneath the Hanford Site.

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 drinking water standard occur in two areas of the 200-West Area and adjoining 600 Area.

Nitrate is widely distributed in groundwater in the 100-F Area 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. Full-scale pump-and-treat systems were constructed in the 100-D, 100-H, and 100-K Areas to prevent chromium contamination from reaching the Columbia River.

An extensive plume of carbon tetrachloride at levels greater than the EPA drinking water standard occurs in groundwater in the 200-WestArea and adjoining 600 Area.

Trichloroethylene and chloroform were above the EPA standard in the 200-West Area. Tri-chloroethylene was found at levels greater than the EPA drinking water standard in the 100-F Area and nearby 600 Area, 100-K Area, 300 Area, and near the former Horn Rapids Landfill, which is 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 Characterization/ 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 17,590,000 picocuries per gram 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.

Summary of Groundwater Pump-and-Treat Systems and Soil Vapor Extraction Efforts at the Hanford Site

Pump-and-Treat Systems

Constituent	Location	Start-up Date	Mass Removed/ Groundwater Volume Processed in 1999	Mass Removed/ Groundwater Volume Processed since Startup
Hexavalent chromium	100-D Area	Jul. 1997	19.2 kilograms 128 million liters	51 kilograms
Hexavalent chromium	100-H Area	Jul. 1997	6.6 kilograms 131 million liters	15 kilograms
Hexavalent chromium	100-K Area	Oct. 1997	37.6 kilograms 296.2 million liters	69.7 kilograms
Carbon tetrachloride	200-West Area 200-ZP-1 Operable Unit	Aug. 1994	1,290 kilograms 339.9 million liters	3.386 kilograms 954.8 million liters
Carbon tetrachloride	200-West Area	Dec. 1994	2.0 kilograms 93.5 million liters	15.8 kilograms 357.2 million liters
Nitrate	200-West Area 200-UP-1 Operable Unit	Mar. 1997	4,859 kilograms 93.5 million liters	12,770 kilograms 357.2 million liters
Strontium-90	100-N Area	1995	~ 0.2 curies 108 million liters	0.7 curies
Technetium-99	200-West Area 200-UP-1 Operable Unit	Mar. 1994	0.0078 kilograms 93.5 million liters	0.062 kilograms 357.2 million liters
Uranium	200-West Area 200-UP-1 Operable Unit	Mar. 1994	19.98 kilograms 93.5 million liters	101.1 kilograms 357.2 million liters

Vapor Extraction Systems

Carbon tetrachloride	200-West Area	1991	832 kilograms	76,462 kilograms

Hanford Site workers monitor waste storage tanks every day.

Vadose Zone Characterization/ 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 to evaluate the remediation effort. Analyses of the soil samples showed that most remaining contamination in the vadose zone was within approximately 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.

Soil vapor extraction is being used to remove carbon tetrachloride from the vadose zone in the 200-West Area. In this process, soil vapor is pumped through granular activated carbon, which absorbs carbon tetrachloride. The granular activated carbon is then shipped offsite for treatment. The EPA and 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, approximately 76,500 kilograms (168,700 pounds) of carbon tetrachloride had been removed from the vadose zone since extraction operations started in 1992.

Twenty-five inactive liquid waste disposal facilities were monitored in the 200-East Area 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. 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 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, soil gas and soil moisture were monitored 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.

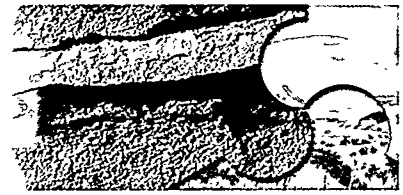
Analyses of soil gas from samples collected at the Old Hanford Townsite area show that the gas is enriched in helium-3. This enrichment is due to decay of tritium in the groundwater beneath the site. The amount of enrichment appears to vary with time, most likely because of atmospheric influences. Nevertheless,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

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 cross-check studies, and splitting samples with other laboratories.

Sample collections 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.



Environmental Research and Monitoring

Hanford Site meteorologists provide weather forecasting to help manage weather-dependent site operations. They also collect climatological data to help plan weather-dependent activities and assess environmental effects of site operations.

At the Hanford Site, a variety of environmental and cultural resource activities are performed to comply with laws and regulations and enhance environmental quality. This section summarizes activities conducted in 1999 to monitor the site's climatology and meteorology, assess the status of the ecosystem, monitor and manage cultural resources, and control incidents of radioactive contamination spread by plants or animals.

Climate and Meteorology

Meteorological measurements are taken to support site emergency preparedness, site operations, and atmospheric dispersion calculations. Hanford Site meteorologists provide weather forecasting and maintenance and distribution of climatological data. Forecasting is provided to help manage weather-dependent operations. Climatological data are provided to help assess the environmental effects of site operations.

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. 1999 was the windiest year on record, with an average wind speed of 14.2 kilometers per hour (11.1 miles per hour), which was

1.8 kilometer per hour (1.1 mile per hour) above normal. The peak gust for the year was 105 kilometers per hour (65 miles per hour). 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. 1999 was slightly warmer than normal, and precipitation was much below normal.

Ecosystem Monitoring

The Ecosystem Monitoring Project monitors the status of plant and animal populations on the Hanford Site, maintains biotic inventory data for the site, and assists in implementing ecosystem management policies. The status of rare plant populations and plant community types, spawning fall chinook salmon, wintering bald eagles, nesting buteo hawks, and Rocky Mountain elk are monitored annually as part of the project.

Fall Chinook Salmon

In 1999, approximately 6,068 fall chinook salmon redds were observed in aerial surveys of the Hanford Reach of the Columbia River, an increase of 700 from 1998 and approximately 80% of the 1996 and 1997 totals. Aerial surveys do not yield absolute redd counts because visibility varies, depending on water depth and other factors, and because the number of redds in high-density locations cannot be counted accurately. However, redd survey data generally agree with adult numbers obtained by counting migrating adult fish at fish ladders on the Columbia River.

Bald Eagles

Historically, federally threatened bald eagles have wintered along the Hanford Reach of the Columbia River. The wintering eagles originate from various places, including interior Alaska, British Columbia, the Northwest Territories, Saskatchewan, and possibly Manitoba. A maximum count of 24 eagles (14 adults and 10 juveniles) were observed along the Hanford Reach in 1999. Only four full surveys were successfully completed due to adverse weather and equipment delays. However, all four surveys were conducted during December and January when maximum counts typically occur. This maximum count is similar to those seen in the late 1970s and early 1980s and indicates that the low count in 1998 likely reflected changes in food availability near the birds nesting territories and hence winter migration patterns.

Hawks

The undeveloped land of the semiarid areas of the Hanford Site provides nest sites and food for three species of migratory buteo hawks: Swainson's, red-tailed, and ferruginous. Under natural conditions, these hawks nest in trees, on cliffs, or on the ground. Power-line towers and poles also can serve as nest sites. These structures are used extensively by nesting hawks on the site because of the relative scarcity of trees and cliffs. The ferruginous hawk is a Washington State threatened species and a U.S. Fish and Wildlife Service candidate species for listing as threatened or endangered. Approximately one quarter of the state's ferruginous hawk nesting territories are located on the site. Since 1995, the number of ferruginous hawks nesting on the Hanford Site has ranged from 7 to 12. There were 8 active nests in 1999, and 7 were successful.

Rocky Mountain Elk

Rocky Mountain elk were first observed on the Fitzner/Eberhardt Arid Lands Ecology Reserve in 1972. Since that time, the herd has grown and now occupies portions of the Hanford Site, the U.S. Army's Yakima Training Center, and private land along Rattlesnake Ridge. In 1999, herd size was estimated from census data at 838 animals before the 1999 hunting season. The 1999 harvest was approximately 101 animals.

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Western Canada geese migrate to the Mid-Columbia Basin in fall and winter.

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In 1972, a few elk moved onto the Fitzer/Eberhardt Arid Lands Ecology Reserve. In 1999, the herd numbered approximately 800 animals.

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The Hanford Site contains biologically diverse shrub-steppe plant communities that have been protected from disturbance, except fire, over the last 55 years. This photo shows native long-leaf phlox and lupine on the Fitzner/Eberhardt Arid Lands Ecology Reserve.

Canada Geese

Nesting Canada geese are valuable recreational and aesthetic resources along the Snake and Columbia rivers in eastern Washington. Goose nesting surveys began in the 1950s to monitor changes in response to reactor operations. Since 1995, nesting surveys have been conducted every 2 years. In 1999, there were 241 nests surveyed, with 193 (80%) that successfully hatched at least one egg. The fate of the remaining nests was affected equally by predation, flooding, abandonment, or other unidentified disturbances. Canada goose populations have been successful on the Hanford Reach because the islands are restricted from human uses during the nesting period and because shoreline habitats provide adequate food and cover for successful brood rearing.

Plant Biodiversity Inventories

The Hanford Site contains biologically diverse shrub-steppe plant communities that have been protected from disturbance, except for fire, over the past 55 years. This has allowed plant species to thrive at Hanford that have been displaced by agriculture and development in other parts of the Columbia Basin. During 1999, a small population of coyote tobacco was discovered on the Fitzner/Eberhardt Arid Lands Ecology Reserve. This state-sensitive species had not been documented in Benton County for more than 100 years, and, although historically documented in Franklin County, has not been located in recent years. Surveys in 1999 also indicated significant increases in the numbers of Piper's daisy, a species of concern occurring in the 200 Areas. Populations of another species of concern in the Columbia River Basin Ecoregion, persistent sepal yellowcress, still appear to be in decline as a result of the high river flow levels over the last 4 years.

Other Important Biological Resources

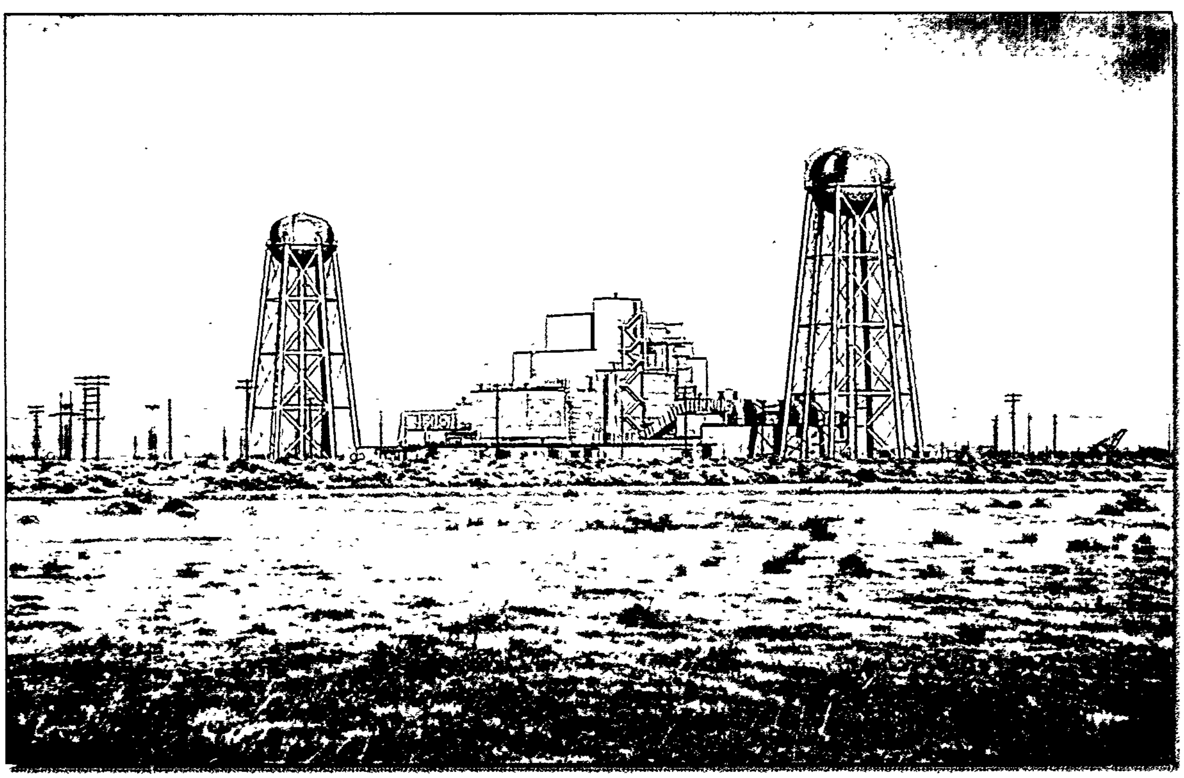
For the first time in more than two decades, several confirmed sightings of sage grouse were made on the Fitzner/Eberhardt Arid Lands Ecology Reserve in 1999. This is significant because the Washington State western sage grouse population has been in decline for many years, and the species was recently listed by the Washington State Department of Fish and Wildlife as threatened. Should a sizable population of sage grouse become established on the reserve, the potential for these birds to escape total eradication in Washington State would increase.

Cultural Resources

Management of archaeological, historical, and traditional cultural resources at the Hanford Site is provided in a manner consistent with the National Historic Preservation Act, Native American Graves Protection and Repatriation Act, Archaeological Resources Protection Act, and American Indian Religious Freedom Act, Historic Sites Buildings and Antiquities Act, Archaeological 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 continuation of a multi-year 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



This photo shows C Reactor, one of several structures included in the Hanford Site Manhattan Project and Cold War Era Historic District.

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.

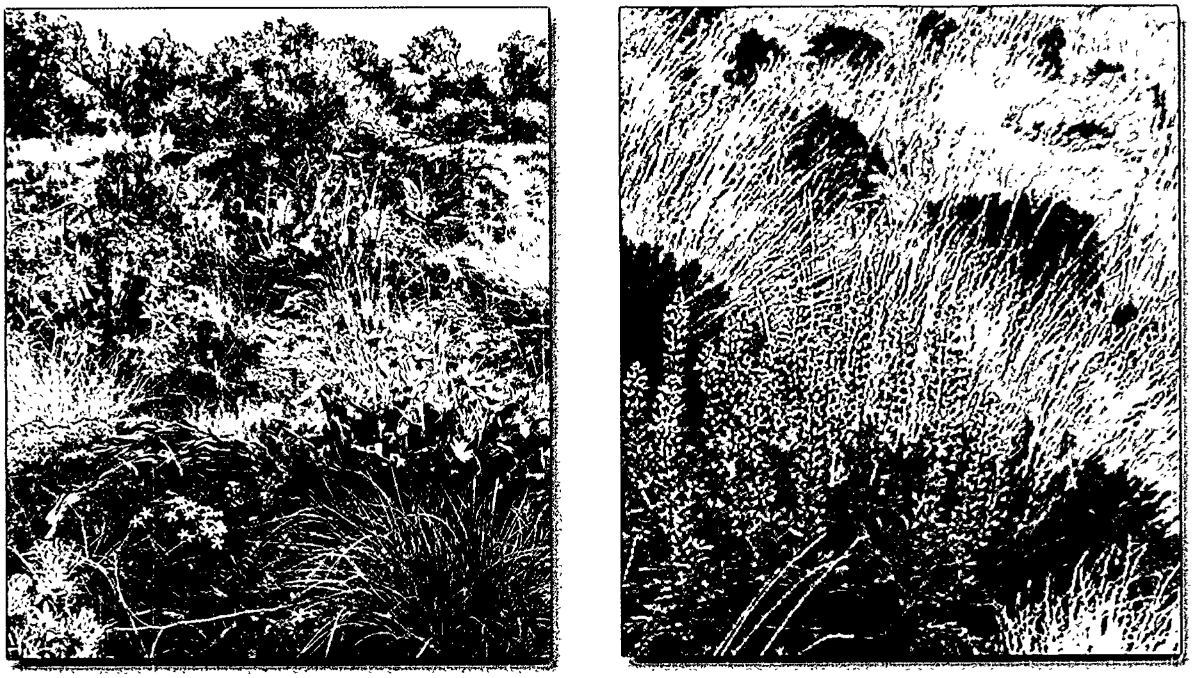
Biological Control

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, approximately 4,617 hectares (11,400 acres) of the site were treated with herbicide to control undesirable vegetation and approximately 2 hectares (5 acres) were reseeded with native vegetation to prevent the growth of tumbleweeds.

Stakeholder and Tribal Involvement



Native vegetation such as Carey's balsamroot (left) and lupine (right) are important to Native Americans. Native peoples used the leaves of lupine for green dye. Balsamroot was an important food staple.

The Role of Indian Tribes

The Hanford Site is located on land ceded to the United States government by the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation in the Treaties of 1855. These two tribes, as well as the Nez Perce Tribe, have treaty fishing rights on portions of the Columbia River. The tribes reserve the right to fish "at all usual and accustomed places" and the privilege to hunt, gather roots and berries, and pasture horses and cattle on open and unclaimed land. The Wanapum people are not a federally recognized tribe, but have historic ties to the Hanford Site and are routinely consulted regarding cultural and religious freedom issues.

The Hanford Site environment supports a number of Native American foods and medicines and contains sacred places important to tribal cultures. The tribes hope to use these resources in the future and want to ensure the Hanford environment is clean and healthy.

The DOE American Indian policy states, "American Indian Tribal Governments have a special and unique legal and political relationship with the Government of the United States, defined by history, treaties, statutes, court decisions, and the U.S. Constitution." In recognition of this relationship, DOE and each tribe interact and consult directly. The three tribes belong to DOE groups such as the State and Tribal Government Working Group and the Hanford Natural Resources Trustee Council. They actively participate in many projects, including the

Hanford Site Groundwater/Vadose Zone Integration Project and the Hanford Cultural and Historic Resources Program. The three tribes have made presentations to DOE and the contractors on treaty rights, tribal sovereignty, the United States government trust responsibility, and the unique status of tribal governments.

Public Participation

Citizens of the state of Washington and neighboring states may influence Hanford Site cleanup decisions through public participation activities. The public is provided opportunities to contribute their input and influence decisions through many forums, including Hanford Advisory Board meetings, Tri-Party Agreement activities, National Environmental Policy Act public meetings covering various environmental impact statements and environmental assessments, and many other outreach programs.

The Tri-Party Agreement provides a means for Hanford to become compliant with environmental regulatory requirements. The Community Relations Plan, a companion to the Tri-Party Agreement, describes how public information and involvement activities are conducted for Tri-Party Agreement decisions. DOE, EPA, and the Washington State Department of Ecology developed and negotiated the plan with input from the public. The plan was approved in 1990. The plan is updated on an as-needed basis; the most recent revision occurred in 1997.

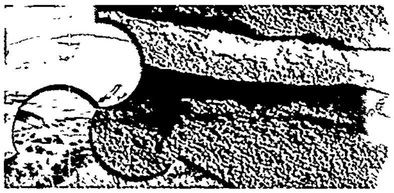
Before each public participation event, the press is informed of the issues to be discussed, and notices are sent to elected officials, community leaders, and special interest groups. A mailing list of approximately 3,800 individuals who have indicated an interest in participating in Hanford Site decisions is maintained and kept current. The mailing list is also used to send topic-specific information to those people who have requested it.

To apprise the public of upcoming opportunities for public participation, DOE publishes the bimonthly *Hanford Update*, which summarizes all ongoing and upcoming Tri-Party Agreement public involvement activities. In addition, the *Hanford Happenings* calendar highlights Tri-Party Agreement meetings and comment periods and is distributed monthly to the entire mailing list.

Citizens of the state of Washington and neighboring states may influence Hanford Site cleanup decisions through public participation activities and public meetings.

Most of Hanford's stakeholders reside in Washington, Oregon, and Idaho. To allow them better access to up-to-date Hanford Site information, four information repositories have been established. They are located in Richland, Seattle, and Spokane, Washington, and Portland, Oregon.

The three parties respond to questions that are received via a toll-free telephone line (1-800-321-2008). Members of the public can request information about any public participation activity and receive a response by calling the Office of Intergovernmental, Public, and Institutional Affairs (DOE Richland Operations Office) at (509) 376-7501. Also, there is a calendar of public involvement opportunities on the Internet:
http://www.hanford.gov/whc/cal/cal.html.



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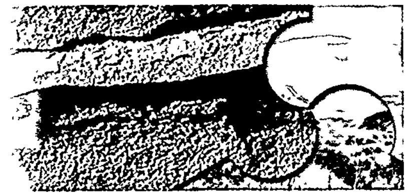

Can We Make This Summary More Useful for You?

We want this summary to be easy to read and useful. To help continue this effort, please take a few minutes to let us know if the summary meets your needs. Then tear out this page, and mail or fax it to Bill Hanf, Pacific Northwest National Laboratory, P.O. Box 999, MSIN K6-75, Richland, WA 99352. Phone: (509) 376-8264; Fax: (509) 376-2210

1. How do you use the information in this summary?

❑ To become more familiar with Hanford monitoring
❑ To help me make a decision about moving to the Tri-Cities
❑ To send to others outside the Tri-City area
❑ To prepare for public meetings on Hanford cleanup
❑ Other (please explain)

2. What parts of the summary do you use?

❑ Hanford Site overview/mission
❑ Site management
❑ Environmental compliance
❑ Environmental monitoring
❑ Quality assurance
❑ Regulatory oversight
❑ Current issues and actions
❑ Potential radiation doses from operations Hanford environmental programs

3. Does this guide contain

❑ enough detail? ❑ too much detail? ❑ too little detail?

Comment: ____

____

4. If you could change this guide to make it more readable and useful to you, what would you change?

____

____

5. What is your affiliation?

❑ Hanford Site contractor
❑ State agency
❑ Public interest group
❑ Member of Native American Nation
❑ University
❑ DOE
❑ Federal agency
❑ Member of the public
❑ Local government
❑ Industry

6. Other Comments? ____

____

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Thank you!

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