Closure Report for N Reactor

United States
Department of Energy
Richland, Washington

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EXECUTIVE SUMMARY

This report has been prepared to satisfy Section 3156(b) of Public Law 101-189 (Reports in Connection with Permanent Closures of Department of Energy Defense Nuclear Facilities), which requires submittal of a Closure Report to Congress by the Secretary of Energy upon the permanent cessation of production operations at a U.S. Department of Energy (DOE) defense nuclear facility (Watkins 1991).

This closure report provides:

- (1) A complete survey of the environmental problems at the facility
- (2) Budget quality data indicating the cost of environmental restoration and other remediation and cleanup efforts at the facility
- (3) A proposed cleanup schedule.

The cessation of production operations at the DOE's 4000-MW N Reactor and its 2.6-km² (640-acre) site on the Hanford Site leaves several environmental problems requiring disposition. These include, in part, over 3,785,000 L (1,000,000 gal) of radiologically contaminated water and 90,700 kg (200,000 lb) of radiologically contaminated hardware in the reactor's spent fuel basin, over 8,000 ci of radionuclides in soil-column disposal facilities, radiologically contaminated groundwater with ⁹⁰Sr concentrations of up to seven times the DOE guidelines, three soil-column disposal facilities requiring closure in compliance with regulations promulgated under authority

of the *Resource and Conservation and Recovery Act of 1976*, as amended, and numerous spills and releases of chemical and radiological materials to the environs.

The N Reactor site has 109 discrete sources of known environmental contamination. The nature and extent of this contamination, together with that found at the eight retired reactor sites on DOE's Hanford Site, formed the bases for Hanford's 100 Areas to be placed on the National Priority List (NPL) in accordance with regulations promulgated under authority of the *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980*, as amended.

The DOE will address these environmental problems through (1) stabilization of existing environmental and industrial safety hazards to preclude any future releases and to minimize surveillance and maintenance requirements, (2) remediation of contaminated soils and groundwater consistent with Federal and State regulations in a manner and time frame described in the *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)* (Ecology et al. 1992), and (3) final decontamination and decommissioning of the facility.

Deactivation of N Reactor is planned to take place from 1994 through 1997 at an estimated cost of \$270M. A significant reduction to the estimated deactivation costs is expected to be realized. The effort to revise the cost estimate is ongoing because the deactivation program is refined and optimized based on the outcome of value engineering analyses and other planning activities that are currently being performed. Remediation of the

contaminated soils and groundwater is scheduled from 1999 through 2006 at an estimated cost of \$400M, based on removing contaminated soil. Decontamination and decommissioning, after completion of future *National Environmental Policy Act of 1969* documents, is assumed to consist of the complete dismantling of the facility by 2016 at an estimated cost of over \$720M.

Cessation of production operations has also identified certain institutional issues concerning potential long-term obligations with the Washington Public Power Supply System's Hanford Generating Plant, which used steam from N Reactor to generate 860 MW of electrical power. Obligations will entail environmental restoration and dismantling of the facility. Hanford Generating Plant bonds have already been retired.

All N Reactor fuel has been removed from the facility and is being stored for the near term in fuel storage basins on the Hanford Site. Unencapsulated fuel will be encapsulated. The final disposition of over 1,800 metric tons of unirradiated nuclear fuel and 2,100 metric tons of irradiated nuclear fuel will be addressed subsequent to the completion of DOE complex-wide material disposition studies.

The environmental restoration and cleanup activities are assigned to DOE's Office of Environmental Restoration within the Office of Environmental Restoration and Waste Management through which they will be assigned priorities and budgeted.

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LIST OF TERMS AND ACRONYMS

ACL	alternate concentration limit
ADM	action description memorandum
AEC	Atomic Energy Commission
ALARA	As Low as Reasonably Achievable
ANPRM	Advanced Notice of Proposed Rulemaking
ARAR	applicable or relevant and appropriate requirements
BAT	best available technology
BDL	below detectable limit
BPA	Bonneville Power Administration
BSL	below sea level
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CPM	counts per minute
CPP	CERCLA past-practice
D&D	decontamination and decommissioning
DCG	Derived Concentration Guide
DOE	U.S. Department of Energy
EA	environmental assessment
Ecology	Washington State Department of Ecology
ECS	emergency cooling system
EDB	emergency dump basin
EDE	effective dose equivalent
EDT	emergency dump tank
EIS	environmental impact statement
ENU	elementary neutralization unit
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERA	expedited response actions
HDPE	high-density polyethylene
HEPA	high-efficiency particulate air (filter)
HGP	Hanford Generating Plant
HRA-EIS	Hanford Remedial Action EIS
HSWA	Hazardous and Solid Waste Amendments to RCRA
LERF	liquid effluent retention facility
LWDF	liquid waste disposal facility
LWLS	liquid waste loadout station
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MSL	Mean Sea Level
MTCA	Model Toxics Control Act
MTU	metric ton units
NESHAP	"National Emission Standards for Hazardous Air Pollutants"
NEPA	<i>National Environmental Policy Act of 1969</i>
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPRM	Notice of Proposed Rulemaking
NRC	Nuclear Regulatory Commission
NTU	nephelometric turbidity unit
NUREG	identifier on Nuclear Regulatory Commission documents
OSHA	Occupational Safety and Health Administration

LIST OF TERMS AND ACRONYMS (continued)

PCB	polychlorinated biphenyl
POTW	Public Owned Treatment Works
PUREX	Plutonium-Uranium Extraction (Plant)
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RCS	reactor coolant system
RCW	Revised Code of Washington
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
RI/FS	remedial investigation/feasibility study
RL	U.S. Department of Energy, Richland Field Office
ROD	record of decision
RPP	RCRA Past Practice
S&M	Surveillance and Maintenance
SNF	spent nuclear fuel
SNM	special nuclear materials
Supply System	Washington Public Power Supply System
SWP	Special Work Permit (protective clothing)
TBC	to be considered (materials)
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
TRU	transuranic waste
TSCA	<i>Toxic Substances Control Act of 1976</i>
TSD	treatment, storage, and disposal
TSDF	Treatment, Storage, and Disposal Facility
WAC	Washington Administrative Code
WDOH	Washington State Department of Health
WHC	Westinghouse Hanford Company
WIDS	Waste Information Data System

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1.0 PURPOSE AND OBJECTIVES

The U.S. Department of Energy (DOE) ordered the permanent cessation of production operations of N Reactor in February of 1991. The facility was dedicated to the irradiation of nuclear fuel on the Hanford Site in south-central Washington State.

N Reactor is a 4,000-MW thermal nuclear reactor used to produce special nuclear materials (SNM) and byproduct steam that provided electricity to the Washington Public Power Supply System's (Supply System's) 860-MW Hanford Generating Plant (HGP) located adjacent to N Reactor. N Reactor is situated on 640 acres of land along the Columbia River. The facility was built in 1963 and operated until 1986 when DOE initiated a series of safety enhancements. The reactor was placed in a standby configuration in 1988, and in 1991 DOE ordered that preservation activities cease and steps be taken to place the facility in a condition requiring only minimal surveillance and maintenance (S&M) until ultimate decontamination and decommissioning (D&D).

Pursuant to the above action and to Public Law 101-189, Section 3156(b), "Reports in Connection with Permanent Closures of Department of Energy Defense Nuclear Facilities," this N Reactor Closure Report has the purpose and objective to provide Congress the following information.

- A complete survey of environmental problems at the facility.
- Budget quality data indicating the cost of environmental restoration (ER) and other remediation and cleanup efforts at the facility.
- A discussion of the proposed cleanup schedule.

Section 3156(a) of Public Law 101-189 was satisfied in a letter dated August 1, 1991, from the Secretary of Energy to the Committees on Armed Services of the Senate and the House of Representatives. This letter discussed the training and job placement services concerning N Reactor (Watkins 1991).

This closure report has been organized into the following sections to provide a comprehensive description of the facility, its environmental problems, and regulatory and institutional considerations in a manner that provides a basis for the estimated cost and schedule presented for cleanup actions.

- 2.0 Setting--This section presents a general overview of the N Reactor area and describes the location and demography. Color Illustration 2-1 is an aerial view of the N Reactor area that can be useful to identify facilities described in the closure report. Figures 2-3 and 2-4 show the general geology and hydrology beneath N Reactor. Figures 2-5, 2-6, and 2-7 illustrate groundwater movement in the area. These figures, in conjunction with Section 5.0, will give the reader a picture of the environmental problems relating to N Reactor closure.

- 3.0 Facility Description--This section gives information about N Reactor operations such as facility process descriptions, waste-generating processes, *Resource Conservation and Recovery Act of 1976* (RCRA), treatment, storage, and disposal (TSD) units at the N Reactor facility and other facilities outside of the N Reactor area. Figures 3-2 through 3-13 are sectional drawings of N Reactor itself, which provide the reader with an idea of the size and elevation of this structure.
- 4.0 History--This section provides a brief summary of N Reactor's operational history. Table 4-1 provides an overview of significant dates.
- 5.0 Environmental Problems--This section describes N Reactor operational activities that affected the environment. The affected environs are groundwater contamination (radionuclides, volatile organics, polychlorinated biphenyls (PCB), metals, and other inorganics); soil contamination (surface and vadose zone contamination from radionuclides and organic compounds); biota contamination (flora [vegetation] and fauna [animals] from radionuclide uptake by plants or ingestion by animals); and evaluated radiation at the Columbia River (unshielded sediments in the 1301-N Liquid Waste Disposal Facility).

Table 5-1 and Figure 5-2 show the waste or release sites at the N Reactor facility. Other tables and figures in this section provide an in-depth look at the environmental contamination that must be handled before closure of N Reactor can take place.

- 6.0 N Reactor Closure Scope--This section describes the deactivation of N Reactor, closure of RCRA TSD facilities, site remediation, and D&D. N Reactor deactivation entails removal of 200,000 lb of radiologically contaminated hardware and over 1,000,000 gal of radiologically contaminated water currently used for shielding. Table 6-1 shows the major deactivation activities for N Reactor. The four RCRA facilities have Part A Applications completed, with the Closure/Post-Closure Plans to be submitted by 1994. Site remediation entails the cleanup of past spills and releases to the soil and groundwater. N Reactor has two aggregate areas, 100-NR-1 Source Operable Unit and 100-NR-2 Groundwater Operable Unit, as illustrated by Figure 6-2. Color Illustrations 6-1 and 6-2 show computer-generated images of ^{90}Sr in the soil and groundwater beneath the 1301-N and 1325-N Liquid Waste Disposal Facilities. The D&D of N Reactor will isolate any remaining radioactive or hazardous waste in a manner that will minimize environmental impact. D&D can be accomplished through ongoing S&M of the facility, dismantling and burial at another location onsite, or dismantling and burial at 100 N. The scope of work for purposes of this closure report is assumed to be dismantling of all 100-N facilities and burial at another location onsite, based on *Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington* (DOE/EIS 1993). The actual means of decommissioning the reactor and other facilities

at the 100-N site will depend on future engineering studies and the *National Environmental Policy Act of 1969* (NEPA) process, which will evaluate alternative actions followed by a Record of Decision (ROD).

- 7.0 Proposed Cleanup Schedule--This section is an integrated schedule aimed at satisfying the objectives of this facility closure. The schedule highlights those cleanup activities that have milestone dates associated with consent order agreements between DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology).
- 8.0 Estimated Cost for Closure--This section estimates the cost for N Reactor deactivation, RCRA facility closures, RCRA past-practice (RPP) site remediation, and D&D. The level of confidence behind these cost estimates is commensurate with engineering and planning currently available. Cost estimates for near-term activities are based on more detailed planning than outyear activities, such as site remediation after 2005 and D&D by 2016.
- 9.0 Regulatory and U.S. Department of Energy Order Compliance--This section briefly describes those promulgated regulations, DOE orders, and consent order agreements between DOE, EPA, and Ecology that are considered applicable or relevant and appropriate requirements (ARAR) to the Hanford Site remediation and cleanup activities. These statutes and regulations are coded by scope of activity and degree of applicability. The potential ARARs are grouped by topic:
 - Contaminant-, action-, or location-specific
 - DOE orders and directives related to facilities and operations, including deactivation implementation actions
 - Decontamination and decommissioning, to provide a logical sequence for review.
- 10.0 *National Environmental Policy Act* Strategy--This section describes the manner in which NEPA will be applied to the ER and cleanup activities. This discussion includes NEPA documentation directed at both N Reactor-specific closure activities and Hanford Site-wide remediation activities.
- 11.0 Disposition of Special Nuclear Material--This section describes the quantity of uranium billets, unirradiated nuclear fuel elements, and irradiated nuclear fuel elements that are being stored and includes a strategy for their disposition.
- 12.0 Institutional Issues--This section describes unique issues directed at future land use and means of dispositioning facilities owned by the Supply System, and the Bonneville Power Administration (BPA) that are built on land leased from DOE.

- 13.0 Closure Management and Programmatic Interface--This section provides a work breakdown structure for N Reactor closure and describes the organizational responsibilities for its implementation and means of performance monitoring together with the budget and cost-control process.
- 14.0 References--This section lists documents used or referred to in preparing this closure report.

In 1991, DOE, EPA, and Ecology entered into the *Hanford Federal Facility Agreement and Consent Order*, popularly known as the Tri-Party Agreement (Ecology et al. 1992). While this agreement sets forth the schedule for site remediation activities required under RCRA and the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), at this time, the Tri-Party Agreement does not include requirements for the D&D of the N Reactor. For the purpose of this report, D&D of the N Reactor is assumed to be performed based on dismantling it and transporting it to the burial site in pieces as described in *Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington* (DOE/EIS 1993).

2.0 SETTING

2.1 LOCATION AND DEMOGRAPHY

The Hanford Site is a 1,450-km² (560-mi²) tract of land located in Benton, Franklin, and Grant Counties in south-central Washington State. Figure 2-1 is a layout of the Hanford Site; Color Illustration 2-1 shows an aerial view of the 100-N Area where N Reactor is located. The 2.6-km² (640-acre) 100-N Area is situated along the Columbia River. The 100-D/DR Area is northeast of the 100-N Area and the 100-K Area is southwest. The 200 Area is southeast of 100-N and was used for the disposal of solid and liquid wastes from N Reactor. The city of Richland is approximately 43 air and 61 river km (27 air and 38 river mi) south of the 100-N Area. Approximately 258,000 people live within an 80-km (50-mi) radius of the 100-N Area. The cities of Richland, Pasco, and Kennewick, located southeast of the Hanford Site, are the main population centers. Many other smaller communities surround the Hanford Site. The nearest residences are farm homes about 9.7 km (6 mi) north of the 100-N Area. No residences remain on the Hanford Site.

2.2 HYDROGEOLOGY

2.2.1 Regional Setting

The Hanford Site is located within a natural depression called the Pasco Basin, as shown in Figure 2-2. The Pasco Basin is part of the larger Columbia Plateau, which includes most of southeastern Washington and northeastern Oregon, a province that is roughly defined by the extent of Columbia River basalt flows. The Pasco Basin is bounded on the north by the Saddle Mountains and on the south by Rattlesnake Mountain. To the west lie anticlines of the Yakima Fold Belt, including Umtanum Ridge, Yakima Ridge, and the Rattlesnake Hills. The eastern boundary is formed by the Palouse Slope, a west-dipping monocline. Within the Pasco Basin lie several northwest-southeast trending synclines; the Wahluke Syncline crosses the northern portion of the basin.

Saturated sediments about the Columbia River Basalt form a series of aquifers (underground beds of gravel or porous stone containing water) and aquitards (confining layers), collectively called the uppermost aquifer system. The shallowest aquifer in the system is unconfined over most of the Hanford Site, and is made up of Hanford and Ringold fluvial (streambed) sediments. It is commonly termed the uppermost or unconfined aquifer. The uppermost aquifer is naturally recharged by runoff from surrounding highlands. Recharge via precipitation on the Hanford Site is negligible because of the desert climate (see Section 2.3). Some areas show evidence of leakage upward from confined aquifers into the uppermost aquifer. Artificial recharge also occurs from irrigation on lands adjacent to the Hanford Site and has occurred in the past from liquid waste disposal on the Site. Groundwater in the uppermost aquifer primarily discharges to the Columbia River, and to a lesser extent, the Yakima River. Recharge to the underlying confined aquifers in the northern portion of the Pasco Basin primarily comes from the southwest, west, and north, with flow generally to the east-southeast across the 100 Areas, as suggested by the structural trend of the Wahluke Syncline (DOE-RL 1990).

The uppermost aquifer system is dominated by gravelly, sandy, and silty sediments associated with fluvial channel and overbank deposits of the ancestral Columbia River. Known groundwater contamination plumes are typically contained in the uppermost aquifer, which comprises sand and gravel. Generally upward hydraulic movement prevents downward migration of contamination. Flow direction is generally toward the Columbia River. Liquid effluent disposal in the past created groundwater mounds, which caused some migration inland as well. Flow rates are in the range of 0.5 to 4.5 m/day (1 to 15 ft/day) under natural conditions. When groundwater mounds were present, flow rates of 15 m/day (50 ft/day) were observed. These higher flow rates were caused by unnaturally steep gradients and thermally hot recharge sources (DOE-RL 1991). Short-term flow near the river is strongly influenced by daily fluctuations in river stage, which may be in the range of 2 to 2.5 m (6 to 8 ft) daily and 2.5 to 3 m (8 to 10 ft) seasonally.

The following description of hydrostratigraphy for the 100 Areas is from Peterson (1992) and was developed from more detailed descriptions in the RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) for the 100-NR-1 Operable Unit (DOE-RL 1990). A generalized stratigraphic and hydrogeologic column is shown in Figure 2-3. Six hydrostratigraphic units are identified: Unsaturated (vadose) zone, Ringold/Hanford producing layer (i.e., uppermost aquifer), Ringold confining layer, Ringold confined aquifer, another Ringold confining layer, and another Ringold confined aquifer. Beneath this sequence, which in total is usually referred to as the unconfined aquifer system, lie Columbia River basalt flows, which contain their own series of confined aquifers. The uppermost confined aquifer in the basalt sequence may be formed either by flow tops in the Elephant Mountain Member or by the Rattlesnake Ridge interbed and underlying Ponoma flowtop zone.

The unsaturated (vadose) zone is contained in Hanford Formation sediments. This zone is approximately 9 m (30 ft) thick. These sediments typically are open-framework pebble- to boulder-sized gravels. Interstitial sand content is generally low and mud-sized sediment is limited to coatings on individual grains and rip-up clasts. Interstratified lenses of sand and mud may be encountered, but they are very localized. Drilling of one well at the 100-N Area near an active liquid waste disposal facility in 1984 led to the only known occurrence of a perched water table within the 100 Areas.

The fluvial sediments of Ringold gravel unit E make up the uppermost aquifer through most of the 100 Areas. At some locations, the uppermost aquifer includes the bottom few feet of the Hanford sediments. Erosional features, such as channels, are present at the unconformity between the Ringold Formation and overlying Hanford sediments. The more transmissive Hanford deposits that fill these channels may act as preferred pathways for groundwater movement.

Underlying the uppermost aquifer is a confining bed that consists of interbedded clays, silts, and a few thin sand layers. These strata represent river overbank deposits. This interval ranges in thickness from 3 to 15 m (10 to 50 ft).

Layers of silty sand to sandy silt that are equivalent to Ringold gravel units B and C form the fourth hydrogeologic unit, a confined aquifer. This unit is 53 to 61 m (175 to 200 ft) thick. Alternating lithologies in the unit suggest the possibility of alternating producing and confining layers.

Another confining layer underlies the sand and silt aquifer. It consists of 30 to 46 m (100 to 150 ft) of interbedded clay and silt assigned to the lower mud sequence of the Ringold Formation. These fine-grained sediments are predominantly lacustrine.

The lowest unit of the unconfined aquifer system consists of fluvial sediments of Ringold gravel unit A. This unit lies unconformably over the Elephant Mountain Member of the Saddle Mountains Basalt. Unit A consists of interbedded sands and pebble- to cobble-sized gravels, with some caliche layers. It ranges in thickness from 5.5 to 20 m (18 to 65 ft). Unit A is present near the 100-N Area.

Within the Columbia River Basalt Group, the Rattlesnake Ridge Interbed and underlying Pomona flowtop zone form the uppermost confined aquifer in most locations. The Rattlesnake Ridge Interbed consists of 14 to 18 m (45 to 60 ft) of tufaceous silt, stone, and sandstone. The Elephant Mountain Member, which is found throughout the 100 Areas, forms the confining layer above the Rattlesnake Ridge Interbed.

2.2.2 Local Setting

Figure 2-4 shows a generalized northwest to southeast geologic cross section. Approximately 70 wells, between 7.5 and 40 m (25 and 132 ft) deep, (shown in Color Illustration 2-2) have been drilled in the 100-N Area since 1962. These wells were installed for several purposes, including the following:

- Monitoring radionuclide migration from soil column disposal facilities used for liquid effluents
- Monitoring for oil and grease from past spills and leaks
- Monitoring for hazardous waste constituents upgradient and downgradient at each of three RCRA landfills.

The geologic units in the 100-N Area include the Ringold Formation and the overlying glaciofluvial sediments informally referred to as the Hanford Formation.

The Ringold Formation in the 100-N Area is composed of five geologic units that are illustrated in Figure 2-3. The units are described as follows, in ascending order: (1) indurated sandy gravel (unit A); (2) lower mud sequence; (3) silty sand to sandy silt (units B and C); (4) overbank deposits; and (5) fluvial gravels (unit E).

The indurated sandy gravel unit rests unconformably on basalt. It consists of interbedded sand and cobbles with some caliche, and ranges in thickness from 5.5 to 20 m (18 to 65 ft). The second unit, the lower mud

sequence, comprises interbedded clay and silt. It is 30 to 46 m (100 to 150 ft) thick. The third unit is made up of silty sand to sandy silt, possibly in alternating fine-grained and coarser-grained layers. This unit is 53 to 61 m (175 to 200 ft) thick. The fourth unit, overbank deposits, comprises clay and silt with a few thin sand layers. The fourth unit is 3 to 15 m (10 to 50 ft) thick. The uppermost unit in the Ringold Formation is composed of fluvial gravels, and is approximately 15 m (50 ft) thick in the 100-N Area.

The Ringold is differentiated from the glaciofluvial sediments by an increase in calcium carbonate with a zone of increased consolidation and cementing, a decrease in the percentages of basalt clasts, and an increase in the quartz/silica-rich materials. These changes are reflected in a distinct color change from the olive gray of the glaciofluvial sediments to a dark grayish brown of the Ringold. This sand gravel unit of the Ringold is heterogenous, varying in texture both laterally and vertically (DOE-RL 1990).

Overlying the Ringold Formation are flood deposits that were laid down when ice-dammed lakes within the Columbia River drainage were periodically breached during Pleistocene glaciation (Waite 1980). Deposits of glaciofluvial sediments from these floods have been informally referred to as the Hanford Formation. These deposits are highly variable both laterally and vertically, reflecting the dynamic nature of deposition. These cataclysmic flood deposits have been divided into two facies: a coarse-grained channel facies (the Pasco gravels) and a fine-grained slackwater facies (the touchet beds). The Pasco gravels predominate at the 100-N Area. These gravels are composed of poorly sorted coarse sand and gravel that were deposited in flood bars along high-energy flood channels (DOE 1988).

The unconfined aquifer in the 100-N Area is contained in the sand/gravel unit of the Ringold Formation with its lower boundary being the mud unit. The water table occurs about 6 m (20 ft) below the contact with the glaciofluvial sediments. The general groundwater flow direction is northwest, toward the Columbia River, based on interpretation of groundwater gradients. The elevation of the water table at the site is affected by the level of the nearby Columbia River, to which the unconfined aquifer is hydraulically connected by groundwater entering the 100-N Area from other parts of the Hanford Site and, in the past, by discharge of wastewater to the disposal facilities. Near the 1301-N facility during high river levels, bank storage along the river is increased. Groundwater levels near the river rise in response (Newcomer 1988).

During N Reactor operation over 7.5 billion L (2 billion gal) of effluent were discharged to the soil column, which caused artificial groundwater mounding on the site, as shown in Figure 2-5. Since the shutdown of N Reactor and the corresponding reduction in effluent discharged to the soil column, the groundwater levels have returned to a natural level leaving older groundwater monitoring wells dry. Figures 2-6 and 2-7 show more recent groundwater table maps of the northern Hanford Site and the 100-N Area.

2.3 METEOROLOGY

The Hanford Site weather is monitored at the Hanford Meteorology Station and at other points situated across the Site, including Station 13 of the Hanford Telemetry Network located at the 100-N Area. The Cascade Mountains, to the west of the Site, greatly affect the local climate. The Hanford Site is situated in the rainshadow of the Cascade Mountains.

2.3.1 Precipitation

The Hanford Site receives an average of 16 cm (6.25 in.) of precipitation annually. Precipitation falls mainly in the winter months, with almost half of the annual precipitation occurring between November and February. Rainfall from July through September makes up only 10 percent of the annual precipitation (DOE-RL 1990).

Precipitation of 1.3 cm (0.5 in.) or more within a 24-hour period occurs only twice yearly on the average. Instances of 2.5 cm (1.00 in.) or more of precipitation within a 24-hour period are rare; only four occurred between 1946 and 1980. One of these events was the record storm of October 1-2, 1957, when 4.8 cm (1.88 in.) of rainfall occurred in 12 hours (DOE-RL 1990).

Winter monthly average snowfall ranges from 13.5 cm (5.3 in.) in January, to 0.8 cm (0.31 in.) in March. The record snowfall of 62 cm (24.41 in.) occurred in February 1916. Between December and February, snowfall accounts for about 38 percent of all precipitation (DOE-RL 1990).

The average yearly relative humidity at the Hanford Site for the period from 1946 to 1980 was 54.4 percent. Humidity is higher in winter than in summer. The monthly averages range from 32.2 percent for July to 80 percent in December. The lowest monthly average (21.9 percent) occurred in July 1959 and the highest monthly average (90.5 percent) occurred in December 1950 (DOE-RL 1990).

2.3.2 Winds

By serving as a source of cold air drainage, the Cascade Mountains greatly affect the wind regime at the Hanford Site. This gravity drainage, plus topographic channelling, results in a northwest to west-northwest prevailing wind direction at the Site (DOE-RL 1990). The average mean monthly speed for the period from 1945 to 1980 was 12.4 km/hour (7.7 mi/hour), with monthly means ranging from 9.8 km/hour (6.1 mi/hour) in December to 14.8 km/hour (9.2 mi/hour) in June (DOE-RL 1990). Peak gust speeds range from 101 to 129 km/hour (63 to 80 mi/hour) and are generally southwest or west-southwest winds (DOE-RL 1990).

Figure 2-8 presents wind roses for the Hanford Telemetry Network (DOE-RL 1990). The Columbia River exerts a strong local channelling effect on the local wind regime. This channelling, along with the gravity drainage from the Cascades, produces a prevailing west-southwest wind at the 100-N Area. In addition, diurnal fluctuations in wind speeds are common during the summer months. In July, hourly average wind speeds range from a low of 8.4 km/hour

(5.2 mi/hour) from 9:00 to 10:00 a.m. to a high of 21 km/hour (13.0 mi/hour) from 9:00 to 10:00 p.m. The diurnal fluctuation is less in the winter months, ranging from 8.8 km/hour (5.5 mi/hour) in the morning to 10 km/hour (6.3 mi/hour) in the evening (DOE-RL 1990).

2.3.3 Temperature

Based on data from 1914 to 1980, winter minimum temperatures vary from -33 to -5.6 °C (-27 to +22 °F), and summer maximums vary from 38 to 46 °C (100 to 115 °F). Temperatures reach 32 °C (90 °F) or above an average of 55 days a year; however, minimum temperatures reach 21 °C (70 °F) or above an average of only 8 days per year. Half of all winters are free of temperatures below -18 °C (0 °F). Between 1914 and 1980, 16 days with temperatures -29 °C (-20 °F) or below were recorded. Ten days are on record when the maximum temperature failed to exceed -18 °C (0 °F). The winter of 1925-1926 is the mildest winter on record, with -5.6 °C (22 °F) recorded as the lowest temperature. In 1954, only one day reached 38 °C (100 °F). Before 1980, there were three summers on record when the temperatures were 38 °C (100 °F) or above for 11 consecutive days (DOE-RL 1990).

2.3.4 Evapotranspiration

Mean annual loss of water from the soil (evapotranspiration) for the Tri-Cities area immediately southeast of the Hanford Site has been estimated to be about 74 cm (29 in.). The actual annual evapotranspiration rate under current conditions in the northern portion of the Hanford Site is estimated to be about 15.5 cm (6.1 in.) (DOE-RL 1990).

2.4 ENVIRONMENTAL RESOURCES

The Hanford Site has a cool desert or a shrub-steppe type of environment and supports a biological community typical to this setting.

2.4.1 Flora and Fauna

More than 240 species of plants have been identified on the Hanford Site. Plants likely to be present at the 100-N Area include the gray rabbitbrush (*Chrysothamnus nauseosus*), cheatgrass (*Bromus tectorum*), tumbleweed (*Salsola kali*), yarrow (*Achillea millefolium*), yellow salsify (*Tragopogon dubius*), false yarrow (*Chaenactis douglasii*), and tumble mustard (*Sisymbrium altissimum*). Cheatgrass and riparian plants are the most prevalent (DOE-RL 1990).

More than 300 species of terrestrial and aquatic insects have been found on the Hanford Site. Specific insects likely to be found in fresh water in the 100-N Area include water striders (*Gerridae*), backswimmers (*Notonectidae*), water boatman (*Corixidae*), and diving beetles (*Dytiscidae*). Seasonal inhabitants would include larvae of the caddisfly (*Trichoptera*), the mosquito (*Culicidae*), and the manfly (*Ephemeroptera*) (DOE-RL 1990).

Approximately 16 species of amphibians and reptiles have been observed on the Hanford Site. The side-blotched lizard is the most abundant reptile. Toads (family: *Bufonidae*) and frogs (family: *Ranidae*) are found along the Columbia River (DOE-RL 1990).

More than 125 species of birds have been identified on the Hanford Site; the horned lark and western meadowlark are the most abundant nesting birds. Wastewater ponds at the Hanford Site are important habitats for songbirds, shore birds, ducks, and geese. The most abundant nesting bird at these sites is the American coot. Waterfowl frequently use the ponds during fall migration. The Hanford Site is located in the Pacific Flyway. The resident waterfowl include the Canada goose, whose nesting habitat includes islands in the Columbia River. Birds identified at the 100-N Area include swallows and robins (DOE-RL 1990).

Of the approximately 30 species of mammals that have been identified on the Hanford Site, most are small and nocturnal. Muskrats and porcupines have been observed along the shorelines of the ponds and ditches, and beavers are resident in the sloughs along the Columbia River. Mule deer are found mostly along the Columbia River and in the Rattlesnake Hills (DOE-RL 1990).

The Columbia River supports a large diverse community of planktonic and benthic invertebrates, fish, and other communities (DOE-RL 1990). Phytoplankton and periphyton are abundant in the Columbia River. Phytoplankton and zooplankton populations in the river are largely transient, flowing from one area to another. However, characteristic endemic groups of plankton generally have insufficient time to develop in the Hanford Reach (DOE-RL 1990).

Forty-four species of fish have been identified in the Hanford Reach of the Columbia River. The chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*Oncorhynchus nerka*), coho salmon (*Oncorhynchus kisutch*), and steelhead trout (*Salmo gairdneri*) use the river as a migration route to and from spawning areas farther upstream. The fall chinook salmon and the steelhead trout also spawn in the Hanford Reach (DOE-RL 1990).

2.4.2 Threatened and Endangered Species

Table 2-1 includes State-designated endangered and threatened flora and fauna that could potentially occur at the Hanford Site. State designations are at least as strict as Federal designations. No plants on the Federal Endangered and Threatened Wildlife and Plants list are known to occur on the Hanford Site.

Two species of plants found at the Hanford Site are identified on the Washington State list of threatened or endangered species: the Columbia milk-vetch (*Astragalus columbianus barneby*), listed as threatened, and persistentsepal yellowcress [*Rorippa columbiae* (Suksde)], designated endangered. Columbia milkvetch occurs on dry land benches of the Columbia River in the Priest Rapids Dam, Midway, and Vernita vicinity. Persistentsepal yellowcress occurs in the wetted zone of the water's edge along the Columbia River (DOE-RL 1990). Both species may exist along the 100-N Area shore, but neither have been specifically identified.

The Federal Government lists the American peregrine falcon (*Falco peregrinus anatum*) as endangered and the bald eagle (*Haliaeetus leucocephalus*) as threatened. The Washington State list includes these two birds and also identifies the white pelican (*Pelecanus erythrorhynchos*) and sandhill crane (*Grus canadensis*) as endangered, and the ferruginous hawk (*Buteo regalis*) as threatened. The peregrine falcon does not nest at the Hanford Site but is a casual migrant. The bald eagle is a regular winter resident in areas where it forages on dead salmon and waterfowl along the Columbia River. "Washington State Bald Eagle Protection Rules" were issued in 1986 (WAC 232-12-292) pursuant to which DOE will prepare a management plan to mitigate eagle disturbance (DOE-RL 1990). The frequency of these birds visiting the 100-N Area is unpredictable, but they visit the Hanford Site between October and March.

The pygmy rabbit (*Sylvilagus idahoensis*), identified as threatened, is the only mammal species listed as endangered or threatened having the potential to occur on the Hanford Site.

Critical Habitats. It is not known if bald eagles or ferruginous hawks roost or forage in the 100-N Area. If roost trees or forage areas for these birds do exist on Site, such areas would be critical habitat. It is also not known if the endangered persistent-sepal yellowcress or the threatened eatonella are present on the Site, but such occurrences would also constitute critical habitat.

2.5 LAND AND WATER USE

2.5.1 Sensitive Environments

The Columbia River's importance as a recreational resource and a regional source of drinking and irrigation water, as well as a productive habitat for waterfowl, economically important fish species, and transitory endangered and threatened wildlife, could merit special concern for this environment during implementation of the remedial activities at the 100-N Area. If critical bald eagle habitats exist on the Site, they may be regarded as sensitive environments as defined in Appendix A of 40 CFR Part 300.

The Columbia River is regarded as an important environment with respect to the 100-N Area. The Hanford Reach is the only significant stretch of the Columbia River within the United States that is not impounded by a dam (DOE-RL 1990). The reach has also been designated a class A (excellent) surface water by Washington State (WAC 173-201). This designation requires that water quality be maintained for the following uses.

- Domestic, industrial, and agricultural water supply
- Stock watering
- Fish and shellfish migration, rearing, spawning, and harvesting
- Wildlife habitat
- Recreation (including primary-contact recreation)
- Commerce and navigation.

2.5.2 Land Use

Land use in the area surrounding the Hanford Site consists primarily of irrigated and dry-land farming, livestock grazing, and urban and industrial development. Principal agricultural crops include hay, wheat, potatoes, corn, apples, soft fruit, hops, grapes, and vegetables. Most industrial activities are associated with either agriculture or energy production (DOE-RL 1990).

Immediately north and across the river from the 100 Areas are the 130-km² (32,100-acre) Saddle Mountain National Wildlife Refuge and the 225-km² (55,600-acre) Washington State Department of Wildlife Reserve. These lands provide a buffer around the reactor sites and are owned by the DOE (DOE-RL 1990). Figure 2-9 shows the use of lands within the Hanford Site.

2.5.3 Water Use

Surface Water Use. The Hanford Reach of the Columbia River forms the northern boundary of the 100-N Area. The entire Hanford Reach is used for boating and fishing. River water is used onsite and at downstream communities for drinking water.

Five management alternatives for future use of the Hanford Reach are being analyzed as part of an environmental impact study being prepared by DOE, the National Park Service, and the U.S. Fish and Wildlife Service (DOE/EIS 1992):

- National wildlife refuge with national wild and scenic river overlay
- Water resource development projects prohibited
- National conservation area
- National river
- No action.

Columbia River water was the source of cooling water at N Reactor until 1987. Water for the heat dissipation system was drawn from the river through a shoreline intake system, circulated through various condensers and heat exchangers, and discharged to the center of the river through the 260-cm (102-in.) discharge line. The normal pumping rate was 1,100,000 L/min (290,000 gal/min) (DOE-RL 1990).

Groundwater Use. No production wells exist at the 100-N Area. The nearest reported domestic groundwater well is located near the Vernita Bridge, over 16 km (10 mi) west (upgradient) of the 100-N Area (DOE-RL 1990).

2.6 ARCHAEOLOGY AND HISTORICAL RESOURCES

Knowledge about the archaeology of the 100-N Area is largely based on reconnaissance-level archaeological surveys. Within 2.4 km (1.5 mi) of the 100-N Area are 8 archaeological sites. Several of these are located north of

the Columbia River; the other sites situated on the south shore make up the Ryegrass Archaeological District. No known sites of religious importance actually lie within the 100-N Area (DOE-RL 1990).

The most common evidence of historic activity now found near the 100-N Area is gold mine tailings on river banks and archaeological sites where homesteads once stood. Few of these vestiges of the early years remain.

Color Illustration 2-1. Aerial View of 100-N Area.

Color Illustration 2-2. N Reactor Monitoring Well Locations.

Figure 2-1. The Hanford Site.

Figure 2-2. Structural Geology of the Pasco Basin.

LEGEND:

- Generalized Areas of Basalt Outcrop in the Pasco Basin
- Syncline
- Anticline
- Monocline

Source: Myers et al. 1979.

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Figure 2-3. Generalized Stratigraphic and Hydrogeologic Column for 100-N.

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Figure 2-4. Geologic Cross Section.

Figure 2-5. Artificial Groundwater Mounding at N Reactor (June 1989).

Figure 2-6. Water Table and Inferred Flow Directions in the Northern Hanford Site, December 1990.

Figure 2-7. Water Table and Inferred Flow Directions in the 100-N Area and Vicinity, December 1990.

Figure 2-8. Wind Roses for the Hanford Site.

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Figure 2-9. Land Use of Area Within the Hanford Site.

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Table 2-1. List of Endangered and Threatened Washington State Species Having the Potential to Occur on the Hanford Site. (2 sheets)

<p><u>Endangered Vascular Plants</u></p> <p>Persistentsepal yellowcress (<i>Rorippa columbiae</i>): Known to have a scattered distribution because of specialized habitat requirements or habitat loss; generally occurs in moist to marshy places and is known to inhabit the wetted shoreline of the Hanford Reach of the Columbia River in Benton County.</p>
<p><u>Threatened Vascular Plants</u></p> <p>Columbia milk-vetch (<i>Astragalus columbianus</i>): Endemic to the area in the immediate vicinity of Priest Rapids Dam, including a portion of Benton County; could occur along the Columbia River in the northwestern portion of the Hanford Site.</p> <p>Eatonella (<i>Eatonella nivea</i>): Known to occur along the Columbia River in Grant County; could occur along the river in the northern portion of the Hanford Site.</p> <p>Hoover's desert parsley (<i>Lomatium tuberosum</i>): Endemic to south-central Washington, including Benton County; known to inhabit rocky hillsides.</p>
<p><u>Endangered Birds</u></p> <p>Aleutian Canada goose (<i>Branta canadensis leucopareia</i>): Nests in the Aleutian Islands of Alaska and winters in California; has been occasionally sighted as a migrant in Benton County; a potential seasonal user of the Columbia River valley, feeding on grasses, sedges, and berries.</p> <p>American white pelican (<i>Pelecanus erythrorhynchus</i>): Winters along the southern Pacific Coast and the Gulf Coast and nests in northern prairie and intermontane lakes; no longer nests in Washington State; migrates through eastern Washington State; flocks are common in the Columbia Basin during the summer; known to occasionally winter on the Columbia River, foraging on fish, amphibians, and crustaceans and roosting on islands.</p> <p>Peregrine falcon (<i>Falco peregrinus</i>): Breeds and winters in eastern Washington State, inhabiting open marshes, river shorelines, wide meadows, and farmlands; nests on undisturbed cliff faces; an erratic visitor at the Hanford Site, feeding on songbirds, shorebirds, and waterfowl.</p>

Table 2-1. List of Endangered and Threatened Washington State Species Having the Potential to Occur on the Hanford Site. (2 sheets)

Endangered Birds (continued)

Sandhill crane (*Grus canadensis*): Inhabits open prairies, grain fields, shallow lakes, marshes, and ponds, nesting in drier grassy and marshy areas; common migrant during the spring and fall in Washington State; some known and suspected nesting sites in eastern Washington State; unlikely visitor at the Hanford Site.

Upland sandpiper (*Bartramia longicauda*): Inhabits ungrazed and lightly grazed prairies, upland meadows, and fields that are usually located near lakes or rivers; breeds in the northern and central portions of North America and winters in South America; uncommon in eastern Washington State; a potential migratory visitor at the Hanford Site, feeding on insects, worms, and some vegetation.

Western snowy plover (*Charadrius alexandrus*): A coastal species rarely observed in eastern Washington State.

Threatened Birds

Bald eagle (*Haliaeetus leucocephalus*): A regular winter visitor to the Columbia River, feeding on spawning salmon and perhaps waterfowl and small mammals; roosting areas are known to exist in the 100 Areas of the Hanford Site (roost sites and winter feeding areas constitute critical habitats for this species).

Ferruginous hawk (*Buteo regalis*): Inhabits open prairies and sagebrush plains, usually with rocky outcrops or scattered trees, located well away from human disturbance; known to nest in Benton and Franklin counties, with Franklin County possessing the majority of the nests within Washington State; known to nest in the Hanford Site on the Arid Lands Ecology Reserve; rarely winters in Washington State; known to occasionally forage on small mammals, birds, and reptiles on sagebrush plains on the Hanford Site.

Threatened Mammals

Pygmy rabbit (*Sylvilagus idahoensis*): May be extinct in Washington State; inhabits undisturbed areas of sagebrush having soils soft enough in which to dig burrows; once known to exist on the Hanford Site near springs in the Snively Basin, west of the 200 Areas plateau, although there have been no documented sightings.

3.0 FACILITY DESCRIPTIONS

3.1 INTRODUCTION

This section describes the N Reactor facility and its major processes. These facilities are summarized in Table 3-1, which includes a brief description of their use and purpose. The facilities and structures are shown in Figure 3-1. Color Illustration 3-1 is a diagram of N Reactor operating components, and Figures 3-2 through 3-13 show floor plans that detail the size and elevation of the facility that houses the reactor.

Two primary numbering systems were used in the 100-N Area and several buildings, structures, and waste units have two number designations. Under the original Hanford Site numbering system, buildings, structures (such as river outfalls), and some waste handling units (such as retention basins) were given a unique number (e.g., 105-N for the N Reactor). Most waste units were not assigned a unique number but were instead referred to by the number of the nearby building (e.g., 163-N waste container storage pad). Under the current *Hanford Site Waste Information Data System (WIDS)* (DOE-RL 1991), most of the waste units and some buildings and structures were assigned site designation numbers (e.g., 116-N-8 for the 163-N storage pad).

3.2 N REACTOR

The N Reactor is a graphite-moderated, light-water-cooled, horizontal-pressure-tube nuclear reactor (see Color Illustration 3-2). The reactor piping was designed for 13,000 kPa (1,825 lbs/in²) and 320 °C (600 °F) maximum operating conditions. Normal operating parameters were 11,000 kPa (1,600 lbs/in²) and approximately 290 °C (550 °F). The reactor coolant circulating pumps are single-stage, horizontal, centrifugal pumps with high-pressure water-injection seals to prevent reactor coolant loss (WHC 1989a).

The N Reactor was designed for two modes of operation: (1) production of SNM only and (2) production of SNM and byproduct steam used by the HGP to generate electricity. For SNM production only, steam from the secondary side of 10 steam generators was routed through 16 river-water-cooled dump condensers. Condensate from the dump condensers was routed back to steam generators for regeneration. For dual-purpose operation, byproduct steam from the steam generators was supplied to the HGP to produce 860 MW (electrical) (WHC 1989a).

For either single- or dual-purpose operation, there were 12 steam generators. During dual-purpose operation, most of the steam produced was available for use by HGP to generate electricity, with some reserved to power the reactor coolant system (RCS) pump drive turbines and the in-plant turbine generator (WHC 1989a).

3.2.1 Confinement System

The N Reactor used a confinement system based on the concept of releasing the initial burst of steam resulting from a postulated reactor-coolant-pipe break. When the confinement pressure subsided, the steam vents were closed and ventilation valves opened. The ventilated steam was filtered through charcoal and high-efficiency filters to prevent any release of fission products from fuel failure (WHC 1989a). Figure 3-14 illustrates the confinement system process.

The 1312-N Liquid Effluent Retention Facility (LERF) was constructed as part of the safety enhancement program initiated in 1987. This facility served as a backup to the existing containment system and was designed to receive primary cooling water during an emergency, such as fuel failure. The LERF consists of a high-density polyethylene (HDPE) bladder contained within a lined and bermed impoundment. The facility has never been used.

3.2.2 Reactor Coolant System

The portion of the RCS within the N Reactor building consists of 16 parallel lines that conducted cooling water from an inlet water manifold in the 109-N heat exchanger building to the reactor. Each of these 16 lines terminates in a vertical header that has 54 to 66 individual pressure tube header-to-inlet nozzle connectors attached. Similar outlet risers and parallel lines conducted the coolant from the pressure-tube-outlet nozzle-to-header connectors to an outlet water manifold (WHC 1989a). Figure 3-15 diagrams the RCS flow at N Reactor.

In the 109-N heat exchanger building, which is immediately adjacent to the N Reactor building, the RCS consisted of six cells in parallel, each containing two steam generators (in parallel), a circulating pump and associated valves and instrumentation. Valves could be used to isolate piping and steam generators in each of the six cells from the main header piping (WHC 1989a).

Reactor coolant pressure and temperature were controlled to prevent boiling at any point in the system. A surge vessel (pressurizer) controlled system pressure and volume surges resulting from normal coolant density changes during reactor transient heat output conditions. The pressurizer consists of a cylindrical pressure vessel of about 34 m³ (1,200 ft³) useful volume directly connected to the reactor outlet piping. Two electric immersion heater systems maintained the pressurizer at saturation temperature and pressure with about 40 percent useful surge volume during normal operations. During outsurges of water from the pressurizer, flashing steam from the saturated water compensated for the drop in pressure. Increases in system pressure were limited by injecting a water spray into the steam space to condense some of the steam. This spray was reactor coolant fed from either reactor inlet water or from the high-pressure injection pumps (WHC 1989a).

3.2.3 Nuclear Fuel System

The N Reactor fuel was slightly enriched U (0.94 percent to 1.25 percent), clad with a zirconium alloy. When last operated in 1986, a concentric tube-in-tube fuel design was in use for coproduction of SNM and byproduct steam. In the past, other materials have been used as a target in connection with an enriched uranium driver fuel element to produce useable isotopes such as ^3H and ^{238}Pu . The fuel cladding is Zircaloy-2 metallurgically bonded to the uranium by a co-extrusion process. The fuel elements used in N Reactor were manufactured by United Nuclear Corporation and ranged from 38 to 66 cm (15 to 26 in.) long (WHC 1989a). A photograph of a fuel element is presented in Color Illustration 3-3.

3.2.4 Heat Dissipation System

The secondary steam system for the N Reactor removed the reactor heat from the RCS by boiling secondary water in the shell side of the steam generator. During operation solely for the production of SNM, the major fraction of this steam was routed to 16 dump condensers arranged in parallel and cooled by untreated Columbia River water. These condensers operated at a pressure near that of the steam generators and eliminated the need for steam pressure reducing stations. Condensate was pumped from the dump condensers back to the steam generators for recycling. To achieve maximum single-purpose production operation, the steam temperature and pressures were maintained as low as practicable. A portion of the steam generated was used by the coolant pump drive turbines and by the turbine generator for local station service (WHC 1989a).

During dual-purpose operation, the major fraction of steam generated was routed to the HGP (Figure 3-15). A portion of the steam generated was used to drive the reactor coolant pumps and the onsite turbine generator and keep the dump condensers warm so they would be ready to accept a full steam load if an HGP turbine generator shut down (WHC 1989a).

3.2.5 Water Supply System

Untreated water from the Columbia River was supplied as coolant to the dump condensers, as well as to the reactor coolant pump drive turbine surface condensers and the local turbine generator condenser. This condenser cooling water was then returned to the river. Untreated water was also supplied to the water treatment facility for the filtered water, sanitary water, and demineralized water systems (see Figure 3-16). The entire untreated water system was supplied by four pumps each with a capacity of 400,000 L/min (105,000 gal/min). Water was supplied from the 181-N river pumphouse to points of process use through two separate headers (WHC 1989a).

The 183-N filtration plant supplied the filtered and potable water needs of the 100-N Area. Filtered water was used for producing demineralized water. Raw water from the Columbia River was treated with chlorine gas (a biocide) and alum (a coagulant) in a mixing tank. From there, it was piped to a coagulator, where a polyelectrolyte was added as a coagulation aid, and then piped to the sand filters where filtration took place. The filtered water was

pumped to the 3,200,000-L (850,000-gal) filtered-water storage tank from a clear well south of the 163-N facility (DOE-RL 1990). This tank supplied water for the following uses:

- Horizontal control rod backup cooling
- Fuel-element storage-basin cooling and cleanup
- Area service water
- Potable water system
- Demineralization plant influent (WHC 1989a).

The sand filter backwash was discharged to the 183-N filter backwash pond.

The 163-N facility (Figure 3-17) produced high-quality, demineralized makeup water from filtered river water for the major coolant systems of the N Reactor. Demineralized water has virtually all dissolved and suspended matter removed by ion exchange. Demineralized water was used to prevent mineral deposits that would foul piping systems and to limit the generation of radioactive waste through neutron activation of dissolved and suspended matter (DOE-RL 1990).

The 163-N facility contains demineralization equipment, including ion exchange units, regeneration tanks, treatment tanks (for pH adjustment) that are part of the elementary neutralization unit (ENU), acid and caustic-materials storage tanks, a heater, and a degasifier (DOE-RL 1990). The basic components of the plant and the demineralization process (Figure 3-18) are described in the following paragraphs.

Primary Cation Exchange Units. The 163-N facility has four primary cation exchange units, which are the top portions of four large tanks (or ion exchange columns). They contain ion exchange resins saturated with hydrogen ions to displace cation impurities (e.g., calcium, sodium, manganese, and iron) in the water. At the same time, the displaced cations accumulate on the resins and the resins eventually become "exhausted," losing their capacity to absorb more cations. When this occurs, the resins are sent to a regeneration tank, where they are again saturated with hydrogen ions while the cation impurities are removed and discharged to the 1324 NA percolation ponds (DOE-RL 1990).

Primary Anion Exchange Units. The four primary anion exchange units are the bottom sections of the tanks that contain the primary cation exchange units. These primary anion units contain ion exchange resins saturated with hydroxide ions. The hydroxide ions displace anion impurities (e.g., chlorides, fluorides, and sulfates) in the water. The resins eventually become exhausted in the process and require regeneration (DOE-RL 1990). When this occurs, the resins are sent to a regeneration tank where they are again saturated with hydroxide ions, while the anion impurities are removed and discharged to the 1324 NA percolation pond (DOE-RL 1990).

Degasifier. Also referred to as the deaerator, this device used heat and vacuum to remove noncondensable gases (e.g., nitrogen and oxygen) from the cation effluent water. The degasifier has two vacuum systems: a steam jet air ejector system that uses medium-pressure steam to create a vacuum and a system that consists of three vacuum pumps (DOE-RL 1990).

Heater. Also referred to as the heat exchanger, this device used medium-pressure steam to warm up the water after it exited the primary cation units. The water was heated to reduce the solubility of gases and make the degasifier more efficient (DOE-RL 1990).

Secondary Cation and Anion Exchange Units. The four secondary cation units and four secondary anion units are in four tanks in the top and bottom sections, respectively. They are arranged in a manner similar to the primary units. The secondary units contained the same ion exchange resins as the primary units. The secondary units were to remove any impurities remaining in the water following treatment in the primary units. Because the water treated in the secondary units had already been largely deionized in the primary units, the resins in the secondary units were less exhausted and required regeneration less frequently (DOE-RL 1990).

Demineralized Water Storage Tank. This tank stored water from the 163-N facility before the water was used at N Reactor. It is a 3.8 M-L (1 M-gal) -capacity tank, located with other water storage tanks southwest of the 163-N facility (DOE-RL 1990).

Regeneration Tanks. The four regeneration tanks were used to regenerate the cation and anion exchange resins when they became exhausted. The regeneration tank for the primary cation units and the regeneration tank for the primary anion units each has an upper compartment where regeneration occurred and a lower compartment where a spare resin charge was stored. The spare resin was sent to the primary units at the same time as the depleted resin charge was sent to the regeneration tank, allowing near-continuous operation of the primary units (DOE-RL 1990).

A sulfuric acid solution was used to regenerate cation resins; a sodium hydroxide solution was used to regenerate anion resins. The solutions were pumped through the resins in the regeneration tanks and drained to the 1324-N Surface Impoundment until 1988, when a spent regenerant surge tank and ENU were installed (DOE-RL 1990).

Acid and Caustic Storage Tanks. Located along the west inside wall of the 163-N facility, acid and caustic-materials storage tanks contained solutions of sulfuric acid (H_2SO_4 , 93 percent by weight) and sodium hydroxide (NaOH, 50 percent by weight), respectively. These solutions were used to regenerate the resins and neutralize the spent regenerant (i.e., the wastewater from regeneration). The storage tanks are surrounded by curbs for spill control. The storage tanks were filled, as needed, through below-grade pipelines that run through concrete trenches from larger tanks located at the 108-N chemical unloading facility east of the 163-N facility (DOE-RL 1990).

Spent Regenerant Surge Tank. The 454,000 L (120,000 gal) capacity spent regenerant surge tank was installed in 1988 and is located outside on the north side of the 163-N facility. The surge tank was designed to store spent regenerant until it could be neutralized in the ENU or to function as an ENU. During normal operation, the surge tank discharged to the ENU system where the effluent stream was then neutralized and discharged to the 1324-NA (120-N-1) percolation pond (DOE-RL 1990).

An alternative mode of operation allowed the waste stream to be neutralized in the surge tanks by recirculation and pH adjustment. On reaching proper pH, the liquid was sent to the 1324 NA (120-N-1) Percolation Pond through a 20-cm (8-in.) chemical waste pipeline. Analyses have confirmed that after neutralization the effluent stream no longer exhibited the dangerous waste characteristic of corrosivity. The surge tank is surrounded by a concrete berm capable of containing the entire volume of the tank if a spill occurred (DOE-RL 1990).

Elementary Neutralization Unit. The ENU was installed in 1988 to replace the 1324-N Surface Impoundment. It consists of three upright tanks adjacent to the acid and caustic-materials storage tanks inside the 163-N building. Spent regenerant is piped from the surge tank to the ENU. After adding the proper amount of acid or caustic solution, the tank contents were mechanically agitated to ensure mixing and pH neutralization. Neutralized spent regenerant was discharged from the ENU to the 1324-NA Percolation Pond (120-N-1) when its pH fell within the range from 6.0 to 9.0. Spent regenerant having a pH outside this range was piped back to the surge tank until it could receive additional treatment in the ENU. The ENU is surrounded by a curb for spill control (DOE-RL 1990).

3.2.6 Emergency Cooling Systems

The emergency cooling system (ECS), an engineered safety system, provided a separate independent water system for once-through cooling of the reactor. Three diesel-driven high-lift pumps were provided to deliver the cooling water to the bottom of the inlet risers where it entered the RCS through check valves when the system pressure fell below approximately 2,000 kPa (300 lbs/in²). The high-lift pumps were initially supplied with treated water from the demineralized water storage tank, which was maintained with a minimum of 1,700,000 L (452,000 gal) for ECS use only. If this supply was depleted, untreated river water was automatically supplied from two diesel-driven pumps located in a separate section of the river pumphouse (WHC 1989a).

A similar diesel-driven pumping system provided emergency once-through cooling to the graphite moderator and shields. This coolant provided backup to the ECS in the event of long-term failure of the ECS (WHC 1989a).

Both ECSs were intended for use only if the normal circulating-water heat-removal systems were disabled. Activation of the ECSs would be triggered by loss of all normal pumping power caused by a major break in the RCS, which would result in depressurizing the RCS (WHC 1989a).

3.2.7 Process Decontamination

A process decontamination system used phosphoric acid for chemical decontamination of the entire RCS or for any of several major portions of the system, including the individual heat exchangers. The graphite and shield cooling system could also be chemically decontaminated. Equipment was included for storing and preparing the necessary chemicals and piping for injecting them at appropriate points. Mixed wastes from decontamination,

along with rinse waters, were routed to the 1310-N (116-N-2) storage tank, then shipped by tank truck or rail car to the 200 Area for disposal (WHC 1989a).

3.2.8 Plant Service Boilers

The onsite plant service boilers provided steam for the reactor coolant pump drive turbines and for the onsite turbine generator as a backup power supply (WHC 1989a).

One boiler was housed in the 184-N plant service powerhouse and two boilers were housed in the 184-N building annex. During reactor operation, the boilers were maintained in a condition capable of being brought on line to carry the shutdown load. These boilers could supply approximately 150,000 kg (340,000 lb) of steam per hour (WHC 1989a).

Fuel for the boilers was piped from the 166-N tank farm to the 184-N day tanks, located north of the 184-N building. Two 130,000-L (35,000-gal) No. 6 fuel oil tanks and one 30,000-L (8,000-gal) No. 2 diesel oil tank provided fuel to the boilers. Underground piping connects the 166-N tank farm, the 184-N day tanks, and the 184-N boilers. These tanks are empty.

3.2.9 Diesel Fuel Storage and Transfer System

The diesel fuel oil storage and transfer system supplied diesel oil to the seven ECS and fog spray diesel engines, the 182-N high lift pumphouse, the diesel fire pump, and the diesel-driven electrical generator located in the 182-N building. The 105-N lift station sump pump diesel engine had an independent underground storage tank. The total storage capacity of the diesel oil storage system is 1,800,000 L (465,700 gal), consisting of four 400,000-L (105,000-gal) bulk storage tanks and 5 day tanks (three 60,000 L [15,000 gal], which have been removed, and two 1,400 L [360 gal]). The unloading station for the four diesel bulk storage tanks is located west of the 166-N building adjacent to the No. 6 fuel oil unloading station at the 166-N tank farm (WHC 1989a). These tanks are empty.

3.2.10 Boiler Fuel Oil System

The boiler fuel oil system supplied No. 6 fuel oil to the plant service boilers. The total capacity of the system is 5,500,000 L (1,445,000 gal). The single bulk storage tank volume is 5,200,000 L (1,375,000 gal); each of the two day tanks contained 130,000 L (35,000 gal) of fuel oil. The unloading station for the bulk fuel oil storage tank is located west of the 166-N building adjacent to the diesel oil system unloading station. This unloading system is a concrete trench containing six tank car connections and four tank truck connections (WHC 1989a). These tanks are empty except for some residual oil in the bottom of the single bulk storage tank.

3.3 WASTE-GENERATING PROCESSES

Radioactive and hazardous wastes were generated in various processes that supported N Reactor. In some cases, wastes were considered both hazardous and radioactive and were referred to as mixed wastes. The main waste-generating processes are discussed in the following subsections. The waste streams are summarized in Table 3-2.

3.3.1 Radioactive Effluents and Wastes

Radioactive effluents and wastes were generated in a variety of process systems. These radioactive wastes included reactor primary coolant water, spent fuel storage basin cooling water, reactor periphery systems cooling water, reactor primary-coolant-loop decontamination and rinse solution, and miscellaneous drainage from reactor support facilities (WHC 1987a).

Primarily, radioactive effluents and wastes were generated within the 105-N reactor building and the 109-N heat transfer building. The radioactive process effluent and waste streams ultimately were sent to either the 116-N-1 crib and trench, the 116-N-3 crib and trench, or the 1314-N liquid waste loadout station (LWLS).

3.3.2 Reactor Primary Coolant System

The reactor primary coolant system was supplied by demineralized water from the 163-N demineralization plant. Ammonium hydroxide and hydrazine were introduced into the primary coolant system to control water pH and oxygen, respectively. Normal operation of the reactor primary coolant system resulted in approximately 760 L/min (200 gal/min) of bleed off and leakage, which were discharged to the 116-N-1 and/or the 116-N-3 crib and trench via the 91-cm (36-in.) radioactive drainline (WHC 1987a). Analysis of primary coolant wastewater in 1985 indicated that it did not exhibit any of the characteristics of a regulated dangerous waste (WHC 1987a) per waste stream designation based on dangerous waste regulations contained in *Washington Administrative Code* (WAC) 173-303.

3.3.3 Spent Fuel Storage Basin Cooling Water System

Until December 1984, essentially all the ^{90}Sr and ^{137}Cs discharged to the 116-N-1 crib originated in the N Reactor spent fuel storage basin. The spent fuel storage basin operated in a single-pass cooling mode from the time of initial N Reactor operation until a recirculation system was installed in December 1984 (DOE-RL 1990).

The single-pass cooling system operated on the basis that every 6 weeks, N Reactor fuel elements were discharged to the spent fuel basin via a large tunnel-like canal located at the outlet face of the N Reactor. During this transfer process, a large quantity of reactor primary-cooling-circuit water, containing considerable amounts of suspended and soluble metals and metal oxides was added to the spent fuel storage basin. Excess basin water was routed to the 116-N-1 and/or 116-N-3 cribs via the basin overflow weirs and a

91-cm (36-in.) drainline (WHC 1987a). Between reactor fuel element transfers, the spent-fuel-basin water level was maintained by adding treated water from the 183-N filtration plant (DOE-RL 1990).

Starting in December 1984, the 107-N spent fuel storage basin cooling water recirculation system was operated. The 107-N basin recirculation facility cleaned N Basin in a closed-loop system. Mixed wastes were routed to the 190,000-L (50,000-gal) tank, where they were neutralized and then pumped to the 1314-N LWLS (DOE-RL 1990).

3.3.4 Reactor Periphery Cooling Systems

Three reactor periphery cooling systems, the graphite and shield cooling system, the reactor control rod cooling system, and the reactor secondary coolant loop system, were closed systems using demineralized water from the 163-N demineralization plant. As with the primary coolant system, bleed off and spillage from the periphery cooling systems resulted in small continuous discharges to the 116-N-1 (1301-N) and/or 116-N-3 (1325-N) liquid waste disposal facilities. Periphery cooling water also had a variety of chemicals added, including ammonium hydroxide and morpholine for pH control and hydrazine for oxygen control.

3.3.5 Reactor Primary Coolant Loop Decontamination System

Approximately every 3 to 5 years, the reactor primary coolant loop was decontaminated with a 70 percent phosphoric acid/diethylthiourea solution diluted to an 8 percent solution by weight. This solution was mixed in the 109-N mix tank, then piped to the RCS manifold in the N Reactor. From the manifold, the solution entered the primary piping through the V-3 valves. The decontamination solution removed the radioactive oxides (containing activation and fission products) that had built up as residues in the piping. The solution exited the primary coolant loop through the V-4 valves and was then routed to the 116-N-2 (1310-N) radioactive chemical waste storage facility tank (DOE-RL 1990). Decontamination solution and subsequent rinsate were pumped into this tank. This volume was approximately 2,300,000 L (600,000 gal) of mixed waste. Another 380,000 L (100,000 gal) of rinsate was pumped through the primary cooling system and discharged to 116-N-1 and/or 116-N-3 (WHC 1987a). The acidic decontamination solution in the 116-N-2 storage tank was neutralized with sodium hydroxide to a pH greater than 7.0 and pumped to the 1314-N LWLS. Before 1987, the pH was required to be between 9.0 and 11.0. From the 116-N-2 tank the waste solution was sent to the 200 Area via rail tank car for disposal in accordance with the *Hanford Site Radioactive Solid Waste Acceptance Criteria* (Willis and Tiner 1991).

3.3.6 Drainage From Reactor Support Facilities

The radioactive drain system is a network of floor drains that collected radioactive water from throughout the N Reactor building and 109-N building. In addition to pump leakage and system bleed off from reactor primary and

periphery cooling systems, spills and waste streams may also have originated at several locations (WHC 1987a,b; DOE-RL 1990), including the following:

- Five wet laboratories that performed chemical analyses on cooling water to 116-N-1 and/or 116-N-3
- Auxiliary power battery lockers (potential spills) to 116-N-1 and/or 116-N-3
- Hydrazine mixing and injection area to the Columbia River
- Room 11 decontamination station to 116-N-2
- Room 307 decontamination station to 116-N-2
- Room 191 decontamination station to 116-N-2.

3.3.7 Water Treatment and Demineralization Plants

The configuration of the 163-N demineralization plant regeneration waste stream that existed before facility shutdown is shown in Figure 3-17. Before 1977, the nonneutralized spent regenerant was discharged from the 163-N facility to the Columbia River, as was common industry practice at the time. The resulting dilution was relied on to mitigate the corrosive nature of this wastewater. Beginning in 1977, spent regenerant from the 163-N facility was discharged to the unlined 120-N-1 (1324-NA) percolation pond. The alternate addition of acidic cation regenerant and alkaline anion regenerant served to neutralize the pH of the pond contents over time. In addition, the buffering capacity of the calcareous soil underlying the pond assisted the neutralizing process. Waste from the 163-N facility was treated in situ at the 120-N-1 percolation pond by a combination of pH neutralization and eventual percolation or evaporation of the wastewater (DOE-RL 1990).

Since early 1986, the 120-N-1 (1324-NA) percolation pond has received only neutralized wastewater because construction of the lined 120-N-2 surface impoundment in that year provided a means of neutralizing and mixing the spent regenerant (in batches from successive regenerations) from the 163-N facility before discharging it to 120-N-1. The neutralizing process involves treating individual batches with either sulfuric acid or sodium hydroxide, as appropriate. From 120-N-2, the neutralized wastewater was then piped to the 120-N-1 for disposal (DOE-RL 1990).

In November 1988 use of the 120-N-2 (1324-N) surface impoundment was discontinued when the newly constructed ENU was put on line inside the 163-N facility. The ENU neutralizes the spent regenerant before it is discharged to the 120-N-1 percolation pond, and does so with greater efficiency and operator control than was possible in the 120-N-2 facility (DOE-RL 1990).

3.4 RESOURCE CONSERVATION AND RECOVERY ACT FACILITIES IN THE 100-N AREA

Table 3-3 lists the active or recently active TSD units in the 100-N Area that must be operated, permitted, and/or closed in compliance with RCRA and the State dangerous waste program regulations identified in Appendix B of the *Tri-Party Agreement Action Plan* within the 100-NR-1 Operable Unit (DOE-RL 1990).

The 100-N Area TSD units historically received hazardous or dangerous wastes, but are either out of service or have stopped receiving such wastes. The 100-N Area TSD units will be closed in accordance with the State dangerous waste program as specified in WAC 173-303-610 (DOE-RL 1991). Draft closure plans have already been prepared for these units, but are scheduled to be submitted to Ecology in 1994 in accordance with the Tri-Party Agreement (Ecology et al. 1992).

3.4.1 1301-N (116-N-1) Liquid Waste Disposal Facility

The 1301-N Liquid Effluent Disposal Facility (LWDF), shown in Figure 3-19, was the primary receiving facility for N Reactor effluent primarily contaminated with corrosion products and fission products. From the operations start of N Reactor in 1963 until September 1985, the 1301-N LWDF was the primary liquid radioactive waste disposal facility for the N Reactor. The nominal effluent flow rate was 6,435 L/min (1,700 gal/min). Wastes disposed of in the 1301-N LWDF consisted of RCS bleed off, spent fuel storage basin bleed off, periphery cooling systems bleed off, reactor primary coolant loop decontamination rinse solution, and discharges from building drains containing radioactive wastes generated in reactor support facilities. This effluent was contaminated chiefly with corrosion products and fission products.

The 1301-N LWDF is an inactive land disposal facility that used the filtration properties of soil to remove radioactive material from effluent water. Radioactive materials included in the discharged wastes were retained in the soil by the filtration, absorption, and ion exchange that occurred in the soil column underlying the 1301-N LWDF (DOE-RL 1990).

The facility is located approximately 18 m (60 ft) above and 262 m (860 ft) east of the shore of the Columbia River, see Color Illustration 3-4. The original facility consisted of a 16-m by 3.5-m (52-ft by 12-ft) concrete trough (weir box) and a 38-m by 88-m (125-ft by 290-ft) rectangular basin (crib). The crib was constructed by excavating existing soil and then surrounding the excavation with a soil and gravel embankment. The bottom of the crib was filled with a 1-m (3-ft) layer of large stones (WHC 1987b).

After only a few years of reactor operation, an extension trench was added to the crib. The trench is an excavated ditch approximately 487 m long, 15 m wide, and 3.5 m deep (1,600 ft long, 50 ft wide, and 12 ft deep), extending in a zigzag pattern. In 1982, the trench was covered with precast concrete panels to prevent animals from coming in contact with the wastes (WHC 1987b).

The radionuclide inventory under 1301-N LWDF has been estimated to 6,800 Ci based on radiological analyses of the effluent stream. Present radiation dose rates on the surface of the facility range from 10 mrem to 1,000 mrem (WHC 1987b).

This facility was replaced in 1985 by the 1325-N LWDF because elevated levels of radionuclides were released via the N-Springs (DOE-RL 1987a).

3.4.2 1325-N Liquid Waste Disposal Facility

The 1325-N LWDF, shown in Figure 3-20, started receiving part of the N Reactor liquid radioactive effluent in 1985. In September 1985, the 1325-N LWDF became the primary liquid radioactive waste disposal facility for the N Reactor. The nominal effluent flow rate during reactor operation was 6,345 L/min (1,700 gal/min) and is now less than 7.5 L/min (2 gal/min). Wastes disposed of in the 1325-N LWDF consist of RCS bleed off, spent fuel storage basin bleed off, periphery cooling systems bleed off, reactor primary coolant loop decontamination rinse solution, and discharges from building drains containing radioactive wastes generated in reactor support facilities. Hazardous wastes generated by laboratories, decontamination activities, and other routine activities at N Reactor were discharged to the building drains. Through laboratory waste collection, additional secondary containment, and application of administrative controls, hazardous wastes are no longer discharged to the 1325-N LWDF (WHC 1987a).

The 1325-N LWDF is a land-disposal facility that also makes use of the filtration properties of soil to remove radioactive material from effluent water. Radioactive materials included in the discharged wastes are retained by the soil and the filtration, absorption, and ion exchange that occur in the soil column underlying the 1325-N LWDF (DOE-RL 1990).

The facility is located approximately 18 m (60 ft) above and 732 m (2,400 ft) east of the shore of the Columbia River (see Color Illustration 3-4). The original facility consisted of a reinforced concrete header box and a 73-m by 76-m (240-ft by 250-ft) rectangular basin (crib). The crib was constructed by excavating existing soil and then covered with precast, prestressed concrete panels sealed with grout. The crib cover is approximately 3 m (10 ft) lower than the surrounding ground and less than 1.5 m (5 ft) above the percolation surface (WHC 1987a).

In 1985, after 2 years of operation, an extension trench was added to the 1325-N crib because it was unable to handle the flow rate of the original design. The trench is an excavated ditch approximately 914 m long, 17 m wide, and 2 m deep (3,000 ft long, 55 ft wide, and 7 ft deep). The trench ties into the crib at two points (from the crib's northern and eastern corners) with the effluent from each combining in a common weir box. The tie-in is composed of rubber gasket-joined, precast, reinforced, concrete box sections. The trench was covered with precast concrete panels that were placed close together, left unsealed, and contain lifting lugs to facilitate panel removal. The 81-cm (32-in.) wide centra-core concrete panels were placed (unsealed) along the side of the trench, mating with the trench cover panels. The sides of the trench were then backfilled (WHC 1987a).

The 2-m (7-ft) deep trench is divided into 4 equal sections by 3 dams (in addition to the weir box) composed of structural fill and concrete. A layer of riprap was added to the downstream side of each dam to prevent scouring. The top 60 cm (24 in.) of the trench bottom were screened to remove fines to aid in preventing trench plugging.

Only the first of the four trench sections have received N Reactor effluent.

3.4.3 1324-N/NA Surface Impoundment/Percolation Pond

The 1324-NA Percolation Pond, shown in Figure 3-21, was constructed in 1977 to receive neutralized regeneration waste water initially from the north and south settling ponds. In 1986 this pond received waste from the 1324-N Surface Impoundment, which was replaced by an ENU in 1988. The 1324-NA is an unlined excavation 82 m by 24 m by 4.5 m deep (270 ft by 80 ft by 15 ft deep) (WHC 1986).

The 1324-N Surface Impoundment shown in Figures 3-21, 3-22, and 3-23 was constructed in 1986 and was used to neutralize corrosive ion exchange regeneration waste water from the 163-N Demineralization Facility. The surface impoundment is a double-lined pond with leak-detection capability between the two liners. The surface impoundment is situated over a previously used unlined north settling pond, Figure 3-24, that had received unneutralized regeneration waste water from the 163-N Demineralization Facility from 1977 to 1986. The 1324-N Surface Impoundment is 23 m by 43 m by 4.5 m deep (75 ft by 140 ft by 15 ft deep).

3.5 OTHER FACILITIES

3.5.1 Hanford Generating Plant

The HGP, owned by the Supply System, received steam via the steam piping system from the N Reactor. The HGP consists of two 430-MW (electrical) low-pressure turbine generator systems with associated auxiliary equipment normally found in a steam power station. The HGP is operated by the Supply System. The HGP condensers and auxiliary cooling systems were supplied by raw water pumped from the Columbia River and discharged back to the river approximately 90 m (300 ft) upstream from the N Reactor raw water intake structure.

3.5.2 Bonneville Power Administration Substation

The BPA Hanford switching substation was built in 1968 to supply electrical power produced by the HGP to the Supply System's main electrical grid. The substation consists of a switch yard and control house on approximately 0.1 km² (30 acres). The control house contains the communication equipment used to run the substation remotely. The control house is also used to store maintenance equipment.

3.5.3 100 D Area Support Facilities

Three interconnected buildings at the deactivated D Reactor were used to support N Reactor.

185-D Building. This building was a warehouse for equipment and spare parts.

189-D Building. An engineering laboratory was operated in the 189-D building to support N Reactor when it was operating.

190-DR Building. This building was a warehouse for equipment and spare parts.

3.5.4 100 C Area Support Facilities

190-C Building. The 117-N filter building used charcoal filters to absorb airborne radioactive materials emitted from N Reactor. The filters were transported to the 190-C building where the spent charcoal was removed and taken to the 200 East burial ground. New charcoal was then added and the filter was placed back in the 117-N building.

N REACTOR

OPERATING COMPONENTS

Color Illustration 3-1. N Reactor Operating Components.

Color Illustration 3-2. Reactor Core.

Color Illustration 3-3. N Reactor Fuel.

Color Illustration 3-4. Aerial View of the 1301-N and 1325-N
Waste Disposal Facilities.

Figure 3-1. 100-N Area
Facilities and Structures

BUILDING LIST					
BUILDING NUMBER	DESCRIPTION	BUILDING NUMBER	DESCRIPTION	BUILDING NUMBER	DESCRIPTION
106-N	REACTOR BUILDING	1125-N	OFFICE BUILDING (TLR.)	1324-NA	SURFACE IMPOUNDMENT
107-N	BASIN RECIRCULATION FACILITY	1126-N	OFFICE BUILDING (TLR.)	1701-N	BADGE HOUSE (LIMITED AREA)
108-N	CHEMICAL UNLOADING FACILITY	1126-NA	OFFICE BUILDING (TLR.)	1702-N	VEHICLE INSPECTION STATION
109-N	HEAT EXCHANGER BUILDING	1127-N	MOBILE OUTAGE LOCKER ROOM	1703-N	WPPSS
109-NA	STEAM & FLOW BUILDING	1128-N	MOBILE OUTAGE LOCKER ROOM	1705-N	PLANT ASSISTANCE FACILITY
110-N	AM STACK	1129-N	SPECIAL WAREHOUSE	1706-N	STORAGE BUILDING
117-N	FILTER BUILDING	1130-N	SWP CHANGE ROOM BLDG.	1707-N	STORAGE BOAT HOUSE
117-NVH	VALVE CONTROL HOUSE	1131-N	KEH FIELD OFFICE	1712-N	INSULATION SHOP
119-N	AM SAMPLING MONITORING	1132-N	MOBILE OFFICE	1714-N	WAREHOUSE
121-N	250 KV ELEC. SUBSTATION	1133-N	MOBILE OFFICE	1714-NA	RECEIVING INSPECTION FACILITY
123-N	SWITCH GEAR BUILDING	1134-N	KEH MOBILE OFFICE	1714-NB	TOOL STORAGE SHED
125-N	B.P.A. SWITCH YARD	1134-NA	MOTOR GENERATOR SUPPORT	1715-N	DIESEL OIL STORAGE TANKS
126-N	DEMINERALIZATION PLANT	1135-N	MOBILE OFFICE	1715-NA	UNDERGROUND OIL TANK 105K GAL
128-N	FUEL OIL STORAGE	1140-N	WOMEN'S RESTROOM	1716-N	GAS STATION
121-N	RIVER PUMP HOUSE (100-N)	1141-N	MEN'S RESTROOM	1722-N	DECONTAMINATION HOT SHOP BLDG.
131-NE	RIVER PUMP HOUSE (WPPSS)	1142-N	TELEPHONE CENTER	1723-N	CONTAM. EQUIP. STORAGE BLDG.
122-N	HIGH LIFT PUMP HOUSE	1143-N	PAINT SHOP	1734-N	GAS BOTTLE STORAGE
123-N	WATER FILTER PLANT	1144-N	SANDIA NATIONAL LAB	1900-N	WATER SUPPLY TANKS
124-N	PLANT SERVICE POWER HOUSE	1145-N	LOCKER ROOM TRAILER	1906-N	SEAL WELL
124-NA	AUXILIARY POWER ANNEX BLDG.	1146-N	OFFICE BLDG. TRAILER	1906-NE	SEAL WELL (WPPSS)
126-N	TURBINE GEN. BLDG. (WPPSS)	1147-N	OFFICE FACILITY	N-10	ALL CRAFTS LUNCHROOM
1100-N	ADMINISTRATION & FIRST AID BLDG.	1148-N	OFFICE FACILITY	N-11	INSULATORS SHOP BLDG.
1101-N	OFFICE BUILDING	1150-N	OFFICE FACILITY	N-12	OFFICE BLDG. (TLR.)
1102-N	OFFICE BUILDING	1151-N	OFFICE FACILITY	N-13	PIPEFITTER STORAGE
1103-N	OFFICE BUILDING (TLR.)	1152-N	OFFICE FACILITY	N-14	OFFICE BUILDING (TLR.)
1104-N	OFFICE BUILDING (TLR.)	1153-N	OFFICE FACILITY	N-15	PIPEFITTER SHOP & IRONWORKER
1105-N	OFFICE BUILDING (TLR.)	1154-N	OFFICE FACILITY	N-16	CARPENTER SHOP
1107-N	OFFICE BUILDING (TLR.)	1155-N	OFFICE FACILITY	N-17	PAINT SHOP
1108-N	OFFICE BUILDING (TLR.)	1157-N	OFFICE FACILITY	N-18	ELECTRICIAN SHOP BLDG.
1110-N	OFFICE BUILDING (TLR.)	1158-N	OFFICE FACILITY	N-19	PIPEFITTER SHOP
1111-N	OFFICE BUILDING (TLR.)	1200-N	RADIOACTIVE WASTE DISPOSAL	N-20	CRAFT SHOP
1112-N	BADGE HOUSE PROTECTED AREA	1201-N	CRIB	N-21	CRAFT SHOP
1113-N	OFFICE BUILDING (TLR.)	1203-N	RADIOACTIVE DUMMY BURIAL FACIL.	N-22	CRAFT SHOP
1114-N	OFFICE BUILDING (TLR.)	1204-N	EMERGENCY DUMP TANK	N-23	CRAFT SHOP
1115-N	OFFICE BUILDING (TLR.)	1210-N	RADIOACTIVE CHEM. WASTE TREATMENT	N-24	CRAFT SHOP
1116-N	SIMULATOR BUILDING (TLR.)	1212-N	LIQUID WASTE LOADOUT STATION	N-25	CRAFT SHOP
1117-N	OFFICE BUILDING (TLR.)	1213-N	CHANGE & CONTROL ROOM	N-26	CRAFT SHOP
1118-N	OFFICE BUILDING (TLR.)	1214-N	LIQUID WASTE DISPOSAL STATION	N-27	CRAFT SHOP
1119-N	LOCKER ROOM BUILDING (TLR.)	1215-N	DIVERSION SYSTEM VALVE HOUSE	N-28	CRAFT SHOP
1120-N	WAREHOUSE-TRAINING BLDG.	1216-N	VALVE HOUSE	N-29	CRAFT SHOP
1123-N	OFFICE BUILDING (TLR.)	1222-N	WASTE TREATMENT PILOT PLANT FACIL.	N-30	CRAFT SHOP
1124-N	EMERGENCY CONTROL CENTER (TLR.)	1224-N	SURFACE IMPOUNDMENT		

Figure 3-1A. Enlarged Legend for Figure 3-1.

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LEGEND

- Ⓘ Zone I Primary Confinement Zone
- Ⓜ Zone II Secondary Confinement Zone
- Ⓜ Zone III Confinement Buffer Zone
- Ⓜ Zone IV Personnel Zone
- Ⓜ Zone V Reactor Control & Personnel Zone

Figure 3-2. Legend for Figures 3-3 through 3-13.

- Zone I Perimeter
- Radiation Zone Boundary
- Center of Reactor

Figure 3-4. Plan - Elevation - 0' 0", 105 N.

Figure 3-6. Plan - Elevation - 28' 3", 105 N.

Figure 3-7. Plan - Elevation - 40' 0", 105 N.

FLOOR PLAN at EL 51'-0"

(EL. 505.5' MSL)

Figure 3-8. Plan - Elevations 51' 0" and 60' 0", 105 N.

FLOOR PLAN at EL 60' - 6"

(EL. 515.0' MSL.)

Figure 3-9. Elevations I, II, and XI, 105 N.

XI XI
 105 N. 221

III — III
Col Line I

V — V
Col Line B

Figure 3-10 Elevations III through VI, 105 N.

IV — IV
Col Line D

VI — VI
Col Line 12

Figure 3-11. Elevations VII through X, 105 N.

VIII — VIII
Col Line 15

X — X
Near Col Line 20

FLOOR PLAN of EL -16'-0"

Figure 3-12. Plan at Elevations 0' 0" and 16' 0", 109-N Building.

FLOOR PLAN at EL 0'-0"

Figure 3-13. Elevations 109-N Building.

C — C

Figure 3-14. N Reactor Confinement System.

Figure 3-15. N Reactor Coolant Flow.

Source: WHC 1989a.

Figure 3-16. Water Supply System.

29212025.36

Figure 3-17. 163-N Facility.

29212025.37

Figure 3-18. 163-N Demineralization Process.

39008093.2

Figure 3-19. Layout of the 1301-N Liquid Waste Disposal Facility.

Figure 3-20. Layout of the 1325-N Liquid Waste Disposal Facility.

29212025.5

Figure 3-21. 1324-NA Facility Diagram with Dimensions, 1977 to 1983.

Figure 3-22. 1324-N Surface Impoundment Physical Dimensions.

29212025.8

Figure 3-23. Liner Construction Details.

29212025.11

Figure 3-24. 1324-N/NA Surface Impoundment/Percolation Pond 1986 to 1988.

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Table 3-1. Facilities in the 100-N Area. (6 sheets)

Current Designation (Alias)	Name	Facility Purpose	Facility Description
105-N (N Reactor)	Reactor building	Provides housing for N Reactor and ancillary facilities.	Nonairtight reinforced concrete and steel structure. Houses reactor, fuel storage, reactor work areas, instrumentation room, and transfer area.
107-N	Basin recirculation facility	Contains filtration system used to remove radionuclides from the N Reactor basin water.	Reinforced concrete structure. Chemical storage tanks located outside building.
108-N (1106-N)	Chemical unloading facility	Unloading area for trucks and tank cars containing sulfuric acid or sodium hydroxide.	Three aboveground sulfuric acid tanks, one aboveground sodium hydroxide tank and six french drains.
109-N	Heat exchange building	Provides means for dissipation of reactor process heat.	A reinforced concrete, structural steel building with channeled steel siding. Shares common wall with south wall of the N Reactor building. Houses six heat exchanger cells, associated pumps, piping, laboratory, offices and shop areas.
109-NA	Steam and flow building	Houses hydraulic power packs used for supplying hydraulic control power to steam valves located in the 109-N building.	Steel butler-type building.
116-N	Air stack	HEPA filtered exhaust air and gas from the N Reactor ventilation system.	Reinforced concrete stack.
116-N-1 (1301-N)	Crib and trench	Received radioactive effluent from N Reactor and 109-N. Water contained activation and fission products and small quantities of corrosive liquids and laboratory wastes.	Rectangular basin: 290 ft long, 125 ft wide, 12 ft deep. The bottom is covered with 3 ft of large stones. An extension trench measured 50 by 1600 ft. Trench surface covered by concrete slabs.
116-N-2 (1310-N, golf ball)	Storage tank	Collection tank for N Reactor primary piping decontamination wastes.	Spherical steel structure with storage capacity of 900,000 gal.
116-N-3 (1325-N)	Crib and trench	Receives radioactive activation and fission products and small quantities of corrosive liquids and laboratory chemicals.	Rectangular concrete diversion box (250 x 240 ft), a header box, and ~1,200 ft of 36-in. diameter pipeline. Covered with precast concrete panels. Extension trench is 3,000 ft long, 55 ft wide, and 7 ft deep.

Table 3-1. Facilities in the 100-N Area. (6 sheets)

Current Designation (Alias)	Name	Facility Purpose	Facility Description
116-N-4 (1300-N)	EDB	Received steam blowdown from N Reactor steam generators containing low levels of radioactive activation and fission product. Also received water from N Reactor lift station and possible contaminated low-point drains.	A steel-lined storage pond with a 650,000-gal capacity.
116-N-8 (163-N mixed waste and hazardous waste container storage pad)	Storage pad	Drum and containerized storage for mixed and miscellaneous hazardous process chemicals.	A 152- x 60-ft curbed and fenced concrete pad located south of the 163-N building in a three-sided building
117-N	Exhaust air filter building	Filters ventilation air from the confinement zone of the N Reactor building before it is discharged to the atmosphere.	Reinforced concrete structure, almost completely below grade, 4,290 ft ² of enclosed space.
117-NVH	Valve control house	Valve house for instrumentation and controls.	Small sheet metal building of approximately 80 ft ² .
118-N-1 (1303-N)	Spacer storage silos	Used for storing irradiated fuel spacers from the N Reactor.	The area consists of three silos, two approximately 16 ft in diameter and 20 ft deep. The third smaller silo has a concrete floor; the other two are open to the soil. All three silos are covered by concrete caps.
119-N	Air sampling and monitoring	Building houses air sampling equipment used for monitoring airborne emissions.	Prefabricated metal building.
120-N-1 (1324-NA percolation pond)	Percolation pond	Received corrosive regeneration waste and filter backwash water.	Unlined pond, 29,000 ft ² with a total volume of approximately 2 Mgal.
120-N-2 (1324-N surface impoundment)	Surface impoundment	Received corrosive waste from 163-N building.	Lined pond (1986-1988) 140 x 75 x 15 ft deep with an approximate capacity of 424,000 gal. Before 1983 was unlined settling pond.
128-N-1 (100-N burning pit)	Burning pit	Used to dispose combustible materials, such as nuisance vegetation, office wastes, tools, hardware, and possibly paints and solvents.	Area located approximately 1,500 ft northeast of 1120-N building, southeast of 116-N-3.
130-N-1 (183-N backwash discharge pond)	Backwash disposal pond	Percolation pond for filter backwash.	Unlined pond

Table 3-1. Facilities in the 100-N Area. (6 sheets)

Current Designation (Alias)	Name	Facility Purpose	Facility Description
143-N	Snubber shop	Stored paint, miscellaneous products, and small power equipment.	Wood structure
151-N	250 KV electric substation	Supplies electrical power to 100-N Area	Located north of 120-N-1 percolation pond
153-N	Switch gear building	Houses a transformer/substation.	Block building of approximately 2,300 ft ²
155-N	BPA switch yard	Electrical power line junction and switch yard	Large area containing electrical energy transmission equipment and support building
163-N	Demineralization plant	Provided demineralized water for reactor primary coolant system.	Reinforced concrete and structural steel, 82 x 78 x 40 ft high immediately west of 183-N building with which it shares a common wall
166-N	Oil pump house and storage tank	Fuel oil transfer.	Includes a 1,375,000-gal tank immediately adjacent to the 1715-N Facility and a two-story block building
181-N	River pump house	Provided raw Columbia River water to various facilities.	Reinforced concrete structures
181-NE	HGP river pump house	Provided raw Columbia River water to Supply System facilities.	Reinforced concrete structure
182-N	High-lift pump house	Provided cooling water to N Reactor and 109-N systems.	Reinforced concrete building 107 x 97 x 20 ft high with channeled steel walls. Houses pumps used to inject demineralized water into cooling systems
183-N	Water filter plant	Provided treated and filtered water for process applications.	Consists of a chemical treatment facility, 102 x 84 x 20 ft high flocculation basins, filter system, and clearwell storage
184-N Day tanks	Storage tanks	Diesel and black oil storage.	Two 35,000 gal fuel tanks and one 8,000 gal diesel oil tank
184-N	Power house	Provided electrical power for routine and emergency use and process steam.	Reinforced concrete and structural steel building 112 x 96 x 70 ft high with channeled steel siding
184-NA, NB, NC	Annex	Houses two boilers that provided auxiliary and additional process steam.	Prefabricated metal buildings
185-N	HGP turbine generator building	Main building that houses turbine generators used for electrical- energy production.	This Supply System facility used surplus N Reactor steam to generate electricity from 1964 to 1987.

Table 3-1. Facilities in the 100-N Area. (6 sheets)

Current Designation (Alias)	Name	Facility Purpose	Facility Description
1100-N	Administration and first-aid building	Vacant	Two-story frame construction 199 x 35 x 28 ft high on a concrete foundation and floor
1101-N	Office building	Vacant	
1102-N to 1105-N, 1107-N, 1109-N to 1111-N	Office buildings	Provides office space for administrative and technical staff.	Variable construction
1112-N	Badge house	Telecommunications	Concrete block building with a glass and steel walk-through
1113-N to 1115-N, 1117-N to 1118-N	Office buildings	Provides office space.	Trailers
1116-N	Simulator building	Control room training (formerly)	Trailer
1119-N	Locker room building	Provides locker space	Trailer
1120-N	Warehouse and training building	Provides office space	Prefabricated metal building
1123-N	Office building	Provides office space	Trailer
1124-N	Office and records control center	Provides office and storage space	Trailer
1125-N, 1126-N	Office buildings	Provides office space	Trailers
1127-N	Mobile outage locker room	Provides office space and change room	Trailer
1129-N	Special warehouse	Vacant	Trailer
1130-N	SWP change room building	Used as a changing and storage facility	Trailer
1131-N, 1132-N, 1133-N, 1134-N, 1135-N	Mobile office buildings	Provides office space	Trailers
1140-N, 1141-N	Restrooms	Provided restroom space	Trailer
1142-N	Telephone center	Telecommunications/storage	Trailer
1143-N, 1143-NA, NB	Paint shop and storage buildings	Provides maintenance space	Prefabricated metal buildings, paint shop, and carpenter shops are approximately 1,450 ft ² each

Table 3-1. Facilities in the 100-N Area. (6 sheets)

Current Designation (Alias)	Name	Facility Purpose	Facility Description
1144-N to 1145-N, 1147-N, 1149-N to 1158-N, 1163-N	Offices	General office space	Trailers
1304-N	EDT	Received emergency blowdown of thermally hot primary reactor coolant water	1,300,000-gal storage tank located west of the N Reactor building.
1312-N	LERF	Backup to existing containment systems to receive primary cooling water	HDPE bladder within a lined and bermed impoundment. This facility has never been used.
1313-N	Change and control room	Remote instrumentation control for waste transfers to 116-N-2	Small metal building of approximately 140 ft ²
116-N-4 (1300-N)	EDB	Received emergency blowdown of thermally hot primary reactor coolant water. Replaced by 1304-N.	1,000,000 gal storage basin located west of the N Reactor building.
1314-N	LWLS	Received spent radioactive decontamination liquid from 116-N-2 facility and 107-N facility for transfer to railway tank farms	Curbed pad with prefabricated metal building. Before 1976 the site consisted of concrete pad.
1315-N	Diversion system valve house	Houses valves that control discharge to the crib	A 130-ft ² steel building
1316 N	Valve house	Houses valves that control discharges to cribs	Small steel building
1322-N and 1322-NA, NB, NC	Pilot plant treatment facility/sample building and valve house	Sample station. Buildings contained automated sampling equipment used to sample the N Springs and radioactive drainlines and the 36 in. and 12 in. effluent lines.	Small prefabricated metal building
1701-N, 1701-NE	Badge house	Security	Trailer
1702-N	Vehicle inspection	Security	Small portable 6 x 8 ft shed
1703-N	HGP offices	Offices	
1705-N	Instrument and electrical facility	Provides space for instrument and electrical shops.	Large steel building with offices and shops
1706-N	Shop area	Provide shop and storage space.	Prefabricated metal building
1707-N	Storage boat house	Provides storage space.	Metal
1712-N	Insulation shop	Provides maintenance space.	Wood

Table 3-1. Facilities in the 100-N Area. (6 sheets)

Current Designation (Alias)	Name	Facility Purpose	Facility Description
1714-N, and 1714-NA	Warehouse and receiving facility	Provides storage space.	Prefabricated metal building
1715-N	Diesel oil storage tanks	Storage of diesel oil used by pumping systems.	Four 105,000-gal aboveground diesel oil tanks
1722-N	Decontamination hot shop building	Provides decontamination space and area for working with contaminated equipment.	Transite- and steel-sided buildings
1723-N	Contaminated equipment storage building	Provides storage space. 1980 to 1984 stored contaminated equipment.	In 1984 the area was decontaminated and made into shipping and receiving warehouse
1734-N	Gas bottle storage	Store pressurized bottles.	Block, transite, and steel construction
1900-N	Water supply tanks	Meets the plant's water storage needs.	Steel tanks
1908-N	Seal well	Provides access to the 102 in. discharge line for sampling, etc.	Concrete-reinforced wier box
1908-NE	HGP seal well	Provides access for the river discharge for sampling, etc.	Concrete-reinforced wier box
N-1 to N-30	Craft shops and office buildings	Provides office and shop space.	Trailers, wood, and steel buildings. Many are being removed.

Sources: DOE-RL 1991, AEC-GE 1964, and WMC personnel.
 BPA = Bonneville Power Administration
 EDB = emergency dump basin
 EDT = emergency dump tank
 HDPE = high-density polyethylene
 HEPA = high-efficiency particulate air (filter)
 HGP = Hanford Generating Plant
 LERF = Liquid Effluent Retention Facility
 LWLS = Liquid Waste Loadout Station
 Supply System = Washington Public Power Supply System
 SWP = Special Work Permit (protective clothing)
 WMC = Westinghouse Hanford Company
 *and the 36" and 12" effluent lines

Table 3-2. 100-N Area Waste Stream Information. (3 sheets)

Waste Stream	Origin	Type	Volume	Disposal Location	Waste Characteristics
Primary Process Systems					
Reactor Decontamination Waste	105-N Zone I	Solid	600,000 gal per decontamination event	Shipped to 200 Area tank farm	Low level*
163-N Demineralization Backwash Waste	163-N demineralization water plant	Solid	~400,000 gal/d	Neutralized at 1324-N then discharged to 1324-NA	Corrosive liquid
107-N Demineralizer Column Regeneration Waste	107-N	Solid	NA	Neutralized at 107-N tank then shipped to 200 Area tank farm	Low-level radioactive waste, corrosive
Solid Waste					
1143-N Paint Shop Wastes	1143-N paint shop	Solid	~55 gal in 2 months	Drum transferred to 116-N-8 storage pad then to 616 bldg	Hazardous waste including MEK, ignitable
Maintenance Shop Contaminated Rags	105-N	Solid	~55 gal in 4 months	Drum transferred to 163-N storage pad then to 616 bldg	Ignitable
105-N Battery Locker Wastes	105-N	Solid	Variable, <100 gal/yr	Acid collected in 13-gal carboys and transferred to 116-N-8, then to 616 bldg	Toxic (cadmium, lead), corrosive
Water Quality Laboratory Wastes	109-N	Solid	300 ml/d when reactor not operating	116-N-8 storage pad then non-radioactive transferred to 616 bldg	Low-level*, corrosive, toxic (mercury)
116-N-8 (163-N Storage Pad)	100-N/K Areas	Solid	1,000 drums*** can be stored at one time	616 bldg or radioactive retrievable storage units	Hazardous and low-level radioactive waste
1310-N Storage Pad	100-N/K Areas	Solid	200 drums*** can be stored at one time	NA	Waste oil

Table 3-2. 100-N Area Waste Stream Information. (3 sheets)

Waste Stream	Origin	Type	Volume	Disposal Location	Waste Characteristics
Liquid Wastes					
183-N Filter Backwash	183-N Filtered Water Plant	Liquid	300,000 to 470,000 gal/day (0.30 to 0.47 mgal/day)	Filter backwash pond	Sand filter backwash
163-N Process Water	163-N	Liquid	200 to 300 gal/min	1324-N/NA	Acid and Caustic liquid waste
105/109-N Radioactive Liquid Discharges	105/109-N	Liquid	1,300 to 2,000 gal/min	1325-N and 1301-N	Low level liquid effluent**
182-N Tank Farm Overflow	182-N	Liquid	4 to 7.2 mgd without low lifts; 50 mgd with low lifts	Columbia River	**NPDES permit #WA-000374-3
182-N Drain System	182-N	Liquid	0.29 mgd without fog spray; 5.4 to 26 mgd with fog spray	Columbia River	**NPDES permit #WA-000374-3
181-N Inlet Screen Backwash	181-N	Liquid	0.31 to 0.48 mgd	Columbia River	**NPDES permit #WA-000374-3
102 in. Outfall	105/109-N	Liquid	390 to 610 mgd	Columbia River	**NPDES permit #WA-000374-3
N-Springs	1325-N and 1301-N (via soil column)	Liquid	0.96 to 1.4 mgd	Columbia River	**NPDES permit #WA-000374-3; plus radioactive constituents
Airborne Emissions					
105/109-N	105/109-N	Gas	210,000 ft ³ /min	116-N stack	Radioactive constituents
109-N	Zone I Cell 1 to 5	Gas	120,000 ft ³ /min	109-N Zone I Cell 1 to 6 Vents	Radioactive constituents
109-N	Zone I cell 6	Gas	28,000 ft ³ /min	109-cell 6 vent	Radioactive constituents
109-N	Zone II	Gas	23,000 ft ³ /min	105/109-N Zone II exhaust fan	Radioactive constituents
109-N	Zone III	Gas	130,000 ft ³ /min	Zone III exhaust fan 10	Radioactive constituents

Table 3-2. 100-N Area Waste Stream Information. (3 sheets)

Waste Stream	Origin	Type	Volume	Disposal Location	Waste Characteristics
109-N	Zone IV	Gas	1,600 ft ³ /min	Zone IV exhaust fans 14 and 15	Radioactive constituents
105-N Transfer Area	105-N	Gas	28,000 ft ³ /min	105-N transfer area exhaust fans	Radioactive constituents
105-N Spacer Decontamination Facility	105-N	Gas	4,800 ft ³ /min	105-N spacer decontamination facility exhaust fan	Radioactive constituents - uses HEPA filter
105-N 14 ft Decontamination Facility	105-N 14 ft	Gas	6,400 ft ³ /min	105-N 14' decontamination facility exhaust fan	Radioactive constituents - uses HEPA filter
107-N Exhaust	107-N	Gas	7,300 ft ³ /min	107-N exhaust vent	Radioactive constituents - uses HEPA filter

*At various times these waste streams may have received mixed waste. Sources: ICF Technology, Inc. and Ebasco Services, Inc. 1988; WHC personnel.

**Pollutants permitted per NPDES permit.

***Drums = 55 gallon drums

HEPA = high-efficiency particulate air

MEK = methylethyl ketone

NA = Not available.

NPDES = National Pollutant Discharge Elimination System

WHC = Westinghouse Hanford Company

Table 3-3. Treatment, Storage, and Disposal Units.

WIDS No.	TSD unit	Year last operated
116-N-1	1301-N Liquid Waste Disposal Facility	1985
116-N-3	1325-N Liquid Waste Disposal Facility	Active
120-N-1	1324-NA percolation pond	1991
120-N-2	1324-N surface impoundment	1988

WIDS = Waste Information Data System

TSD = treatment, storage, and disposal

4.0 HISTORY

4.1 OPERATIONAL HISTORY OF N REACTOR

In 1953, studies were conducted by the U.S. Atomic Energy Commission (AEC) to show the technical and economic feasibility of constructing a dual-purpose reactor capable of producing SNM for weapons and research and steam for electricity. In 1957, Congress authorized the AEC (now a part of DOE) to build a special reactor on the Hanford Site. Construction of the New Production Reactor, now simply called N Reactor, began May 1, 1959. It took 4.5 years to complete; initial criticality was achieved December 31, 1963. Table 4-1 provides an overview of significant dates for major activities occurring at 100-N.

N Reactor's purpose was to produce weapons-grade plutonium, but between 1966 and 1967 a special program successfully showed that tritium could be produced as well.

To aid in generating electricity for the region, the Supply System constructed the HGP on land leased from DOE adjacent to N Reactor. There, two turbine generators converted steam from N Reactor to 860 MW of electrical power making N Reactor the first dual purpose reactor. HGP became operational in 1966. During N Reactor's operations, the revenues received by the government from selling the steam to HGP for the production of electrical power totaled \$6.7 billion.

In January 1967, N Reactor was shut down because its plutonium production capability was not needed, but in April 1967 DOE agreed to operate N Reactor solely in a power-production mode for supplying steam to HGP in response to electrical power needs in the Northwest. On June 21, 1967, a fire in the 109-N Steam Generator Building Cell 3 of the reactor resulted in a temporary shutdown. The N Reactor was restarted on July 21 of the same year.

In 1980, in response to a mission to upgrade the nation's nuclear weapons, N Reactor began producing plutonium again. In 1986, following the Chernobyl accident, N Reactor's safety was studied to determine if it could incur a similar accident. In 1987, the reactor was shut down to perform a number of safety reviews and facility upgrades as part of the Safety Enhancement Program. In 1988, DOE announced that N Reactor would be placed in a cold standby preservation mode while the nation's needs for further plutonium production were evaluated. In 1989, all fuel elements were removed from the Reactor core and on October 1, 1990, the program to place the facility in a preserved standby state was declared complete. In 1991, DOE directed the cessation of preservation activities directed at maintaining the facility in condition for possible future use and to initiate steps to prepare the facility for eventual D&D.

N Reactor facilities are currently being maintained in an environmentally safe condition awaiting funding to commence the stabilization program for transition to decommissioning. The N Reactor Deactivation Program is a 4-year effort required to remove all hazardous and radioactive wastes including over 306 m³ (400 yd³) of material and sediment and 4.5 ML (1.2 Mgal)

of contaminated water from the fuel storage basins, and to stabilize all radioactively contaminated surfaces. Table 6-1 identifies key activities of the stabilization programs.

Table 4-1. Overview of Significant Dates for 100-N Area Operation.

Date	Activity
May 1959	Construction of N Reactor begins
September 1963	Construction of HGP begins
October 1963	Construction of N Reactor completed
December 1963	N Reactor achieves initial criticality
November 1964	N Reactor reaches 4,000 MW (thermal)
April 1966	HGP completed; production of electricity begins
December 1966	HGP output reaches 800 MW (electrical)
June 1975	N Reactor irradiated fuel storage begins in the 105 KE fuel storage basin
February 1981	N Reactor irradiated fuel storage begins in the 105 KW fuel storage basin
December 1986	N Reactor shutdown for safety upgrades
February 1988	DOE directive to prepare N Reactor for cold standby issued
January 1989	Defueling of reactor core begins
April 1989	Defueling completed
October 1990	Layup completed; cold standby begins
October 1991	N Reactor deactivation/preparation for D&D ordered

HGP = Hanford Generating Plant

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5.0 ENVIRONMENTAL PROBLEMS

This section provides a description of environmental problems at the 100-N site linked to N Reactor operations. The operational activities affecting the environment are described first, followed by an assessment of the affected environments (groundwater, soil, and biota). The net effect of N Reactor operations on the environment is also included.

5.1 OPERATIONAL ACTIVITIES AFFECTING THE ENVIRONMENT

The 100-N Area has 109 discrete sources of known or potential contamination. Table 5-1 contains brief background information on these sources: location, waste description, and unit/release description.

The sources are placed together into logical groupings, either according to geographic location or process and waste-handling similarities. Figure 5-1 shows the area affected by N Reactor operations and Figure 5-2 shows the locations of waste source units within the 100-N Area (WHC 1989d).

All the currently available information for the 100-N Area sources is discussed below. No data concerning unplanned releases are available from before 1973, but releases probably did occur. All historical records are being reviewed as part of the source record compilation task, as discussed in Chapter 5 of the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-NR-1 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1990). If additional information becomes available for any of the sources or unplanned releases, it will be incorporated in the RFI/CMS as appropriate. At present, no cleanup levels have been negotiated for the unplanned releases.

5.1.1 1314-N Liquid Waste Loadout Station

This grouping is located at the 1314-N LWLS near the west fence, north of the N Reactor building. The grouping consists of one waste management unit and two unplanned releases that occurred at this unit.

The 1314-N LWLS is a transfer station consisting of numerous valves, pumps, underground and overhead piping and couplings, and underground tanks at the north end of the 100-N Area, approximately 90 m (300 ft) from the Columbia River. The unit received liquid radioactive waste from the 116-N-2 radioactive chemical waste treatment and storage facility and the 107-N spent fuel basin recirculation facility. The waste was transferred into railway tank cars and transported to the 200 Area for processing and disposal.

The dimensions of valve pits and the concrete spill catch basin below the railroad tank car loading station are unknown. Valve pit floors are soil. Two drains in the catch basin connect to a separate catch tank and a 3,800-L (1,000-gal) transfer tank located inside the 1314-N building.

The radioactive effluent piped from the 116-N-2 storage tank was internal decontamination solution from cleaning the primary coolant loop in N Reactor and various waste decontamination solutions from small decontamination jobs. The primary loop was decontaminated every 3 to 5 years. The radioactive wastewater resulting from this procedure contained phosphoric acid and diethylthiourea. The wastewater was neutralized in the 116-N-2 facility.

Two unplanned releases associated with the 1314-N LWLS have been documented. The releases are described in the following paragraphs.

- September 24, 1973 (UN-100-N-13) - Operations personnel were filling a railroad tank car with waste material from 1314-N when the solution began overflowing from the tank car fittings. The tank car loading pump was turned off. Solution flowed up through the drain in the catch basin beneath the car and overflowed into the dry well, which also filled and overflowed. The catch basin and dry well are located within the 1314-N building. Approximately 380 L (100 gal) of solution flowed out of the dry well, covering a 6-m by 6-m (20-ft by 20-ft) section of ground inside the radiation zone at the loading station. Total activity in approximately 280 L (75 gal) released to ground through the dry well was estimated at 0.011 Ci. Total activity in the 6-m by 6-m (20-ft by 20-ft) area on the ground surface was estimated at 0.015 Ci. An unknown amount of contaminated soil was packaged and shipped to the 200 Area burial ground (DOE-RL 1990).
- December 7, 1978 (UN-100-N-26) - The second unplanned release was a 3,800-L (1,000-gal) spill of reactor decontamination solution. The solution backflowed while being pumped into a tank car and contaminated the valve pit. Most of the solution was pumped back into the tank car. The remaining wastewater was absorbed by commercially available material and sent to the 200 Area burial ground (DOE-RL 1990).

5.1.2 119-N Air Sampling and Monitoring Building

This grouping is located in the vicinity of the 119-N air sampling and monitoring building, which is 150 m (500 ft) north of the N Reactor building and directly south of the 1314-N LWLS grouping. The grouping consists of one waste management unit and two unplanned releases listed in this paragraph. All sources are adjacent to the 119-N building.

- UN-100-N-14 unplanned release
- UN-100-N-9 unplanned release
- 116-N air stack.

119-N Air Sampling and Monitoring Building Unplanned Releases. The 119-N building houses the equipment used to sample effluent gases and particulates in the adjacent 116-N air stack. One sample collection device used clean water as the coolant for a condenser. When originally installed, the coolant drain pipe was improperly connected to the nearby 91-cm (36-in.) low-pressure flush line that carried irradiated reactor cooling water from the

105-N lift station to the 116-N-1 crib and trench. The improper connection caused the 119-N drain to become pressurized whenever the 105-N lift station pumps were operating.

The first unplanned release occurred when 119-N plumbing repairs were being attempted. The repairs were being done without knowledge of the improper connection, which was not shown on plans.

- August 5, 1974 (UN-100-N-14) - Maintenance personnel were working on the 119-N drain system to correct loss of coolant flow in a condensate collection sampler. When this opened the 5-cm (2-in.)-diameter drain system to the atmosphere, a backflow from the drain occurred, causing an unplanned release. Intermittent flow was observed from the opened line, until the drain system was reconnected. Approximately 265 L (70 gal) of effluent covering an area of 74 m² (800 ft²) was released to the ground near the 119-N sample building. Total activity was estimated at 0.8 mCi of beta/gamma activity. The contaminated soil area was covered with plastic sheeting and the area barricaded. An unknown amount of soil was excavated and moved to the 200 Area burial ground. The area was backfilled with clean soil (DOE-RL 1990).

The second unplanned release occurred during attempts to find the improper connection point. The drain line was eventually disconnected permanently and routed to a soil column disposal pit (DOE-RL 1990).

- October 14, 1974 (UN-100-N-9) - A 8,300-L (2,200-gal) leak from the same 5-cm (2-in.)-diameter cooling water drain line connected to the 91-cm (36-in.) low-pressure flush line occurred when a backhoe hooked onto a buried 5-cm (2-in.) valve in the drain line (depth unknown). Contaminated water immediately flowed into the excavation hole around the valve. To facilitate inspection of the valve, excess water was pumped from the hole into a nearby load lugger for temporary storage and the excavation was enlarged. Inspection showed water leaking from the valve bonnet because the valve bonnet bolts failed. The leak was repaired by replacing the valve bonnet bolts. The excavation site, including the backhoe, was roped off as a radiation zone. Total activity was approximately 4 mCi. An unknown amount of contaminated soil was excavated and removed to the 200 Area burial ground (DOE-RL 1990).

5.1.3 166-N Facility

166-N Fuel Unloading and Storage Area. This grouping is located near the 116-N air stack and the 116-N-2 radioactive chemical waste treatment and storage facility and includes the following potential sources:

- Fuel oil unloading station
- 166-N Tank Farm
- UN-100-N-17 unplanned release
- UN-100-N-20 unplanned release
- UN-100-N-24 unplanned release.

Fuel Oil Unloading Station. The fuel oil unloading station is a concrete-lined containment structure containing 30-cm (12-in.) fuel oil supply piping that loads to the No. 6 fuel oil storage tank at the 166-N Tank Farm. The unit is located east of the 1314-N LWLS. Tanker railcars unloaded No. 6 fuel oil at the station and oil was transferred via underground piping to the tank farm. Small amounts of diesel oil were periodically spilled at the 166-N diesel oil loadout station. The spills (3.75 to 7.5 L [1 to 2 gal] each) occurred when the tanker gas truck fill hoses were disconnected from the diesel oil receiving line (WHC 1989b).

166-N Tank Farm. The 166-N Tank Farm is an earthen-bermed tank farm containing one aboveground 5,200,000-L (1,375,000-gal) No. 6 fuel oil tank and four aboveground 400,000-L (105,000-gal) diesel oil storage tanks. The earthen berm has a total containment capacity of 11,500,000 L (3,030,000 gal) (WHC 1989b). The tank farm is located between the 116-N air stack and the 116-N-2 radioactive chemical waste treatment and storage facility. It has been in operation since 1963.

No. 6 fuel oil was unloaded at the fuel oil unloading station from rail tanks and piped via underground lines to the storage tank. A 20-cm (8-in.) underground transfer line runs from the storage tank to the 184-N day tank, where the oil was stored before being used in the boilers (WHC 1989b).

Diesel oil was unloaded from tanker trucks into the diesel storage tanks. The oil was pumped from the storage tanks via a 10-cm (4-in.) underground transfer line to the 184-N day tanks and gravity-fed through a separate 10-cm (4-in.) line to the 182-N underground storage tanks (WHC 1989b).

Three documented unplanned releases have been associated with the 166-N Tank Farm:

- August 1966 (UN-100-N-17) - One unplanned release at the unit was caused by the external corrosion of a 10-cm (4-in.) supply line between the diesel oil storage tank and the west dike, detected when a discrepancy in the diesel oil inventory was discovered. By that time, 300,000 L (80,000 gal) of diesel oil had been released. The diesel oil drained through the soil to groundwater, then migrated to the Columbia River. A trench was excavated along the river bank in an attempt to intercept the oil before it could reach the river. Oil exposed in the trench was ignited and burned periodically through 1967 (WHC 1989b). No contaminated soil was removed from the site, and the supply line was repaired in September 1966 (DOE-RL 1990).
- June 1985 (UN-100-N-20) - External corrosion reportedly caused a leak in a 5-cm (2-in.) diesel oil return pipeline within the bermed area containing the four diesel oil tanks. The release of 760 L (200 gal) ran onto the soil. No cleanup occurred (DOE-RL 1990).
- February 1, 1987 (UN-100-N-24) - A leak was caused by external corrosion brought on by a leaking heat transfer line. The leak occurred on the west side of the No. 6 fuel oil tank outside of the bermed area. The release consisted of an unknown amount of No. 6

fuel oil that ran onto the soil. No information is available concerning the cleanup of this spill. A portion or all of this spill penetrated the soil (DOE-RL 1990).

5.1.4 116-N-1 Crib and Trench Grouping.

This grouping is located directly east of the 166-N fuel storage area and consists of the following sources.

- 116-N-1 crib and trench
- UN-100-N-31 unplanned release
- 1322-N and 1322-NA sampling buildings
- UN-100-N-8 unplanned release
- UN-100-N-4 unplanned release.

116-N-1 Crib and Trench. The 116-N-1 crib and trench is a major inactive waste management unit located approximately 300 m (1,000 ft) east of the N Reactor building. The system is commonly referred to as the 1301-N LWDF. The 116-N-1 crib and trench was used from 1964 until September 1985. This ground disposal facility made use of the filtration and ion exchange properties of soil to remove radioactive material from radioactive liquid effluents from N Reactor (DOE-RL 1990). No liquid remains in the crib and trench; however, approximately 7,000 Ci of radionuclides remain in the soil column. The crib is 88 m (290 ft) long and 38 m (125 ft) wide. The walls of the crib are sloped soil and gravel embankment and approximately 3.7 m (12 ft) deep from floor to ground surface (DOE-RL 1990). The crib outline is shown in Figure 5-3.

A zig-zag extension trench, 15 m (50 ft) wide and 3.7 m (12 ft) deep, extends 490 m (1,600 ft) from the crib. The 116-N-1 extension trench was built in 1965 because wastewater volume exceeded the capacity of the crib. A 0.9-m (3-ft) layer of boulders was placed in the crib. Precast concrete cover panels were placed over the trench in 1982 to minimize wildlife access and airborne contamination (DOE-RL 1990).

Pipelines that discharged directly into the 116-N-1 crib and trench through a 16-m by 3.7-m (52-ft by 12-ft) concrete weir box included an underground 91-cm (36-in.) main effluent line from the 105-N lift station, an underground 30-cm (12-in.) effluent drainline from the 109-N steam generator building, and a 15-cm (6-in.) effluent drain line from the 109-N floor drains.

The 116-N-1 crib and trench is a dangerous waste disposal facility under RCRA interim status. The cumulative inventory (accounting for decay to September 1985) of major long-lived radionuclides disposed of in the 116-N-1 crib and trench from 1964 to September 1985 is presented in Table 5-2. The dangerous wastes disposed in the 116-N-1 crib and trench are listed in Table 5-3 (WHC 1987b).

One unplanned release (other than systematic releases of radionuclides to the soil and groundwater) is associated with the 116-N-1 crib and trench.

- July 22, 1974 (UN-100-N-31) - While sample lines were being installed in a 15-cm (6-in.) steel casing through the berm on the west side of the 116-N-1 crib, the water level in the crib was raised 38 to 46 cm (15 to 18 in.) as a result of an emergency dump tank (EDT) drawdown test being conducted. The increased water level allowed an unplanned release of approximately 3,800 L (1,000 gal) of effluent water to flow through the casing. This release contaminated 190 m² (2,000 ft²) of soil. Sand and fines were used to stabilize soil contamination (DOE-RL 1990). The extent of remediation instituted is unknown.

1322-N and 1322-NA Sample Buildings. These buildings contain the liquid effluent waste treatment facility pilot plant. They are located immediately north of the 116-N-2 tank. Building 1322-N contains a drainage tank. Building 1322-NA contains automatic sequential sampling equipment for the 30-cm (12-in.) and 91-cm (36-in.) radioactive drainlines and the riverbank springs (DOE-RL 1990).

Two documented unplanned releases have occurred and are described below:

- May 11, 1975 (UN-100-N-8) - An operator on routine patrol at 4:00 a.m. noticed a small but steady spray of contaminated water coming from the 91-cm (36-in.) radioactive drain return line sampler located near the back of the building. The operator stopped the leak by shutting down the sample pumps. Contaminated water was observed to cover the floor and various pieces of equipment in the rear of the building. Subsequent contamination surveys showed that the water had run out the back door and contaminated approximately 2.3 m² (25 ft²) of ground. The amount of water released was estimated to be 190 to 380 L (50 to 100 gal). All contaminated areas were roped off, covered with plastic, and identified as a radiation zone. Total activity was estimated to be less than 0.5 mCi. An unknown amount of the contaminated soil was removed, transported to the 200 Area, and replaced with clean fill (DOE-RL 1990).
- May 7, 1977 (UN-100-N-4) - A contaminated water leak in the 1322-N and 1322-NA buildings was discovered at 1:00 a.m. An operator on routine patrol found water running out from under the doors in the 1322-NA building. He then checked the adjacent 1322-N building and found water spraying out of the top vent on the drainage tank. The sump pump was not operating at the time, and the water left the tank via the vent, backing up the sink drain in the 1322-NA building. The water flowed out of the drains and over the 15-cm (6-in.) curb onto the ground in front and back of the building. The amount of water released is unknown. All electrical equipment in the buildings was shut off, preventing further leaks. The contaminated soil outside the front and rear doors, an area of approximately 140 m² (1,500 ft²), was covered with plastic, roped off, and

controlled as a radiation zone. Total activity was 0.5 mCi. An unknown amount of contaminated soil was removed and transported to the 200 Area (DOE-RL 1990).

5.1.5 116-N-2 Radioactive Chemical Waste Treatment and Storage Facility

These potential sources are grouped together because they are all located at or near the 116-N-2 radioactive chemical waste treatment and storage facility. See Color Illustration 5-1 for a photograph of the facility.

- 116-N-2 radioactive chemical waste treatment and storage facility
- UN-100-N-5 unplanned release
- UN-10C-N-25 unplanned release
- Spring, 1983 unplanned release
- 124-N-4 septic tank and drainfield.

116-N-2 Radioactive Chemical Waste Treatment and Storage Facility. The 116-N-2 facility is a waste management unit complex consisting of piping, pumps, a transfer tank commonly referred to as the silo, and a large treatment and storage tank referred to as the golf ball (1310-N). The treatment tank is a spherical steel tank with a capacity of 3,400,000 L (900,000 gal). It is partly buried in the ground and surrounded by a 7.6-m (25-ft) high compacted soil radiation barrier on three sides. The unit operated from 1968 until 1987.

The 116-N-2 facility was used to neutralize and temporarily store radiologically contaminated phosphoric acid waste used in the internal decontamination of the N Reactor. Chemical wastes from the internal decontamination of the primary loop of the reactor were transferred to the 116-N-2 silo by a 15-cm (6-in.) underground transfer line. The silo is a transfer station for materials going into or out of the 116-N-2 storage tank. An additional 3.8-cm (1.5-in.) decontamination line enters the silo from the N Reactor building. This line was for transporting small-scale decontamination solutions. Decontamination chemical solutions could be transferred to the 116-N-1 crib and trench, if necessary, via a 61-cm (24-in.) aboveground transfer line from the 116-N-2 storage tank.

The silo routed the acidic decontamination solutions into the 116-N-2 storage tank for neutralization. The dangerous wastes in the decontamination solution included approximately 80,000 L (21,000 gal) of 70 percent phosphoric acid and 140 to 180 kg (300 to 400 lb) of diethylthiourea. The primary loop of the reactor was decontaminated every 3 to 5 years. Approximately 2,300,000 L (600,000 gal) of solution were generated during each decontamination event.

From 1968 until 1972, the neutralized decontamination solution was routed from 116-N-2 directly to tanker trucks parked east of the containment area. Trucks would then take the waste from the containment area to the 200 Area for disposal. After 1972, the neutralized decontamination solution from 116-N-2 was sent to the 1314-N LWS for transfer to rail cars (DOE-RL 1990).

Three documented unplanned releases associated with the 116-N-2 radioactive chemical waste treatment and storage facility have occurred. These releases are described in the following paragraphs.

- June 27, 1972 (UN-100-N-5) - An unplanned release occurred from a leak in the piping between the recirculation pump and the 116-N-2 tank. Evidence indicated that a failure occurred in the underground section of this pipe, causing discharge of approximately 340,000 L (90,000 gal) of radioactive chemical waste to the ground. The low-level radioactive wastewater contained decontamination chemicals used in the decontamination of the N Reactor primary loop. The waste contained 35 Ci of activity, 26 Ci of which were ⁶⁰Co. The pH of the solution was about 9. An unknown amount of contaminated soil was removed and sent to the 200 Area burial ground. The excavation was then backfilled with clean soil (DOE-RL 1990).
- May 15, 1975 (UN-100-N-25) - An unplanned release occurred during transfer of chemical decontamination solution into the 116-N-2 tank. A surge of contaminated water sprayed out an open access hole on the tank. An estimated 1,900 L (500 gal) of primary loop decontamination solution containing phosphoric acid and diethylthiourea was released to the ground inside the radiation zone surrounding the tank. A radiation survey outside the posted zone showed no contamination after cleanup (DOE-RL 1990).
- Spring, 1983 - An unplanned release of caustic sodium hydroxide occurred in the spring of 1983 in association with the reactor decontamination event taking place at that time. A tanker truck was offloading sodium hydroxide to the silo when a fitting came loose and spilled approximately 380 L (100 gal) of liquid to the open soil. No remediation was conducted.

124-N-4 Septic Tank and Drainfield. The 124-N-4 septic tank and drainfield was the primary septic system that served the majority of the 100-N buildings from 1963 until 1987. It is located east of the 116-N-2 facility, and consists of two septic tanks (the second tank was installed in 1975) with a total fluid capacity of 53,000 L (14,000 gal). The septic tank effluent drained into a large drainfield. The drainfield is divided into four sections, with a distribution box in each section feeding eight drainlines. The drainfield provided approximately 830 m² (8,900 ft²) of infiltrative surface area. The unit received approximately 110,000 L/day (30,000 gal/day) of sanitary sewage (DOE-RL 1990).

No releases to or from the unit other than sanitary sewage are documented. In addition, this unit is near the 116-N-2 radioactive chemical waste treatment and storage facility where tanker trucks were loaded with irradiated, neutralized decontamination solutions from 1968 until 1972. The close proximity of the units suggests that the possibility of contamination from small releases during tanker loading may exist here.

5.1.6 116-N-3 Crib and Trench

The 116-N-3 crib and trench (1325-N LWDF) waste management unit is located approximately 300 m (1,000 ft) east of the 116-N-1 facility. The crib is 76 m (250 ft) long and 73 m (240 ft) wide and provides 5,600 m² (60,000 ft²) of percolation surface. An extension trench 914 m long by 17 m wide by 2 m deep (3,000 ft by 55 ft by 7 ft) was added to augment the operational capacity of the crib.

The 116-N-3 crib was constructed as a replacement liquid radioactive waste disposal facility for the 116-N-1 crib and trench and first received N Reactor effluent in 1983. The 116-N-3 trench was put in full service in September 1985 (DOE-RL 1990). Between these two dates, both the 116-N-1 and the 116-N-3 facilities were in service. Both the 116-N-3 crib and trench are covered by precast concrete panels to prevent access by the local fauna to contaminated water.

The 116-N-3 system's reinforced concrete header box is tied in to the 116-N-1 weir box, with 366 m (1,200 ft) of 91-cm (36-in.) diameter piping. The 116-N-3 facility, like the 116-N-1 facility, received radioactive liquid effluents from the RCS, spent fuel storage basin, periphery coolant systems, and various radioactive drain systems located throughout the reactor facility. The average monthly flow rate into the 116-N-3 facility during 1983 through 1986, when the N Reactor was in normal operation, was approximately 5,300 L/min (1,400 gal/min) (DOE-RL 1990).

The cumulative inventory of select radionuclides disposed of in the 116-N-3 crib from October 1983 to January 1, 1988 is shown in Table 5-4 (WHC 1987a). An estimate of other wastes annually disposed of in the 116-N-3 crib (1984 through 1986) is shown in Table 5-5.

5.1.7 128-N-1 Burning Pit

The 128-N burning pit is located directly east of the 116-N-3 crib and trench grouping. The unit was used primarily for burning nonhazardous waste (e.g., paper, wood, and trash) generated at the 100-N Area. The amount of waste managed by the unit is unknown. There is no documented evidence of release of dangerous or radioactive wastes from the unit. The unit size and location changed during the period of operation (1962 to 1986) (DOE-RL 1990).

5.1.8 181-N River Pumphouse

The 181-N river pumphouse grouping consists of two potential sources that are grouped based on their location at or near the 181-N river pumphouse. The grouping is located between the railroad tracks and the Columbia River and includes the following potential sources.

- April 18, 1986 unplanned release (WHC 1987d)
- Aboveground waste oil tank (DOE-RL 1990).

Aboveground Waste Oil Tank. An aboveground steel waste oil tank is located at the base of the bluff near the 181-N river pumphouse. The capacity of the tank is 980 L (260 gal). The tank was designed to store waste oil from drip pans used to catch oil from the river pumps, but was never used (DOE-RL 1990).

5.1.9 1304-N

1304-N Emergency Dump Tank Grouping. The 1304-N EDT grouping consists of two waste management units and six associated unplanned releases. These sources are grouped together because they are close geographically and manage waste similarly. The potential sources in this grouping are:

- 1304-N EDT
- UN-100-N-1 unplanned release
- UN-100-N-29 unplanned release
- UN-100-N-30 unplanned release
- UN-100-N-32 unplanned release
- UN-100-N-2 unplanned release
- UN-100-N-7 unplanned release
- 116-N-4 emergency dump basin (EDB).

1304-N Emergency Dump Tank. The 1304-N EDT is a 4.9-ML (1.3 Mgal) steel aboveground pressure vessel (see Color Illustration 5-3). It is located south of the 107-N basin recirculation building and west of the 1300-N EDB. It replaced the EDB as a quench tank for emergency blowdown of thermally hot, pressurized reactor primary coolant water. The tank maintained a constant volume of 2,600,000 L (680,000 gal) of unheated water for quenching the hot water to prevent it from flashing to steam. Because a small flow of primary coolant was maintained to the EDT to keep interconnecting piping thermally warm, overflow from the tank, normally containing a small inventory of radioactive materials, was discharged to the 116-N-3 crib. The unit was used from 1973 until reactor shutdown in 1987.

Several documented unplanned releases have been associated with the 1304-N EDT:

- March 27, 1974 (UN-100-N-1) - The EDT 76-cm (30-in.) overflow line developed a leak through a 76-cm (30-in.) inflatable pipe flow stoppage device during maintenance operations. In addition, a fill valve on the EDT began leaking at the same time. Approximately 110,000 L (30,000 gal) of irradiated cooling water was spilled on the ground near the tank and flowed over the bank to an area near the 181-N river pumphouse. The spilled material did not reach the river. Analyses of samples taken at the time of the leak indicate that 0.2 Ci was released in the 110,000 L (30,000 gal) spill. Contaminated soil reading greater than 1,000 counts per minute (cpm) was removed and transported to the 200 Area for burial. The remaining contaminated soil was covered using 10 to 15 cm (4 to 6 in.) of clean soil (DOE-RL 1990).
- April 23, 1974 (UN-100-N-29) - A faulty check valve in the EDT bypass line allowed approximately 380 L (100 gal) of irradiated primary coolant water to leak to the ground. The water ran out from

under a concrete ground cover on the slope above the tank and covered an area of approximately 1.2 m by 9.1 m (4 ft by 30 ft). A sample of the mud and water yielded a reading of 5,000 cpm. Approximately 0.1 Ci of radioactive material, mostly ^{56}Mn and ^{24}Na , was released. The contaminated soil was removed and taken to the 200 Area for disposal (DOE-RL 1990).

- July 27, 1974 (UN-100-N-30) - While filling the EDT in preparation for a drawdown test of the system, the EDT overflowed through a vacuum breaker vent in the top of the tank. Approximately 9,500 L (2,500 gal) of water spilled to the ground around the tank and contaminated an area of approximately 230 m² (2,500 ft²) to a maximum of 500 cpm. No water reached the river. Sands and fines were used to stabilize the soil contamination. It is unknown if the contaminated soil was removed (DOE-RL 1990).
- September 16, 1974 (UN-100-N-32) - A repeat of the April 23, 1974 incident occurred because of a faulty check valve. Approximately 1,900 to 3,800 L (500 to 1,000 gal) of irradiated primary coolant water spilled down the slope from the metal culvert housing the check valve and contaminated soil by the south and east walls of the tank. A sample of the mud yielded a reading of 20,000 cpm. Two days later, an evaporated sample was analyzed and results indicated that less than 10 mCi of radioactive material remained in the ground. An unknown amount of contaminated soil was removed and taken to the 200 Area for disposal. The remaining contaminated soil was covered using clean fill (DOE-RL 1990).
- February 19, 1980 (UN-100-N-2) - A leak in the 2.5-cm (1-in.) valve body relief line occurred. The valve is on the 81-cm (32-in.) low-pressure flush line between the 109-N heat exchanger building and the EDT. Approximately 95,000 to 110,000 L (25,000 to 30,000 gal) of irradiated water leaked to the ground. Most of the water in the area was transferred to the EDB using a portable pump. Based on sample analysis it is estimated that less than 1 Ci of beta/gamma radioactivity was released to the ground. An unknown amount of contaminated soil was removed and taken to the 200 Area for disposal. The remaining contaminated soil was covered using clean fill (DOE-RL 1990).
- April 29, 1985 (UN-100-N-7) - Approximately 1,900,000 L (504,000 gal) of irradiated water was released to the soil from a leak in the 25-cm (10-in.) drain line between the N Reactor building and the EDT. The cause of the leak is unknown. Approximately 32 m³ (1,130 ft³) of contaminated soil was removed and taken to the 200 Area for disposal.

116-N-4 Emergency Dump Basin. The 116-N-4 EDB is a liquid effluent storage basin that was originally designed to receive emergency cooling water from the N Reactor (see Color Illustration 5-2). It is located northwest of the 109-N building. The unit is a concrete basin with a welded steel liner (DOE-RL 1990), and is approximately 40 m (130 ft) long by 24 m (80 ft) wide by 4.6 m (15 ft) deep and has a storage capacity of 3,800,000 L (1,000,000 gal) (DOE-RL 1990).

The EDB was constructed in 1963 to receive single-pass radioactive emergency cooling water. In the late 1960s, the unit was determined to be insufficient for its original use. The basin did not have the capacity needed to contain the volume of coolant used during an emergency cooling operation. It was replaced by the 1304-N EDT in 1973. From 1973 until 1987, the EDB received contaminated liquid effluent generated during the periodic blowdown of N Reactor's 12 steam generators located in the 109-N building. This condensate contained low levels of radioactive contamination. Contents of the unit were sampled monthly from 1978 to 1985. Table 5-6 shows the average annual concentrations by radionuclide in the 1300-N EDB unit (DOE-RL 1990). At various times, the EDB also received radioactive wastes from the N Reactor lift station. Since the N Reactor was shut down in 1987, water has been maintained in the EDB [approximately 2,800,000 L (750,000 gal)] so that the bottom sludge layer will not become exposed. Subsequent drying of the sludge could expose receptors to airborne exposure from contaminated particulate matter. Filtered river water has been added as needed to maintain the water level. Documentation of the amount of water added to the EDB has not been maintained. There are no documented releases associated with the unit (DOE-RL 1990).

5.1.10 118-N-1

118-N-1 Spacer Storage Silos. The 118-N-1 spacer storage silo grouping consists of three waste management units and three unplanned releases associated with the spacer storage silos. These potential sources are located in the vicinity of the spacer storage silos and include the following locations:

- 118-N-1 spacer storage silos
- UN-100-N-3 unplanned release
- UN-100-N-12 unplanned release
- 124-N-3 septic system
- 105-N lift station underground storage tank
- Corridor 22 unplanned release.

118-N-1 Spacer Storage Silo Group. The three 118-N-1 spacer storage silos were used for the temporary storage of irradiated fuel spacers. The steel spacers came in immediate contact with the fuel elements in the N Reactor. The silos, approximately 4.9 m (16 ft) in diameter by 6 m (20 ft) deep, are located north of the N Reactor building. Two of the three silo floors are open to the soil; the third silo has a concrete floor. The silos have approximately 0.5- to 1-m-thick concrete caps covered with soil (DOE-RL 1990).

Releases occurred from 1963 until 1987 when spacers were placed in or removed from the silos. Spacers were transferred to the silos using a buried spacer transfer line connected to the 105-N fuel basin. The depth of the line is variable. There was no secondary containment surrounding the line. Small amounts of irradiated water passed through the line with the spacers and was deposited in the silos. In addition, water was sprayed over the spacers during removal from the top of the silos to eliminate the potential airborne release of radionuclides. In recent years, paint was used as a fixative when spacers were transferred from the silos. The silos currently contain dry

irradiated spacers. The volume of radiologically contaminated water that reached the soil either through the bottom of the silos or the exposed soil around the silos is unknown.

Two documented releases to the ground have been associated with the spacer storage silos and associated piping.

- March 8, 1978 (UN-100-N-3) - A leak was detected in the spacer transfer line. The first indication of the leak was the appearance of a 1.2-m (4-ft)-diameter by 76-cm (30-in.)-deep sinkhole between the 105-N lift station and the spacer storage silos. Excavation of the sinkhole area revealed a crack in the 7.6-cm (3-in.) reinforced plastic pipe approximately 3.4 m (11 ft) below grade. It is estimated that approximately 1,400,000 L (360,000 gal) of irradiated N Reactor fuel storage basin water entered the ground. Estimated radionuclide releases to the soil were ^{60}Co (70 mCi), ^{90}Sr (80 mCi), ^{137}Cs (250 mCi), $^{144}\text{CePr}$ (140 mCi), and ^{239}Pu (0.4 mCi). An unknown amount of soil was removed and disposed of at the 200 Area burial ground (DOE-RL 1990).
- February 27, 1979 (UN-100-N-12) - A leak similar to the March 8, 1978 release occurred. A 0.6-m by 0.9-m by 46-cm (2-ft by 3-ft by 18-in.) sinkhole was discovered at the backfilled location of the previous leak. The pressure of transporting the spacers within the line apparently caused a rupture. An estimated 950,000 L (250,000 gal) of irradiated N Reactor fuel storage basin water was released to the ground. Estimated radionuclide releases to the soil were ^{60}Co (190 mCi), ^{90}Sr (126 mCi), ^{137}CS (396 mCi), $^{144}\text{CePr}$ (34 mCi), and $^{239/240}\text{Pu}$ (0.57 mCi). The plastic pipe was replaced with a stainless steel pipe. Whether the contaminated soil was removed and taken to the 200 Area for disposal or covered with clean fill is not documented (DOE-RL 1990).

124-N-3 Septic Tank. The 124-N-3 septic system is a cesspool that served the 107-N building from 1982 to the present. The unit served two to three employees working at the 107-N building, as well as temporary construction workers in the area, and was designed to receive only sanitary sewage. The cesspool includes a 1,900-L (500-gal) precast concrete tank, perforated tile pipe, and solid cover with 0.6 m (2 ft) of crushed stone below the tank. The estimated daily flow was 170 L/day (45 gal/day) (DOE-RL 1990).

105-N Lift Station Underground Storage Tank. The 105-N lift station underground storage tank was a 19,000-L (5,000-gal), single-wall carbon steel tank used for storing diesel oil (DOE-RL 1990). The tank had no cathodic or interior protection and was approximately 11 to 15 years old when it was removed in December 1990. Soil sampling during tank removal indicated that the site is not contaminated with petroleum derivatives.

Corridor 22 Unplanned Release. In 1984 several hundred liters of radioactively contaminated water were spilled outside the Corridor 22 doorway in the N Reactor building. Scrub water from the fission product filter trap overflowed and was discharged to the ground. The concrete was painted over and an indeterminate amount of soil was removed and taken to the 200 Area for disposal (DOE-RL 1990).

5.1.11 182-N Underground Storage Tank Area

This grouping consists of the site where three 182-N underground storage tanks and a septic tank were located south of the N Reactor building.

Three underground diesel storage tanks were located on the north side of the 182-N high lift pumphouse. These tanks were identified as 182-N-1-DT, 182-N-2-DT, and 182-N-3-DT. All tanks were single-wall carbon steel and each had a capacity of 15,000 gal. They were approximately 16 to 20 years old and had no cathodic or interior protection. The three tanks were pumped dry and removed in December 1990. Soil sampling following tank removal shows the site clean of petroleum derivatives (DOE-RL 1990).

The septic tank and seepage pit are located southeast of the 182-N building and were installed in 1963 (DOE-RL 1990). The system is still operating, but only receives sanitary sewage (DOE-RL 1991). The seepage pit for this system provides about 19 m² (200 ft²) of infiltration surface area and 8,540 L (2,256 gal) of fluid storage. In 1985 the system served 10 personnel and the calculated daily flow was 760 L/day (200 gal/day) (DOE-RL 1990). No remedial activities have taken place.

5.1.12 105-N Reactor Spent Fuel Storage Basin

The N Reactor spent fuel storage basin is a concrete containment basin for the storage of process tubes, spent fuel elements, irradiated spacers, and other fuel handling equipment. Underwater transfer carts moved the irradiated fuel elements to the storage basin where they were stored in the temporary storage baskets. Baskets were emptied and fuel elements were placed in storage canisters, sorted by enrichment and discharge dates. The filled canisters were moved by bridge cranes to storage cubicles, formed by a lattice of boron concrete walls. The storage basin began operating in 1963 and ceased storing irradiated nuclear fuel in 1989 when all fuel was transferred to the 100-K fuel storage basins. However, the basin remains filled with water for shielding and radiological contamination control. Color Illustrations 5-4 and 5-5 show above- and below-water photographs of the basin, respectively.

Two releases near the N Reactor fuel storage basin have been documented. These releases are described below.

- May 13, 1975 (UN-100-N-10) - A leak of irradiated water to the ground occurred on May 13, 1975 during preparation for the removal of a check valve from a Zone I gravity drain line to the 105-N lift station. Pumps were used to remove water from the lift station during the shutdown of the lift station pumps. The pumps also were used to drain the 91-cm (36-in.) radioactive drain line. The water was to be pumped to the EDB during this process. During the drawdown test, approximately 380 L (100 gal) leaked to the ground through a loose hose fitting between the temporary pump and the EDB. The exact location of the spill is not documented. Approximately 9 m² (100 ft²) of soil were contaminated with 1 mCi of mixed fission and activation products. An unknown amount of contaminated soil was removed and disposed of in the 200 Area burial ground (DOE-RL 1990).

- February 28, 1986 (UN-100-N-35) - Routine sampling of 100-N Area groundwater monitoring wells revealed elevated levels of ^{131}I . Testing showed the leak to be basin water. Investigation showed water leaking through an expansion joint 8.5 m (28 ft) below ground level. Water was leaking to the lift station and through an expansion joint to the ground. The leaking only occurred when the basin water level was high and water flowed out the overflow weirs. A weir contributing to the leak was located and the leak was determined to be coming from a cleanout valve. The weir and drain line were grouted and sealed on December 5, 1986 (DOE-RL 1990).

5.1.13 182-N High Lift Pumphouse

The 182-N high lift pumphouse grouping consists of four potential sources within the area surrounding the 182-N high lift pumphouse. The grouping includes the water supply tank farm and extends to the Columbia River. The following potential sources are located in this area:

- 124-N-2 septic tank
- 182-N tank farm overflow (Nation Pollutant Discharge Elimination System [NPDES] outfall No. 005)
- 182-N drain outfall (NPDES outfall No. 006)
- February 6, 1987 unplanned release.

124-N-2 Septic Tank. The septic tank and seepage pit making up sewer system II are located southeast of the 182-N building and were installed in 1963. The system is still operating and only receives sanitary sewage. The seepage pit for this system provides about 19 m² (200 ft²) of infiltration surface area and 8,540 L (2,256 gal) of fluid storage. In 1985, the system served 10 personnel and the calculated daily flow was 760 L/day (200 gal/day). No remedial activities have taken place (DOE-RL 1990).

182-N Tank Farm Overflow. This unit is a NPDES-permitted discharge point (Source No. 005) to the Columbia River. It contains drainage (water) from the 182-N tank farm area. The area discharges to the river by a 91-cm (36-in.) raw water return line. The discharge point is located 90 m (300 ft) upstream of 181-N. In 1987, the average daily discharge to the river via this point was 10 million L (2.7 million gal). Currently, discharges from this point are minimal. The startup date for the discharge was 1964. There is no documented dangerous or radioactive release to the river via this discharge point (DOE-RL 1990).

182-N Drain System. This unit is a NPDES-permitted discharge point (Source No. 006) to the Columbia River. Drainage from the 182-N high lift pumphouse is discharged to the river by a 107-cm (42-in.) raw water return line. Raw and filter water from pump seal leakage is discharged from this point. Westinghouse Hanford Company (WHC) personnel have indicated that low-level radionuclides have been released from reactor emergency core cooling system pumps. When the reactor was operating, small amounts of irradiated water were released through the seals and drained to the river. The discharge

point is 30 m (100 ft) upstream of 181-N. In 1987, the average daily discharge to the river via this point was 1,000,000 L (270,000 gal). The startup date for the discharge was 1964. It is currently in use (DOE-RL 1990).

Oil Release to the Columbia River. On February 6, 1987, approximately 19 L (5 gal) of turbine oil was discharged to the Columbia River through the 182-N tank farm raw water return line. A small (pin-hole size) leak in a lube oil line in the No. 2 drive turbine allowed oil to enter the secondary steam system. Steam condensate from this system returns to the 100-N steam condensate system that drains to the river. The leak in the lube line was repaired (DOE-RL 1990).

5.1.14 Acid/Caustic Storage and Transport System

The acid/caustic storage and transport system grouping includes all the process units, waste management units, unplanned releases, and pipelines associated with the storage and transport of acids and caustics used in the 163-N demineralization plant. Because of its location, the 124-N-1 septic tank is also included in this grouping. The following potential sources are included in this grouping.

- 108-N chemical unloading facility
- 120-N-7 unloading station french drain
- 120-N-6 sulfuric acid tank french drains
- 108-N neutralization pit
- UN-100-N-15 unplanned release
- UN-100-N-33 unplanned release
- December 26, 1987 unplanned release
- 120-N-5 acid/caustic trench and neutralization unit
- UN-100-N-34 unplanned release
- August 7, 1987 unplanned release
- September 2, 1987 unplanned release
- November 9, 1987 unplanned release
- 120-N-3 neutralization pit and french drain
- 120-N-8 sulfuric acid day tank french drain
- Regeneration waste transport system
- June 14, 1986 unplanned release
- June 30, 1986 unplanned release
- 124-N-1 septic tank.

108-N Chemical Unloading Facility. The 108-N chemical unloading facility was used for storage and transfer of 93 percent sulfuric acid and 50 percent sodium hydroxide solutions received by railroad tank car or tank truck. The unloading station french drain (120-N-7) was used for neutralization of small releases from the overhead transfer boom. The french drain was used from 1963 until March 1987 (DOE-RL 1990). The french drain was 0.9 m (3 ft) in diameter by 1.2 m (4 ft) deep and consisted of a clay pipe filled with lime (DOE-RL 1990).

There are three 38,000-L (10,000-gal) aboveground steel sulfuric acid storage tanks and one 290,000-L (76,800-gal) sodium hydroxide tank located at the 108-N facility. The tanks began operating in 1964. Adjacent to the

sulfuric acid tanks are french drains for overflows. The french drains are approximately 0.6 m (2 ft) in diameter and consist of a clay pipe packed with lime. The french drains operated from 1963 until March 1987 (DOE-RL 1990). The acid transfer system uses a 3,800-L (1,000-gal) steel transfer tank located in a pit west of the 108-N building. The tank is filled with acid via gravity flow from the storage tanks. Air pressure is used to transfer the acid via piping through a trench to the 163-N day tank. No french drains are associated with the sodium hydroxide tank. Transfer pumps located in the 108-N building were used to transfer the sodium hydroxide directly to the 163-N day tank from the storage tank via piping through the trench (DOE-RL 1990).

108-N Neutralization Pit. The brick-lined 108-N neutralization pit is located outside the 108-N building. This facility received drainage from the 108-N floor drains and from the acid transfer tank. The pit was used to manually neutralize waste acid. The neutralized waste was sent via a water jet pump to the 183-N facility where it was then discharged to the river through the 260-cm (102-in.) outfall line. The unit was in operation since 1963. The unit is 1.8 m (6 ft) wide by 1.2 m (4 ft) long by 1.8 m (6 ft) deep. The brick lining has been replaced at least once (DOE-RL 1990).

Various small, intermittent spills have occurred over the years at the 108-N facility that were associated with unloading and transfer operations. Several larger documented spills are described in the following paragraphs.

- March 20, 1981 (UN-100-N-15) - Sulfuric acid and rinsewater were spilled inside the 108-N building. The unknown amount of liquid was transferred to the acid tank french drains for neutralization. The transfer line developed a leak and released acid solution to the ground. The affected area was estimated to be less than 4.6 m² (50 ft²) (DOE-RL 1990). The extent of remedial measures is unknown.
- November 9, 1981 (UN-100-N-33) - Approximately 3,800 L (1,000 gal) of sulfuric acid were spilled during transfer from a rail car to an acid storage tank (DOE-RL 1990). The extent of remedial measures is unknown.
- December 26, 1987 - Approximately 38 L (10 gal) of sodium hydroxide were spilled to the ground during transfer from a rail car to the caustic storage tank. Difficulties during the transfer prompted the operator to disconnect the transfer line and set it on the ground while investigating the problem. At that time the sodium hydroxide leaked from the transfer line. The extent of remediation is unknown (WHC 1989c).

120-N-5 Acid/Caustic Transfer Trench and Neutralization Unit. The unit is a polymer concrete-lined neutralization pit and acid/caustic transfer trench between the 163-N demineralization plant and the 108-N chemical unloading facility. The neutralization unit consists of two containment vaults: one for sulfuric acid and one for sodium hydroxide. Each containment vault is approximately 1.8 m (6 ft) long by 1.8 m (6 ft) wide by 3 m (10 ft) deep. The trench, containing both acid and caustic piping, slopes toward the neutralization unit so that spills can be contained within the vaults.

The polymer concrete lining was installed in parts of the trench in 1986. According to personnel, the unit consisted of unsealed concrete from 1963 to 1986 (DOE-RL 1990).

Several documented releases associated with the unit have occurred. These releases are described in the following paragraphs.

- May 12, 1980 (UN-100-N-34) - During the weekly transfer of sulfuric acid from the 108-N storage tank to the 163-N day tank, a rupture in the pipeline occurred. Approximately 13,000 L (3,400 gal) of sulfuric acid spilled into the containment vault, some of which overflowed to the ground. The acid in the containment vault was neutralized with 50 percent sodium hydroxide and pumped to the clearwell overflow (located south of the unit). The unknown amount of acid that overflowed to the ground was neutralized with soda ash and liquid sodium hydroxide (DOE-RL 1990). No further remediation has been documented.
- August 7, 1987 - Water was found leaking outside the 163-N building north wall to an area of the trench that had not been treated with polymer cement because of clearance restrictions due to the proportions of the trench. Sulfuric acid had corroded away exposed concrete (WHC 1987c). The extent of contamination, amount of sulfuric acid released, and the extent of remediation is unknown.
- September 2, 1987 - During caustic transfer from the 108-N caustic storage tank to the 163-N caustic day tank, a leak was noted in the piping and caustic collected in the trench. Transfer was stopped and the pipeline was patched. The amount of caustic released into the trench is unknown and there is no documentation that caustic reached the soil (WHC 1987d).
- November 9, 1987 - A leak of approximately 760 L (200 gal) of sulfuric acid occurred during transfer operations. This leak was cleaned up at the time. On December 4, 1987, it was noticed that the trench was open to the soil at the location where the leak occurred. This open area was found to be a dry well installed in 1986 when the trench was upgraded. The dry well was installed for steam trap drainage, not for containment of acid spills. An estimated 57 to 114 L (15 to 30 gal) of sulfuric acid was released to the ground (WHC 1987e). An unknown amount of contaminated soil was removed.

120-N-3 (163-N) Neutralization Pit and French Drain. The unit is a french drain and vault located immediately west of the 163-N demineralization plant. The unit was constructed in 1963 and is still in place (DOE-RL 1990). It serves as a spill containment unit for the two 38,000-L (10,000-gal) acid and caustic day tanks located immediately inside the 163-N building. A drain in the tank area leads to the unit. The vault is approximately 2.4 m by 7.6 m (8 ft by 25 ft) in size and approximately 2.4 m (8 ft) deep. The walls of the vault are constructed of concrete and the floor is unlined earthen material. Located in the vault is a 1.2- to 1.8-m (4- to 6-ft)-diameter french drain made of clay. The depth of the french drain is unknown. No liquid is currently present in the pit and french drain.

Small intermittent releases of sulfuric acid or sodium hydroxide occurred during transfer operations to or from the 163-N day tanks (DOE-RL 1990). No releases other than the small releases have been documented.

120-N-8 Day Tank Vent French Drain. The unit is a french drain used to receive overflow of sulfuric acid from the 163-N demineralization plant sulfuric acid day tank. The unit is 1.2 to 1.8 m (4 to 6 ft) in diameter and consists of a clay pipe filled with lime to neutralize any sulfuric acid releases. It is located on the north side of the 163-N building. The unit was installed in 1963 and taken out of service on May 13, 1988 (DOE-RL 1990).

The unit received unknown amounts of intermittent sulfuric acid discharges. Each discharge is estimated to have averaged less than 3.8 L (1 gal) of liquid. There are no specific documented releases associated with the unit (DOE-RL 1990).

Regeneration Waste Transport System. The regeneration waste transport system includes the storage and piping systems that conveyed spent regeneration effluent (either acid, caustic, or neutralized) from the 163-N demineralization plant and routed this effluent to the 120-N-1 and 120-N-2 ponds. The system took on various configurations from 1977 until 1990. Before 1977, the spent regeneration waste was discharged to the Columbia River (DOE-RL 1990).

From 1977 until 1983, regeneration effluents flowed through lined concrete trenches, 0.3 m (1 ft) deep by 0.6 m (2 ft) wide, in the 163-N demineralization plant. The trenches were covered with a metal grating. The trenches carried the effluent to a sump located near the northwest corner of the 163-N building. There the sump pumps transferred the effluent in an underground 20-cm (8-in.) epoxy resin waste transfer line with filter backwash water effluent from the 183-N water filter plant to the north and south settling ponds and subsequently the 120-N-1 percolation pond (WHC 1987f). Figure 5-4 shows the regeneration waste transfer system configuration from 1977 until 1983.

In 1983, the piping was modified to deliver the acid and/or caustic effluent from 163-N directly to the 120-N-1 percolation pond, bypassing the inactive settling ponds. In addition, the filter backwash water was no longer combined with the regeneration effluent, but was piped to the new 130-N-1 filter backwash discharge pond. The regeneration waste transport system operated in this configuration from 1983 until 1986 (WHC 1987f). Figure 5-5 shows the design of this system for that time period.

In 1986, the 120-N-2 surface impoundment was put into service. At that time, the acid and/or caustic regeneration effluent was routed directly to this unit, where the effluent was neutralized. The neutralized effluent was then piped to the 120-N-1 (1324-NA) percolation pond (WHC 1987f). Figure 5-6 shows the design of the regeneration waste transport system between 1986 and 1988.

In 1988, an ENU was installed within the 163-N demineralization plant. At that time, the 120-N-2 surface impoundment was taken out of service. From 1988 until 1990, spent regeneration effluent was routed via the same trenches mentioned previously to the spent regeneration surge tank, located on the

north exterior of 163-N building. The tank discharged to the ENU. After adding the proper amount of acid or caustic solution, the contents were mechanically agitated. When the pH was within the range of 6.0 to 9.0, the neutralized effluent was piped via the 20-cm (8-in.) waste transfer line to the 120-N-1 percolation pond (DOE-RL 1990).

Low levels of radionuclides have been found in the piping. Based on analyses of piping scale, the material was determined to be naturally occurring thorium found in alum used during the water purification processes (DOE-RL 1990).

Two documented releases have been associated with the regeneration waste transport system. These releases are described in the following paragraphs.

- June 14, 1986 - A leak was detected in the waste transport pipe while wastes from the anion and cation regeneration process were being routed to the 120-N-2 surface impoundment. Once the leak was discovered, regeneration processes were shut down. A sample was collected at the point of the leak and found to have a pH of 1.4. It was estimated that approximately 25,000 L (6,500 gal) of acidic regeneration waste had leaked to the ground and formed a pond in an area south of the 163-N building. Caustic regeneration waste was pumped through the line and allowed to leak into the acidic pond to neutralize the spilled material. Several hours elapsed until the pH of the spilled material reached 6.9. The neutralized liquid was then pumped to the 260-cm (102-in.) outfall line and released to the Columbia River. An unknown amount of soil around the leak was excavated and disposed of. The pipe was repaired (DOE-RL 1990).
- June 30, 1986 - Approximately 3,800 L (1,000 gal) of acidic (pH of 1.1) cation regeneration waste spilled to the ground in the area of sump No. 1 when a temporary transport line became dislodged from the sump. When this was discovered, the regeneration process was stopped and the hose was placed back in the sump and secured. The pH was adjusted by adding 82 kg (180 lb) of caustic soda (soda ash) to the spilled waste. The soil was sampled and the pH was 10.1; therefore, no further remediation was conducted (DOE-RL 1990).

124-N-1 Septic Tank. The septic tank and seepage pit making up sewer system I are located south of the 163-N building and were installed in 1963 (DOE-RL 1990); the system is still operating (DOE-RL 1990). This unit receives sanitary sewage. It was originally designed to serve only personnel in the 163-N and 183-N buildings. The seepage pit for this system provides about 19 m² (200 ft²) of infiltration surface area and 8,540 L (2,256 gal) of fluid storage. In about 1982, two bathroom utility trailers were hooked up to this sewer system to serve the personnel in the 1127-N and 1128-N buildings. In 1985, the unit served 50 personnel and calculated daily flow was 5,400 L/day (1,420 gal/day) (DOE-RL 1990). There are no documented dangerous or radioactive releases associated with the unit.

5.1.15 116-N-8 Hazardous and Mixed Waste Storage Area

The 116-N-8 hazardous and mixed waste storage area is a concrete-paved less-than-90-day waste container storage pad. The pad is curbed and surrounded by a wire mesh fence. The pad is 18 m by 46 m (60 ft by 152 ft) in size. It is located inside the double-fenced reactor area at the southern corner of the fence. The pad is covered by a roof and walled on two sides. The unit has been in operation since December 1986 (DOE-RL 1990).

Drums and containers stored in this area may contain mixed or hazardous wastes. Hazardous or mixed wastes from satellite collection areas from other generation points within the 100-N Area and at the 100-K Areas are stored at the unit. There are no documented releases to the soil from this unit. Before 1986, the area was used as a maintenance storage area (DOE-RL 1990).

5.1.16 184-N

184-N Plant Service Power House, Tanks, and Piping System. The 184-N plant service power house consists of three boilers located in the 184-N building and the 184-N annex. The boiler system provides oil-fired boiler-generated steam to the main steam supply system during reactor startup and shutdown periods. This area is distinguished by the significant number of hydrocarbon product releases. The following potential sources are listed.

- 184-N day tank area
- UN-100-N-19 unplanned release
- UN-100-N-21 unplanned release
- October 9, 1987 unplanned release
- 166-N-184-N piping (not shown in Figure 5-2)
- UN-101-N-18 unplanned release
- UN-100-N-22 unplanned release
- UN-100-N-23 unplanned release
- October 14, 1987 unplanned release
- April 26, 1989 unplanned release.

184-N Day Tank Area. The 184-N plant service power house has three aboveground oil day tanks located outside the building on the north side and one 5,678 L (1,500 gal) diesel fuel underground storage tank. These include two 130,000-L (35,000-gal) No. 6 (Bunker C) fuel oil day tanks and one 30,000-L (8,000-gal) diesel oil day tank. The day tanks are surrounded by a concrete retaining wall with the ground surface exposed inside.

Several documented unplanned releases are associated with the 184-N day tank area. These are described below.

- April 1984 (UN-100-N-19) - Approximately 7,600 L (2,000 gal) of No. 6 fuel oil spilled to the ground when the day tank overflowed during filling. All the fuel oil was contained within the surrounding retaining walls and did not penetrate the hard sand floor of the containment structure. The waste oil was removed and disposed of (WHC 1989b).

- April 25, 1986 (UN-100-N-21) - Approximately 3,000 L (800 gal) of diesel oil was released to the ground when the day tank overflowed during filling. This was attributed to a failure of the tank-level annunciator. The annunciator was repaired and the oil removed from the tank impoundment area. Groundwater monitoring wells were sampled and no oil was detected (DOE-RL 1990).
- October 9, 1987 - The diesel oil day tank overflowed during filling operations because a level indicator was not reading the correct oil level. An unknown amount of oil was cleaned up (WHC 1987g).

166-N - 184-N Piping. The 184-N fuel oil day tanks are connected to the oil storage tank at 166-N by a 20-cm (8-in.) underground supply line. The 184-N diesel oil day tank is connected to the storage tanks at 166-N by a 10-cm (4-in.) underground supply line (WHC 1989b). Several unplanned releases from the pipelines have been documented. They are described in the following paragraphs.

- August 1973 (UN-100-N-18) - A leak caused by external corrosion occurred in the 10-cm (4-in.) diesel oil supply line between the 166-N storage tanks and the day tank. The leak was detected by a pressure test after approximately 760 L (200 gal) of diesel oil had been spilled to the ground (WHC 1989b). The line was excavated and repaired (DOE-RL 1990).
- June 23, 1986 (UN-100-N-22) - External corrosion of the diesel oil supply line caused a 3,800 L (1,000 gal) leak of diesel oil just outside the 184-N tank area. The line was excavated and rerouted. An unknown amount of contaminated soil was removed. Groundwater Monitoring Well 199-N-16 was sampled and oil was detected in July 1986. Well 199-N-16 is located approximately 9 m (30 ft) west of the 184-N building. An unknown amount of residual oil was recovered from the groundwater through Well 199-N-16 (WHC 1989b).
- January 10, 1987 (UN-100-N-23) - External corrosion caused a leak in the diesel oil supply line. Approximately 760 L (200 gal) of diesel oil was released to the soil. The line was isolated, excavated, and repaired. Groundwater Monitoring Well 199-N-16 was sampled and oil was found. Residual oil was recovered from the well (WHC 1989b).
- October 14, 1987 - An unknown amount of fuel oil leaked from a loose pipe fitting at the 184-N annex. Oil was being transferred from the day tank to the No. 2 boiler. Oil was contained in the 184-N annex drain trench and cleaned up (DOE-RL 1990).
- April 26, 1989 - The diesel oil supply pipeline developed leaks in three places between 166-N and the 184-N day tanks. The specific cause of the leaks was unknown. A minimum of 1,100 L (300 gal) of diesel oil was released to the soil along the pipeline. Monitoring Wells 199-N-16 and 199-N-17 were sampled. Oil was detected in these samples. Forty-six drums and eight dump trucks of contaminated soil were removed (WHC 1990b).

5.1.17 Decontamination Drainline Leak

A mixed waste leak from the 3.8-cm (1.5-in.) decontamination drainline connecting the N Reactor building to the 116-N-2 radioactive chemical waste storage facility distinguishes this small area from the surrounding source unit areas. Decontamination of the N Reactor occurred every 3 to 5 years. The decontamination solution generally contained phosphoric acid and diethylthiourea, but small-scale decontaminations occurred that contained a variety of cleaning solutions. Generally, the 3.8-cm (1.5-in.) chemical decontamination waste drainline transported these smaller scale decontamination solutions to the 116-N-2 facility.

On September 10, 1985, a leak of radiologically contaminated water occurred at four locations near the N-29 craft shop along the decontamination waste drain line between the N Reactor building and 116-N-2 facility (UN-100-N-6). Approximately 6,800 L (1,800 gal) of irradiated water was released. The water contained a total estimated 0.2 Ci of ^{60}Co , 0.04 Ci of ^{54}Mn , 0.003 Ci of ^{103}Ru , and 0.003 Ci of ^{137}Cs . Approximately 17 m³ (590 ft³) of contaminated soil reading between 7,000 and 25,000 cpm was excavated and removed to the 200 Area burial ground for disposal. No documented sampling was conducted at the base of the excavation. The area was backfilled with clean fill (DOE-RL 1990).

5.1.18 120-N-4

120-N-4 Storage Area Grouping. This grouping consists of two potential sources in an area southwest of the 116-N-2 radioactive chemical waste treatment and storage facility.

- 120-N-4 storage area
- 1716-N service station underground storage tanks.

120-N-4 Storage Area. The unit is currently used as a nonhazardous and/or low level radioactive waste storage pad. It is a 30-m by 23-m (100-ft by 75-ft) curbed concrete pad located immediately southwest of the berm surrounding the 116-N-2 radioactive chemical waste treatment and storage facility. The unit has been in its current configuration since November 1985 (DOE-RL 1990).

Before 1985, the unit was unpaved and used as a laydown yard for radioactively contaminated equipment as well as for storage of radioactively contaminated oils. Information regarding types and amounts of wastes stored in this area is unavailable. Aerial photographs before 1985 indicate storage of unknown materials in the area immediately southeast of the current pad. There are no documented releases to the soil from this unit (DOE-RL 1990).

1716-N Service Station Underground Storage Tanks. Two underground storage tanks were located at the 1716-N service station, located south of the 120-N-4 storage area. The tanks are identified as 100-N-SS-27 and 100-N-SS-28. Both tanks contained unleaded gasoline. Tank 100-N-SS-27 had a capacity of 11,000 L (3,000 gal) and tank 100-N-SS-28 had a capacity of 7,600 L (2,000 gal). The tanks were constructed of single-wall carbon steel and neither had cathodic or interior protection. Tank 100-N-SS-27 was installed in 1967 and Tank 100-N-SS-28 was installed in 1976 (DOE-RL 1990).

Tank 100-N-SS-27 was removed in December 1990 and 100-N-SS-28 was removed in July 1991. Soil sampling during tank removal indicates that the tanks have leaked. Site remediation is in progress.

5.1.19 Regeneration/Filter Backwash Waste Disposal Area

The regeneration/filter backwash waste disposal area grouping includes those units that have received corrosive regeneration wastes from the 163-N demineralization plant and filter backwash water from the 183-N filtered water plant. This area has five potential sources.

- 120-N-1 percolation pond
- South settling pond
- 120-N-2 surface impoundment
- 130-N-1 filter backwash discharge pond
- 1143-N paint shop.

The 1143-N paint shop is included in this area because it is located near the 120-N-1 and 120-N-2 facilities.

120-N-1 Percolation Pond. The 120-N-1 percolation pond is a large unlined pond located approximately 910 m (3,000 ft) southeast of the N Reactor building. The pond was placed in service in August 1977 and was used to treat corrosive regeneration effluent from the 163-N demineralization plant and filter backwash water from the 183-N filtered water plant. The effluent was treated in the 120-N-1 percolation pond by the alternate addition of acidic cation column regeneration effluent and alkaline anion column regeneration effluent. This alternate addition of low- and high-pH effluent served to neutralize the effluents. The 120-N-1 percolation pond also made use of the buffering capacity and calcareous nature of the soil underlying the pond to neutralize these corrosive wastes. Treated effluents were transferred to the north and south settling ponds located directly west of the percolation pond. These settling ponds were used to settle out the solids in the filter backwash water waste stream. The settling ponds were removed from service in early 1983. The 120-N-1 percolation pond managed an average of 600,000 L/day (160,000 gal/day) of corrosive regeneration effluent and 1,100,000 L/day (300,000 gal/day) of filter backwash water (WHC 1987f). Figure 5-7 shows the configuration of the 120-N-1 percolation pond area from 1977 to 1983. Tables 5-7 and 5-8 show representative analyses of cation and anion regeneration effluent cycles, respectively, which were discharged from 163-N to 120-N-1. Table 5-9 shows representative analyses of the filter backwash effluent discharged from 183-N to 120-N-1. The frequency of these analyses is not known.

Low levels of naturally occurring thorium was present in the water purification chemical, alum, and may have been disposed of in this unit. This radionuclide has been found in the water treatment plant piping (DOE-RL 1990).

In the spring of 1983, the 120-N-1 percolation pond was enlarged from a bottom area of 850 m² (9,200 ft²) with a volume of approximately 4,500,000 L (1,200,000 gal) to a bottom area of 2,700 m² (29,000 ft²). This enlarged pond was designed to contain up to 11,000,000 L (3,000,000 gal) of corrosive wastes from the regeneration of ion exchange columns in the 163-N demineralization

plant. The filter backwash water was routed to the 130-N-1 filter backwash disposal pond at this time, and the south settling pond was backfilled to grade (WHC 1987f). The entire bottom area of the 120-N-1 pond has not been covered with wastes since its enlargement (DOE-RL 1991).

Use of the 120-N-1 percolation pond to treat dangerous wastes was discontinued by May 13, 1986 when the 120-N-2 surface impoundment was put into service to treat the corrosive regeneration effluents. The 120-N-2 surface impoundment is a double-lined pond with a leachate collection system that was used to neutralize the wastes before their discharge to the 120-N-1 percolation pond (WHC 1987f). This unit was used from 1986 until 1988, when it was replaced by an ENU located at the 163-N demineralization plant. The 120-N-1 percolation pond began receiving neutralized regeneration effluent in 1986 and continues to receive effluent from the ENU. The enlarged 120-N-1 percolation pond and the 120-N-2 surface impoundment are shown in Figure 5-8.

South Settling Pond. The south settling pond, in conjunction with the north settling pond, received corrosive regeneration effluent and process and cooling water from the 163-N demineralization plant and filter backwash water from the 183-N filtered water plant from 1977 until 1983. The volume of effluent being sent to these ponds is the same as for the 120-N-1 percolation pond. Analyses of effluents discharged to the south settling pond are presented in Tables 5-7, 5-8, and 5-9. Additional information regarding contaminants possibly contained in the 163-N demineralization plant waste waters is presented in the RFI/CMS for the 100-NR-2 Operable Unit (DOE-RL 1991). Low levels of naturally occurring thorium may be present in the pond as a result of using alum in the water treatment process (DOE-RL 1990).

The south settling pond was a rectangular, unlined basin constructed below grade. The dimensions of the pond were approximately 34 m by 15 m (110 ft by 50 ft) at grade; the sides sloped to a bottom measuring approximately 21 m by 3 m (70 ft by 10 ft). Depth is estimated to have been approximately 4.6 m (15 ft). After solids, primarily from the filter backwash effluent, were settled, the contents of the south settling ponds were transferred to the 120-N-1 percolation pond. Between 1983 and 1986 the north and south settling ponds were closed. The regeneration effluent was then discharged directly to the 120-N-1 percolation pond and the filter backwash effluent was discharged to the 130-N-1 filter backwash disposal pond. The south settling pond was backfilled (DOE-RL 1990).

120-N-2 Surface Impoundment. The 120-N-2 surface impoundment was constructed and placed in service in 1986 and operated until 1988. It is located approximately 910 m (3,000 ft) southeast of the N Reactor building in the former location of the north settling pond (WHC 1986). The operating history for the north settling pond is the same as for the south settling pond described above.

The 120-N-2 unit is a double-lined surface impoundment with leak detection equipment. The unit is approximately 43 m by 23 m (140 ft by 75 ft) at grade sloping to 24 m by 4.6 m (80 ft by 15 ft) at approximately 4.6 m (15 ft) below grade. The impoundment was designed to contain a volume of

1,600,000 L (424,000 gal) (WHC 1986). Figure 5-9 and Color Illustration 5-6 show the physical design of the unit. No leaks have been detected from this unit (DOE-RL 1990).

Acid and caustic regeneration effluent from the 163-N demineralization plant was neutralized in the 120-N-2 surface impoundment. Approximately 1,630,000 L/day (430,000 gal/day) were neutralized (DOE-RL 1990). Tables 5-7 and 5-8 show representative analyses of cation and anion regeneration effluents, respectively. The caustic anion regeneration effluent was generally neutralized in the surface impoundment by the addition of the acidic cation regeneration effluent. Acid cation regeneration effluent was similarly neutralized by the addition of caustic anion regeneration effluent. Once neutralization was complete, the neutralized effluent was discharged to the 120-N-1 percolation pond via a 30-cm (12-in.) drainline and 30-cm (12-in.) overflow line (WHC 1986). In 1988, the 120-N-2 surface impoundment was taken out of service and replaced by an ENU located at the 163-N demineralization plant.

130-N-1 Filter Backwash Discharge Pond. The 130-N-1 filter backwash discharge pond is a percolation pond used for disposal of effluents generated during backwash of the sand filters in the 183-N filtered water plant. The pond is a natural basin, marsh-like in appearance, located about 0.8 km (0.5 mi) southeast of the N Reactor building.

The filter backwash discharge pond was placed in service in early 1983 following reconstruction of the 120-N-1 percolation pond, which was formerly used for disposal of the backwash effluent. The pond is fed via a 25- to 30-cm (10- to 12-in.) buried line from the 183-N filtered water plant. Approximately 1,100,000 L/day (300,000 gal/day) of backwash effluent were disposed of at the unit. The 183-N filter backwash effluent has a neutral pH and contains low concentrations of several anions and cations (DOE-RL 1990). Aluminum sulfate (alum) is used as a flocculent and polyacrylamide is used as a filter aid/coagulant in filtered water production (DOE-RL 1990). Analysis of the filter backwash effluent indicates that it does not contain any listed dangerous wastes or dangerous waste sources, or exhibit any dangerous waste characteristics or criteria per WAC 173-303 (DOE-RL 1990). Table 5-9 shows representative analyses of the filter backwash effluent.

1143-N Paint Shop. The 1143-N paint shop has three waste management units: a water scrubber for paint overspray, a 210-L (55-gal) solvent accumulation drum, and an associated outdoor sandblasting area, the 1143-N blast yard.

Paint wastes were collected, drummed, and transferred offsite for disposal. Overspray collected by the water curtain filtration system was disposed of onsite. The blast yard manages paint chips and spent garnet sand. These waste management units are still active and no remedial activities have taken place.

5.1.20 Office Septic Tank Area

The four septic systems in this area are shown near the 1117-N, 1113-N, 1115-N, and 1134-N buildings in Figure 3-1. The only known waste managed by these units is sanitary sewage. There is no documented information that any

other wastes were released into the septic systems or evidence that remedial activities were performed. The office septic tank area consists of the following tanks.

- 124-N-5 septic tank
- 124-N-6 septic tank
- 124-N-7 septic tank
- 124-N-8 septic tank.

124-N-5 Septic Tank. The septic tank and drainfield making up Sewer System V are located south of building 1117-N and were installed in 1981; the system was taken out of service in February 1987 (DOE-RL 1990). Sewer System V serves buildings 1111-N, 1116-N, 1117-N, 1118-N, 1123-N, 1124-N, 1125-N, and 1131-N. The septic tank has a fluid capacity of 14,000 L (3,677 gal) and a drainfield providing approximately 90 m² (960 ft²) of infiltrative surface area. Fill dirt was placed over the drainfield to a depth of 0.6 m (2 ft) or more in the early 1980s. In 1985, the unit served 210 personnel and the calculated daily flow was 140,000 L/day (3,780 gal/day) (DOE-RL 1990). The sewer system is still in place; it is unknown if residual liquid is present.

124-N-6 Septic Tank. The septic tank and drainfield making up Sewer System VI are located south of building 1113-N and were installed in 1979-80; the system was taken out of service in February 1987 (DOE-RL 1990). This unit received sanitary sewage. The septic tank has a fluid capacity of 7,600 L (2,000 gal) and the drainfield has an infiltrative surface area of 74 m² (800 ft²) (DOE-RL 1990). This system is directly hooked up to Sewer System VII just upstream of the septic tank. Sewer System VI serves buildings 1113-N, 1114-N, and 1115-N. In 1984, the septic tank was pumped out and the system was abandoned (DOE-RL 1990).

124-N-7 Septic Tank. The septic tank and drainfield making up Sewer System VII are located south of building 1115-N under the high-voltage power lines and were installed in 1984 (DOE-RL 1990); the system was taken out of service in February 1987 (DOE-RL 1991). This unit received sanitary sewage. The septic tank has a fluid capacity of 28,000 L (7,500 gal). Sewer System VII serves buildings 1103-N, 1104-N, and 1145-N. In 1985, the unit served 290 personnel and the calculated daily flow was 20,000 L/day (5,220 gal/day) (DOE-RL 1990). The sewer system is still in place and it is unknown if residual liquid is present.

124-N-8 Septic Tank. The septic tank and drainfield making up Sewer System VIII are located south of building 1134-N and were installed in 1983. This unit received sanitary sewage. The septic tank has a fluid capacity of 19,000 L (5,000 gal), and the drainfield has an infiltrative surface area of 150 m² (1,650 ft²). Sewer System VIII served buildings 1132-N, 1133-N, 1134-N, and 1135-N. In 1985, the unit served 51 personnel and the calculated daily flow was 3,500 L/day (915 gal/day) (DOE-RL 1990). The sewer system is still in place, but is no longer in use. It was replaced by the 124-N-10 sewer system in 1987.

5.1.21 N-17 Paint Shop

This grouping includes the entire craft shop area.

Paints, solvents, and oils are used at the N-17 paint shop, which has two waste accumulation drums, one for waste paint and the other for waste oil. A sandblasting area is also associated with the N-17 paint shop. The paint shop is located about 300 m (1,000 ft) west of the N Reactor facility. This unit is currently active.

An air compressor located east of the paint shop has leaked nonhazardous lubrication oil over the years; the surrounding soil is oil stained. The extent of contamination is unknown. Six drums of contaminated soil were removed (DOE-RL 1990).

5.1.22 1120-N Septic Tank Grouping

124-N-9 Septic Tank. The septic tank and drainfield making up the 129-N-9 sewer system are located northeast of building 1120-N and were installed in 1985. The septic tank has a fluid capacity of 11,000 L (3,000 gal) and the drainfield has an infiltrative surface area of 325 m² (3,500 ft²). This unit receives 8,300 L/day (2,200 gal/day) of sanitary sewage (DOE-RL 1990). There is no documented information regarding disposal of any other wastes to the unit. The sewer system is still in place. No documented remedial activities have taken place.

5.1.23 100-N-10 Sewer System Grouping

124-N-10 Sewer System. The 100-N sewer system was constructed to replace five 100-N Area sewer systems. The system includes a two-pond lagoon facility, a sewer trunk line and other pipelines, three lift stations, service access holes, and associated sewer system instrumentation and annunciation capability. Five sewer systems were replaced (DOE-RL 1990):

- Sewer System IV, which served the 105-N, 109-N, 184-N, 1100-N, 1101-N, 1102-N, 1107-N, 1112-N, 1119-N, and 1126-N buildings and contractor construction buildings
- Sewer System V, which served the 1111-N, 1116-N, 1117-N, 1118-N, 1123-N, 1124-N, 1125-N, and 1131-N buildings
- Sewer System VI, which served the 1113-N, 1114-N, and 1115-N buildings and was abandoned
- Sewer System VII, which served the 1103-N and 1104-N buildings, and 1113-N, 1114-N, 1115-N, and 1146-N buildings (1152-N, 1153-N, and 1154-N buildings were also connected to this system)
- Sewer System VIII, which served the 1132-N, 1133-N, 1134-N, and 1135-N buildings.

This unit has been operational since February 1987 and receives 190,000 L/day (50,000 gal/day) of sanitary sewage (DOE-RL 1990). There is no documented information regarding disposal of any other wastes to the unit other than sanitary sewage routinely trucked there from the 200 Area. The central sewer system is still in place. No remedial activities have taken place. Currently this unit does not have a Washington State Permit, but by June 1994, a WAC 173-216 permit for groundwater discharges will be submitted to the state.

UN-100-N-11 Unplanned Release. On October 2, 1975, a radioactively contaminated 230 kg (500 lb) valve bonnet fell from a truck onto the road and into the adjacent field. This occurred at the corner of Route 4 North and the 100-N Area access road (see Figure 2-1). Cleanup consisted of removal and disposal of 6.1 m³ (8 yd³) of contaminated soil and asphalt (DOE-RL 1990).

5.2 AFFECTED ENVIRONMENT - GROUNDWATER

Groundwater in the 100-N Area has been monitored for years as part of the Environmental Surveillance Program at the Hanford Site. The location of groundwater monitoring wells in the 100-N Area is shown in Color Illustration 2-2. Since December 1987, selected wells have been monitored as part of the RCRA interim status detection monitoring program. Detection monitoring networks were established for the 116-N-1 crib and trench (1301-N LWDF), 116-N-3 crib and trench (1325-N LWDF), 120-N-1 (1324-NA percolation pond), and 120-N-2 (1324-N Surface Impoundment). Results of chemical and radiological analyses are discussed in this section for samples taken from wells in the vicinity of the 116-N-1 and 116-N-3 crib and trench, 118-N-1 spacer storage silos, 120-N-1 percolation pond/120-N-2 surface impoundment, and the 1304-N EDT. All these sources are either RCRA facilities or high-priority sites as described in the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-NR-2 Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1991).

5.2.1 116-N-1 and 116-N-3 Crib and Trench Areas

The 116-N-1 and 116-N-3 facilities (1301-N and 1325-N LWDF) have been used primarily to dispose of radioactive effluent originating in N Reactor and the 109-N heat exchanger buildings. These effluents contained low levels of a number of radioactive constituents, including tritium, plutonium, ¹³⁷Cs, ⁹⁰Sr, ⁶⁰Co, ¹⁰⁶Pu, ¹²⁵Sn, and ¹³¹I (WHC 1990a).

Some radionuclides contained in the effluent such as plutonium and ¹³⁷Cs, are held strongly by soil and are virtually immobile. Other radionuclides, such as iodine, are minimally sorbed and are highly mobile. Because tritium is an analog of the water molecule, it migrates at the same rate as water. Still other constituents, such as ⁹⁰Sr and ⁶⁰Co, are adsorbed to the soil but not as strongly as radionuclides such as ¹³⁷Cs. The migration of these constituents is retarded, but not as heavily as the more strongly adsorbed constituents. As a result, plumes containing the more mobile radionuclides, such as tritium and ¹³¹I, had developed in groundwater soon after discharge to the cribs was initiated, while concentrations of less mobile constituents gradually increased in groundwater (DOE-RL 1990).

Activity levels for selected radionuclides in groundwater measured during 1981 (DOE-RL 1990 and DOE-RL 1991) show the contamination patterns that had developed by that time in the vicinity of the 116-N-1 crib and trench (Table 5-10). The tritium data indicate high levels of contamination in the entire area covered by the then-existing monitoring network. These data also demonstrate that the impact of the 116-N-1 crib and trench extended in all directions. The full extent of influence of the 116-N-1 facility at this time, particularly in the southern and eastern directions, cannot be determined because the network of groundwater monitoring wells is limited.

Examination of these data also indicate elevated levels of other radionuclides throughout much of the area, and there appears to be a pattern of decreasing levels of activity of many radionuclides as the distance from the 116-N-1 crib and trench increases. This pattern is consistent with retardation caused by adsorption, as well as radioactive decay and dilution. A similar pattern of radionuclide activity in groundwater was identified by the RFI/CMS for the 100-NR-1 Operable Unit in its study of radionuclide migration from the 116-N-1 crib and trench (DOE-RL 1990).

In addition to the elevated levels of activity directly observed in groundwater, the springs (N Springs) that developed as a result of discharge to 116-N-1 were also observed to exhibit elevated levels of radioactivity. To help monitor these releases, a composite sampling system was installed in 1973 at Well 199-N-8T, located approximately 15 m (50 ft) from the largest of the N Springs. Radionuclide activities in this well increased steadily through the year; however, the rate of increase of ^{131}I and ^{90}Sr activities accelerated in 1982. This was taken as evidence that the soil was saturated with radionuclides and was losing its capacity to retain them. This development prompted the building of the 116-N-3 crib and trench (DOE-RL 1990).

The 116-N-3 crib and trench was built in 1983. It operated jointly with the 116-N-1 crib and trench until September 1985 when the 116-N-1 facility was abandoned. This caused a dramatically different flow regime, accompanied by the formation of additional downstream springs, in the 100-N Area. The activity levels in these springs during 1987 and 1988 have been investigated via RFI/CMS (DOE-RL 1990). The activity measurements reported in 1988 in the N Springs for tritium and ^{90}Sr are shown in Figures 5-10 and 5-11, respectively. These measurements indicate a relatively even distribution of tritium along this entire reach of the river, while ^{90}Sr activity is heavily concentrated in the area adjacent to 116-N-1. Almost no ^{90}Sr activity is observed downstream from 116-N-1.

This pattern in spring activity is thought to result from several different influences (DOE-RL 1990 and DOE-RL 1991). The relatively even distribution of tritium activity along the entire shoreline is thought to result from recent discharge to 116-N-3. The high ^{90}Sr levels adjacent to the 116-N-1 are thought to result from the remobilization of radionuclides previously adsorbed to the soil (during past operation of the 116-N-1) as water flowing from the 116-N-3 passed through this area. The removal of ^{90}Sr from the effluent by adsorption in the immediate vicinity of the 116-N-3 is probably responsible for the low levels of this constituent observed in the downstream springs. Analysis of historical trends in ^{90}Sr and tritium levels also support this hypotheses. Strontium trends are presented in Figures 5-12 and 5-13.

Levels of ^{90}Sr in areas adjacent to 116-N-1 are shown to increase until 1985 when discharge from the unit was terminated. After this time, ^{90}Sr levels stabilized and even began to fall in some wells. This pattern is consistent with an increase in adsorbed levels during operation of the 116-N-1 and a stabilization and decrease in levels as adsorbed radionuclides are gradually desorbed and remobilized when discharge to the unit is no longer occurring.

The trends in ^{90}Sr levels adjacent to 116-N-3 (Figure 5-13) are not as clear. Wells 199-N-27 and 199-N-29, however, do show a gradual increase in ^{90}Sr levels until a more stable level was reached. This level may represent the point at which adsorbed levels of ^{90}Sr reach equilibrium with levels of ^{90}Sr in the effluent. Consequently, no more adsorption occurs.

Historical trends in tritium levels in groundwater based on data from wells located between 116-N-3 and the Columbia River are shown in Figure 5-14. These trends clearly show a significant variability in tritium levels since 1987 when the N reactor changed its operating status. These changes are reflected in all wells but are more attenuated in areas closer to the river. The wells shown in Figure 5-14, however, are generally screened close to the water table. As discussed, there is some evidence indicating that discharge from 116-N-3 may take a slightly deeper pathway and, consequently, the variations in tritium levels adjacent to the river may be more pronounced at depth (DOE-RL 1991).

Contours of tritium activity in the 100-N Area measured during September/October 1989, November/December 1989, and February 1990 are shown in Figures 5-15, 5-16, and 5-17, respectively. These data indicate widespread tritium contamination. An increase in tritium concentrations from September/October 1989 to February 1990 is also evident. This increase was probably caused by an increase in average tritium activities in the reactor effluent discharged to the 116-N-3 crib and ponds during this period. Release reports indicate that average tritium activities increased from 74,000 pCi/L in August 1989 to 550,000 pCi/L in November 1989 (DOE-RL 1991).

Contours of ^{90}Sr activity in the 100-N Area measured during September/October 1989, November/December 1989, and February 1990, are presented in Figures 5-18, 5-19, and 5-20 respectively. These data indicate that ^{90}Sr contamination appears confined to the area immediately adjacent to the 116-N-1 and 116-N-3 facilities, although insufficient data are available to characterize contamination northeast of the 116-N-1 trench and south and east of the 116-N-3 crib. In addition, a number of anomalous data points appear in the vicinity of 116-N-3. Variations in monitoring-well-screen lengths and depths may be responsible for many of these anomalies (DOE-RL 1991).

Data on ^{90}Sr from Well 199-N-36 may indicate some increase in contaminant levels from September/October 1989 to November/December 1989 in the immediate vicinity of 116-N-3, with a slight fall-off in activity noted by February 1990. A decrease in ^{90}Sr activities is evident from November/December 1989 to February 1990. This trend is particularly evident in the peak concentrations observed in Well 199-N-29. These changes conform to the pattern of changes observed in the reactor effluent during this period. In September 1989 average ^{90}Sr activities in the reactor effluent increased to

25,000 pCi/L from 2,300 pCi/L in August 1989. These levels increased to 210,000 pCi/L in November 1989. Average activity levels in the reactor effluent dropped back to 4,900 pCi/L in January of 1990. ^{90}Sr levels in the vicinity of 116-N-1 remained relatively stable, further verifying that ^{90}Sr in effluent disposed of in 116-N-3 is not migrating significant distances.

The presence of large groundwater mounds at various times beneath 116-N-1 and 116-N-3 indicate that significant vertical gradients with corresponding migration of contaminants down past the water table could be expected below both these facilities. Only limited data currently are available for characterizing the vertical distribution of contamination at the site; however, these data do seem to indicate that much of the contamination has been limited to a relatively narrow zone centered around the water table.

Currently two well pairs have been routinely monitored and provide some useful data for characterizing the vertical distribution of contaminants. Wells 199-N-67 and 199-N-69 are located adjacent to the 116-N-1 crib and trench. Well 199-N-67 is completed at the current water table (based on May 1990 water levels) with a 4.6-m (15-ft) screen, while the screened zone of Well 199-N-69 (3 m or 10 ft) is located 4.3 m (14 ft) below that of Well 199-N-67. Wells 199-N-39 and 199-N-70 are located adjacent to the 116-N-3 trench approximately 300 m (1,000 ft) from the 116-N-3 crib. Well 199-N-39 is completed at the current water table (based on May 1990 water levels) with a 6-m (20-ft) screen, while the screened zone of Well 199-N-70 (3 m or 10 ft) is located 4.9 m (16 ft) below that of Well 199-N-39.

Water quality data from samples taken in February 1990 indicate a significant difference in ^{90}Sr activities between Wells 199-N-67 and 199-N-69. Negligible ^{90}Sr was measured in Well 199-N-69, while an activity of 8,980 pCi/L was measured in Well 199-N-67. It is interesting to note that an activity of 1,960 pCi/L was measured in nearby Well 199-N-2. The screen in 199-N-2 intercepts the water table and extends over approximately 18 m (60 ft) of saturated aquifer; thus, the activity measured in the well apparently represents some average measurement over the entire unconfined aquifer. Data from November/December 1989 confirm this general pattern of vertical distribution of ^{90}Sr .

Activity measurements for ^{90}Sr from samples taken in November/December from Wells 109-N-39 and 199-N-70 also indicate a similar pattern. An activity of 490 pCi/L was measured in Well 199-N-39, while no measurable activity was detected in Well 199-N-70.

Several other studies conducted in the 100-N Area have confirmed this general pattern for the vertical distribution of contaminants. The RFI/CMS for the 100-NR-1 Operable Unit (DOE-RL 1990) demonstrated that adsorbed radionuclides in the vicinity of the 116-N-1 crib and trench were concentrated in the soil column at depths close to the water table. In the RFI/CMS, four wells in the 199-N-8 cluster (199-N-8-P, -Q, -R, and -S) were sampled between January 12 and February 18, 1987 to determine the vertical distribution of radionuclides in groundwater at the riverbank immediately adjacent to 116-N-1 (DOE-RL 1990); these data are provided in Table 5-11. These data indicate that the radionuclides measured were concentrated in a zone within 10 m (32 ft) of the water table.

Recent tritium data from Wells 199-N-67 and 199-N-69 (Color Illustration 2-2), however, show a different pattern. These data indicate significant contamination at depth, and in both Wells 199-N-67 and 199-N-69 higher levels of contamination at depth than at water table. For example, tritium activity observed in Wells 199-N-67 and 199-N-69 in November/December 1989 was 42,600 pCi/L and 78,400 pCi/L, respectively. The higher tritium levels at depth in the vicinity of 116-N-1 may indicate a deeper, preferential flow path for discharge from 116-N-3, particularly in the most direct pathway towards the river. The ^{90}Sr activity associated with discharges to 116-N-3 is presumably not observed at this point in the migration pathway because it was previously removed through adsorption in the immediate vicinity of the crib.

In addition to the extensive radiological monitoring routinely performed in the vicinity of 116-N-1 and 116-N-3, an extensive program of sampling and analysis for organic constituents was performed during 1989. Many of the wells in this operable unit were included in this program. All of the wells in the basic RCRA monitoring networks for the 116-N-1 and 116-N-3 facilities were sampled in March 1989, and those wells in the extended 116-N-1 assessment monitoring network were sampled in November/December 1989. This program was associated with the Hanford Site liquid effluent study and included analyses for the dangerous waste constituents list established by Washington State (WAC 173-303-9905). The analyses have indicated no significant difference for upgradient wells for organic contamination. The organic contamination levels reported were less than detection limits. However, the sampling undertaken in March 1989 did identify low levels of chloroform in a number of wells, and other organics were observed in Well 199-N-2. In addition, the more recent sampling in November/December 1989 has detected 2-methylnaphthalene at 26 $\mu\text{g/L}$, naphthalene at 12 $\mu\text{g/L}$, and polycyclic aromatic hydrocarbons totaling 28 $\mu\text{g/L}$ in Well 199-N-56 (DOE-RL 1991).

A limited area along the northwest corner of the plumes emanating from 116-N-1 and 116-N-3 has also been contaminated by the sodium (Figure 5-21), and sulfate (Figure 5-22), and pH plumes resulting from discharge to the 120-N-1 percolation pond and 120-N-2 surface impoundment. These contaminants may have played an important role in mobilizing radionuclides adsorbed to soil in this area (DOE-RL 1991).

5.2.2 1304-N Emergency Dump Tank and 118-N-1 Spacer Storage Silos Area

Several wells are located in the vicinity of the 1304-N EDT and the 118-N-1 spacer storage silos. All of these wells are located in the northwestern portion of the operable unit immediately adjacent to the Columbia River. Wells 199-N-48 and 199-N-23 through 199-N-25 monitor groundwater quality beneath the 1304-N EDT and wells 199-N-47 and 199-N-20 through 199-N-22 monitor beneath the 118-N-1 spacer storage silo. Well 199-N-23 is located directly between the two sources.

With the exception of Well 199-N-48, all of these wells have undergone radiological analyses during 1989. These analyses have indicated relatively low levels of radionuclides. During this period, the highest ^{90}Sr activity was 11.7 pCi/L observed in Well 199-N-24. Levels of ^{60}Co have been below

method detection levels, with the exception of Wells 199-N-20 and -21 for which activities of 8.4 and 5.7 pCi/L were reported. Levels of ^{106}Ru have all been below method detection limits. Tritium levels have ranged from below detection limits (BDL) in Well 199-N-25 to a high of 15,800 pCi/L in Well 199-N-47 (DOE-RL 1991).

Elevated levels of metals have been measured in several wells, most notably Well 199-N-23 (DOE-RL 1990). December 1989 measured concentrations included 348 mg/L for iron, 1,620 $\mu\text{g/L}$ for barium, 103 $\mu\text{g/L}$ for cadmium, and 529 $\mu\text{g/L}$ for chromium. The samples from which these measurements were made were highly turbid (i.e., more than 200 nephelometric turbidity units [NTU]) and were unfiltered. Consequently, they do not accurately reflect dissolved metal concentrations in water (DOE-RL 1991).

Many of the wells have undergone recent sampling and analysis for an extensive set of organic constituents. This sampling was done during November/December of 1989 as part of the Hanford Site liquid effluent study and included Wells 199-N-21, 199-N-23 through 199-N-25, and 199-N-47. Analyses were performed for the list of dangerous waste constituents established by Washington State (WAC 173-303-9905) and have indicated no significant organic contamination, with organic contaminant levels generally reported at less than detection limits. Well 199-N-47 did contain bis(2-ethylhexyl)phthalate at 26.0 $\mu\text{g/L}$ and tetrahydrofuran at 60 $\mu\text{g/L}$. Volatile organic analysis also identified acetone in Well 199-N-25 at the detection limit of 10 $\mu\text{g/L}$ (DOE-RL 1990).

5.2.3 120-N-1 Percolation Pond/120-N-2 Surface Impoundment Area

The 120-N-1 and 120-N-2 facilities have been used to treat and dispose of corrosive wastes from 1977. The waste has been characterized as a hazardous waste based solely on its corrosive nature. The waste exhibited no other dangerous characteristics; analysis indicated that it did not contain any listed hazardous waste or dangerous waste sources (DOE-RL 1991). Groundwater quality data from nearby Wells 199-N-58 through 199-N-61 have supported these conclusions. These wells underwent sampling and analysis for this list of dangerous waste constituents established by Washington State (WAC 173-303-9905) during March 1989. The analysis indicated no significant organic contamination, with organic contaminant levels generally reported at less than detection limits (DOE-RL 1991). A few organic constituents [bis (2-ethylhexyl) phthalate, chloroform, methylene chloride, and acetone] were found at trace levels. Radiological analyses of samples from these wells indicate that key radionuclides (^{106}Ru , ^{60}Co , and ^{90}Sr , and tritium) are present at low levels above detection limits, with an activity of 63.5 pCi/L reported for Well 199-N-59 (DOE-RL 1991). Groundwater quality data indicate that the 120-N-1 and 120-N-2 facilities are responsible for elevated sodium and sulfate plumes in the groundwater.

5.2.4 Summary of Groundwater Contamination

Monitoring data have indicated that groundwater in the 100-N Area has been widely contaminated by constituents in wastes disposed of to the ground (DOE-RL 1990). Table 5-12 lists the constituents measured above drinking

water standards from April 1987 to November 1989 and the number of instances for exceeding standards for each constituent during this period (WAC 248-54, 40 CFR 143). Table 5-13 identifies those individual wells in which drinking water standards were exceeded during a sampling round (July/August 1989). These constituents include beta activity and concentrations of ^{90}Sr , tritium, nitrate, and sulfate. Beta and ^{90}Sr activities exceeded drinking water standards in the same 10 wells. Tritium activities were greater than the standard in eight wells, and nitrate was exceeded in one well. Sulfate was higher than secondary drinking water standards in seven wells (DOE-RL 1991).

A summary discussion of groundwater quality in the 100-N Area beginning in 1980 and extending to November 1989 is provided in the following paragraphs. This discussion is based on review of the Hanford Sitewide groundwater monitoring and RCRA compliance monitoring reports published for this period. An emphasis is placed on identifying peak concentrations for individual constituents within the 100-N Area. The following discussion is broken into five major constituent groups:

- Radionuclides
- Volatile organics
- PCBs
- Metals
- Other inorganics.

5.2.4.1 Radionuclides. The radiological parameters identified in groundwater in the 100-N Area include gross beta, gross alpha, tritium, ^{60}Co , ^{106}Ru , ^{90}Sr , ^{137}Ce , ^{99}Tc , ^{125}An , uranium, and radium.

The maximum activity measured for gross beta in groundwater was 40,800 pCi/L in Well 199-N-67 (downgradient from the 116-N-1 crib and trench) on December 19, 1988 (DOE-RL 1991). Activities in this well have ranged from 24,100 to 40,800 pCi/L (DOE-RL 1991). The next highest beta concentration was 8,150 pCi/L on August 17, 1988 in Well 199-N-18 (DOE-RL 1990).

The maximum activity of gross alpha detected in the groundwater during the period was 36.6 pCi/L in Well N-59 on December 4, 1987 (DOE-RL 1990). In a more recent sampling event (June through August 1989), the highest concentration was 2.49 pCi/L in Well 199-N-42 (DOE-RL 1991).

Tritium is found at elevated levels throughout the areas adjacent to the 116-N-1 and 116-N-3 facilities and provides an excellent indicator of the extent of influence of these units. The maximum activity measured for tritium in groundwater during the period from 1980 to 1989 was 457,500 pCi/L on December 1, 1988 in Well 199-N-45 (adjacent to 116-N-3) (DOE-RL 1990).

The maximum activity of ^{60}Co (a beta and gamma emitter) in groundwater was at 554 pCi/L in Well 199-N-32 on November 1, 1987 (DOE-RL 1991). All the wells sampled on that date (199-N-14, 199-N-30, 199-N-31, 199-N-32, 199-N-33, 199-N-36, and 199-N-37) had activities above 100 pCi/L. Recent values have been considerably lower, ranging from 9.43 to 26.9 pCi/L in July and August 1989 (DOE-RL 1991).

The maximum activity of ^{106}Ru (a beta emitter) in groundwater was detected in Well 199-N-29 at 530 pCi/L on May 29, 1984. The highest value observed in recent sampling was 50.8 pCi/L in Well 199-N-60 on August 1, 1989, but this value is below the laboratory contract detection limit (DOE-RL 1991).

The maximum activity of ^{90}Sr (a beta emitter) measured in groundwater was 23,400 pCi/L in Well 199-N-67 on March 8, 1989. Activities in this well have ranged from 11,600 to 23,400 pCi/L. The next highest concentration was observed in Well 199-N-39 on July 23, 1987 at 10,400 pCi/L (DOE-RL 1991).

The maximum activity measured for ^{137}Cs in groundwater was 31 pCi/L in Wells 199-N-30 and 199-N-32 in 1986 (DOE-RL 1991). Recent samples have all been below the detection limit of 20 pCi/L (DOE-RL 1990).

The maximum activity of ^{99}Tc detected in groundwater was 55.8 pCi/L in Well 199-N-6 on January 29, 1988 (DOE-RL 1990). The maximum detected uranium activity in groundwater was 8.12 pCi/L in Well 199-N-23 on March 22, 1988 (DOE-RL 1990). Antimony-125 has been detected at a maximum activity of 540 pCi/L in Well 199-N-37 in 1986 (DOE-RL 1991). Radium has not been detected in groundwater in the 100-N Area above its detection limit of 1 pCi/L.

5.2.4.2 Volatile Organics. Several volatile organic compounds (benzene, toluene, xylene, chlorobenzene, ethyl benzene, three aliphatic hydrocarbons, and three other indeterminate organic compounds) were reported in a sample from Well 199-N-2 collected on December 19, 1988. Two indeterminate organic compounds and an aliphatic hydrocarbon were detected in a sample from Well 199-N-4 on the same date. Resampling of Well 199-N-2 on March 19, 1989, showed no such contamination, but sample contamination is suspected (DOE-RL 1991). Sampling from March through August 1989 did not show any of these constituents in either Well 199-N-2 or 199-N-4. An unknown aliphatic hydrocarbon was detected in Well 199-N-33 and its duplicate samples on March 6, 1989 (DOE-RL 1991). Samples from June through August 1989 were not analyzed for these constituents (DOE-RL 1991).

Acetone and methylene chloride have been detected occasionally and are probably the result of laboratory and/or sampling contamination (DOE-RL 1991).

Chloroform has been detected in several wells (199-N-3, -27, -29, -31, -33, -36, -58, -59, -60, -61, and -70) at low concentrations. Concentrations ranged from 5 $\mu\text{g/L}$ (in several wells) to 15 $\mu\text{g/L}$ (in 199-N-61 on July 23, 1989) (DOE-RL 1991). The chloroform may be derived from the disposal of chlorinated water.

5.2.4.3 Polychlorinated Biphenyls. The PCB arochlor 1016 was first detected in Well 199-N-33 on March 6, 1988 at 4 $\mu\text{g/L}$ (DOE-RL 1991). The well was resampled in July 1989 and had arochlor 1016 at concentrations as great as 148 $\mu\text{g/L}$. The source of this contamination is thought to be an oil-lubricated submersible pump that was leaking. The pump was removed in August 1989 (DOE-RL 1991).

5.2.4.4 Metals. Metals are naturally occurring constituents and have commonly been detected in the groundwater in the 100-N Area. Metals detected include aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium,

copper, iron, lead, lithium, magnesium, manganese, nickel potassium, sodium, strontium, titanium, uranium, vanadium, and zinc. Of these metals, only cadmium, iron, and manganese have exceeded drinking water standards (DOE-RL 1991).

Unfiltered cadmium has been detected in groundwater in concentrations up to 45 $\mu\text{g/L}$ (Well 199-N-23 on August 22, 1989). In recent sampling (June through August 1989) Wells 199-N-18, and 199-N-23 through 199-N-25 had concentrations above 10 $\mu\text{g/L}$. These wells are located adjacent to the Columbia River. The source of these elevated levels of cadmium is not known (DOE-RL 1991).

Unfiltered iron has been detected at a maximum concentration of 134,000 $\mu\text{g/L}$ in Well 199-N-23 on August 22, 1989. The maximum concentration of filtered iron was 659 $\mu\text{g/L}$ in Well 199-N-17 on August 18, 1989 (DOE-RL 1991). The high iron concentrations may be related to the condition of the steel casings, although Wells 199-N-32, 199-N-42, and 199-N-66, which have stainless steel screens, also have been associated with elevated iron concentrations (2,240, 2,070 and 5,360 $\mu\text{g/L}$, respectively in July and August 1989). Other wells with elevated iron concentrations from June through August 1989 are 199-N-4, -14, -16, -17, -18, -21, -23, -24, -25, -26, and -41. These wells are scattered throughout the 100-N Area and the source of the elevated levels of iron is not known (DOE-RL 1991).

The maximum observed concentration of unfiltered manganese was 4,380 $\mu\text{g/L}$ in Well 199-N-18. This concentration was measured in a sample taken on June 20, 1989. The maximum concentration of filtered manganese was 1,180 $\mu\text{g/L}$ in Well 199-N-17 on August 18, 1989 (DOE-RL 1991). Wells with elevated concentrations observed from June through August 1989 include 199-N-16, -17, -18, -23, -24, -25, -26, -42, -59, and -66. The source of the elevated manganese levels is not known (DOE-RL 1991).

The concentration of sodium in groundwater has been measured at more than five times greater than background (see Table 5-14). The highest observed concentration was 1,010,000 $\mu\text{g/L}$ in Well 199-N-61 on July 28, 1989. Wells 199-N-16, -21, -23, -24, -25, -47, -58, -59, -60, and -61 all have had concentrations greater than 10,000 $\mu\text{g/L}$. These wells are all downgradient from the 120-N-1 percolation pond and the 120-N-2 surface impoundment. The source of the sodium appears to be the sodium hydroxide used in the anion regeneration process and then discharged to 120-N-1 and 120-N-2 (DOE-RL 1991).

5.2.4.5 Other Inorganics. Many naturally occurring inorganics have been detected in the groundwater in the 100-N Area, including nitrate, sulfate, boron, chloride, and fluoride.

The highest observed nitrate concentration was 89,000 $\mu\text{g/L}$ in Well 199-N-30 on May 29, 1984 (DOE-RL 1991). High concentrations also have been observed in Well 199-N-67 at 87,800 $\mu\text{g/L}$ on March 8, 1989 (DOE-RL 1991). This concentration dropped to 23,500 $\mu\text{g/L}$ on August 16, 1989. A high concentration of 63,600 $\mu\text{g/L}$ was observed on June 21, 1989 in Well 199-N-56. This concentration dropped to 23,500 $\mu\text{g/L}$ on August 15, 1989 (DOE-RL 1991). The wells with the highest concentrations in August 1989 were 199-N-24 and 199-N-69 (DOE-RL 1991).

Elevated sulfate concentrations have commonly been observed downgradient from 120-N-1. The source of the high sulfate concentrations appears to be the sulfuric acid that was used in the cation regeneration process and then disposed of to the 120-N-1/120-N-2 facility. The highest sulfate concentration measured in the groundwater was 2,180,000 $\mu\text{g/L}$ in Well 199-N-61 on August 14, 1989. If those wells immediately surrounding 120-N-1/120-N-2 (199-N-58 through 199-N-61) are not considered, the highest concentration measured in groundwater in the 100-N Area was 345,000 $\mu\text{g/L}$ in Well 199-N-24 on August 21, 1989 (DOE-RL 1991).

5.3 AFFECTED ENVIRONMENT - SOIL

This section discusses known and suspected contaminant occurrences in the soil column as a result of releases from potential sources identified at the 100-N Area.

5.3.1 Surface Soil Contamination

Surface soil samples have been collected from various locations in the vicinity of N Reactor's 1301 N (116-N-1) and 1325 N (116-N-2) LWDFs since 1975. From 1975 to 1980, soil samples were collected at unspecified locations within the 116-N-1 trench. Analytical data from these samples indicate that ^{90}Sr and $^{239/240}\text{Pu}$ concentrations increased during this time, while ^{60}Co and ^{137}Cs values varied yearly (DOE-RL 1990).

Beginning in 1980, soil sampling was conducted in the 100-N Area as part of the annual Environmental Surveillance Program. In 1980, nine surface soil samples were collected in areas both north and south of the 116-N-1 crib and trench and nine surface soil samples were collected within the trench. Results of these analyses are presented in Table 5-15. Concentrations in the trench are at least 100,000 times higher than in the adjacent soil surface (DOE-RL 1990).

Relatively consistent surface soil sampling locations were established by the Environmental Surveillance Program in 1981; these locations were then sampled annually. Sampling locations were added periodically (e.g., sampling locations south of 116-N-1 on activation of the 116-N-3 crib and trench). The sample location map is presented in Figure 5-23. It must be emphasized that each location may not have been sampled each year, and some sample collection locations were not consistent from year to year. The average concentration of select radionuclides over the entire soil sampling area between 1980 and 1988 is presented in Table 5-16. The concentrations of most of the constituents have decreased since 1980.

5.3.2 Vadose Zone Soil Contamination

In addition to surface soil analyses, soil samples were collected within the vadose zone as part of a 1982 research project (DOE-RL 1990). Three wells were installed at varying distances from the 116-N-1 crib and trench, and soils from the borings were analyzed. The locations of these wells are shown in Figure 5-24. Well 199-N-9 was installed 30 m (100 ft) from the trench,

while Wells 199-N-12 and 199-N-13 were installed 46 and 73 m (150 and 240 ft), respectively, from the trench. Depth to groundwater varied from 16 to 18 m (53 to 59 ft). Boreholes were logged using gamma-ray logging tools to assess the occurrence of radionuclides in the borehole (DOE-RL 1990).

Data from these logs indicate that very low concentrations of radionuclides such as ^{60}Co , ^{137}Cs , ^{125}Sb , and ^{106}Ru were present in Well 199-N-9 soils above the water table, although the concentration increases markedly in soils at the water table. Wells 199-N-12 and 199-N-13 are more distant from the trench and had lower radionuclide concentrations in the unsaturated zone but also had elevated concentrations at the water table (within the saturated zone). These data indicate that extensive lateral migration of contaminants from the trench within the unsaturated zone is not apparent in these borings (DOE-RL 1990). Mechanisms that control the lateral migration of contaminants through the unsaturated zone include dispersion, diffusion, capillary flow, migration through a low-permeability zone because of increased moisture content and perched water, and the adsorption capacity of the soil.

Because these wells were installed between the trench and the springs, they could be used to assess the chemical speciation of wastewater as it migrates from the trench to the springs. While this is more specific to the groundwater pathway, the 1982 study also sheds light on the retention of specific radionuclides that could also occur in the vadose zone. This study indicates that as the trench water percolates into the soil and moves downward to the water table and on to the springs, selective removal of the cationic and particulate radionuclides occurs, with the more mobile anionic and nonionic species transmitted with groundwater essentially unattenuated (or with low attenuation). For example, ^{137}Cs is the least mobile of the radionuclides in this study; while 16,100 pCi/L were present in trench water (all as a soluble cation), no ^{137}Cs was detected in either the wells or springs, indicating that this radionuclide was probably bound in the soil column. On the other hand, 50 percent of the ^{131}I in trench water was present as a soluble anion, and this species was relatively mobile in groundwater (present in both the wells and springs) and did not sorb readily as an anionic species to the soil column.

The occurrence of organic compounds within trench sediments was also assessed as part of the DOE-RL study (1990). The presence of organic compounds in sediments/soils is important because they can form complexes with radionuclides, thus enhancing their mobility. Specific compounds were identified, including alkenes, alkanes, alkynes, elemental sulfur, and three cyclic sulfur species. Organic constituent concentrations are presented in Table 5-17.

Most of the unplanned release locations throughout the 100-N Area have not been sampled to determine the extent of contamination. Although screening sampling or radiation surveys were usually performed and exposed surface contamination was excavated, quantitative radionuclide- and chemical-specific analyses were not performed. Based on the areas of known releases (e.g., 116-N-3 crib and trench) and areas of inferred releases, inferred areas of soil contamination have been identified. These areas are shown in Figure 5-25 and the sources are listed in Table 5-1.

Estimates of total activity either released or remaining in soil were usually included in unplanned release or "occurrence" reports. The bases for these estimates are uncertain. However, the general extent of contamination at these locations can be inferred from discussions in the 100-NR-1 and 100-NR-2 work plans.

Where a release of a few hundred to a few thousand liters of radionuclide-contaminated wastewater occurred, the unsaturated soil column directly below the release location probably still holds most of the long-lived radionuclides. These locations include the 119-N building and 1322-N/NA sampling buildings.

At locations where more than a few thousand liters of radionuclide-contaminated water were released (particularly with high concentrations), the long-lived radionuclides are expected to be present in the saturated soils and (to an unknown extent) in the groundwater directly below and downgradient from the release location. These locations include the 116-N-2 radioactive chemical waste treatment and storage tank, the 118-N-1 spacer storage silos, the 1304-N EDT, and the 1314-N LWLS.

5.4 AFFECTED ENVIRONMENT - BIOTA

5.4.1 Flora

As part of the annual Environmental Surveillance Program, collection and analysis of vegetation for radionuclides occurred in the 100-N Area at three locations:

- Along the Columbia River at the N Springs
- Near the 116-N-1 crib and trench
- In the southeast section of the 100-N Area. The average concentration of selected radionuclides for the years 1980 through 1988 are presented in Tables 5-18, 5-19, and 5-20.

In 1990, the Columbia River shoreline within the Hanford Site was surveyed for potential edible natural vegetation and samples were collected for radiological analysis. Table 5-21 shows results for samples of mulberry leaves and berries, and one sample of curly dock collected from the N Springs area. DOE initiated removal of all contaminated vegetation from the N Springs area in September 1990. Mulberry trees and other plants were removed and disposed of in the 200 Area burial grounds.

5.4.2 Fauna

The effects of the 100-N Area on animals living near or at the 100-N Area have been investigated since 1979. The predominant area of investigation has been the 116-N-1 crib and trench. Barn swallow nests and excrement were sampled near the 1304-N EDB in 1979. Rabbits were trapped and collected around 116-N-1 in 1981. In 1982 and 1985, deer mice were trapped and collected in the 116-N-1 vicinity. In 1983, deer mice at the N Springs were trapped and collected.

5.4.2.1 Birds. The first fauna study conducted was an investigation of barn swallow nests and barn swallow excrement in 1979. Samples were collected in the vicinity of the 1304-N EDB. One of the sources of mud used to build the nests was the 116-N-1 trench before the precast concrete cover panels were installed. The nests and excrement were sampled to determine the amount of radionuclides in the nests. Two rounds of sampling were performed. The second round of sampling results, including soil sampling results for the same period, are presented in Table 5-22. Nests, excrement, and shell/embryo samples of barn swallows were collected in 1985 near the 1304-N EDB. The results of these analyses are presented in Table 5-23. The lowering of radionuclide concentrations may be the result of installing a cover over the 116-N-1 trench, which prevents the birds from using mud from the unit for nest building or eating insects that live in the unit (DOE-RL 1990).

Investigation of other nests at the 100-N Area noted a contaminated nest on the side of a craft building. The nest was tentatively identified as a robin's nest that was partly built using mud from the 116-N-1 trench. A Cutie Pie reading of 250 mrad/hr was the highest reading observed for the nest. Subsequent surveys located one contaminated wasp's nest on the craft building and about 15 nests inside. The highest reading of the nests was 15,000 cpm; however, the meter and frequency of monitoring were not described. A sample of either a wasp's nest or a composite sample of several wasp's nests was collected and analyzed. The following results, reported in pCi/g, are considerably higher than background (DOE-RL 1990):

- ^{54}Mn 1.68 E+5
- ^{60}Co 1.06 E+6
- ^{137}Cs 1.55 E+5
- $^{144}\text{CePr}$ 5.02 E+4.

5.4.2.2 Cottontail Rabbits and Deer Mice. Cottontail rabbits (*Sylvilagus nuttallii*) were collected and radioanalyzed in 1981. Five rabbits were collected from inside the 116-N-1 security fence and four rabbits were collected to the northwest of the fenced area. Rabbit feces were also collected around 116-N-1 for analyses. The study found much higher concentrations of radionuclides in rabbits collected within the 116-N-1 fenced area (Table 5-24). Concentration differences were attributed to rabbits inside the security fence drinking from the 116-N-1 trench and eating vegetation growing near the trench. The rabbits outside the fenced area were found to have radionuclide concentrations at or near background levels (DOE-RL 1990).

Deer mice (*Peromyscus maniculatus*) were collected near the 116-N-1 trench in 1981 for radioanalysis. Eighteen mice were collected over 3 days from 30 snap traps set along the first leg of the trench. Results of the sampling are presented in Table 5-25. Fission and activation products were detected in the mice. The ^{60}Co concentrations ranged from 54 to 17,000 pCi/g and ^{137}Cs concentrations ranged from 25 to 2,300 pCi/g. Concentrations of ^{131}I were also noted, which indicated the mice were using the 116-N-1 trench as a drinking water supply. Ingestion of vegetation in the area also may have increased the concentrations of radionuclides in the mice. Total gamma activity ranged from about 3,200 pCi to nearly 1 μCi in the mice. Four composite samples of the 18 mice were formed based on the concentration of ^{137}Cs in each mouse. The composite with the highest average ^{137}Cs

(1,800 pCi/g) also had the highest ^{90}Sr concentration (190 pCi/g). This study was conducted before a concrete cover was installed on the 116-N-1 trench (DOE-RL 1990).

During 1985, 16 deer mice again were collected from 50 traps near 116-N-1. Sampling results from whole body analysis of the mice, presented in Table 5-27, indicated relatively high concentrations of ^{60}Co , ^{59}Fe , and ^{54}Mn . In addition, ^{131}I and ^{137}Cs were detected. These results suggest that the mice were still obtaining radionuclides directly from the effluent to the 116-N-1 trench (DOE-RL 1990).

Deer mice were collected at the N Springs for analysis of gamma-emitting radionuclides in 1982. Twelve mice were collected over 3 days from 30 snap traps. The results of the analyses, presented in Table 5-26, indicate that the levels were probably caused by ingestion of vegetation growing at the springs and drinking N Springs water (DOE-RL 1990).

5.5 AFFECTED ENVIRONMENT - RADIATION

Elevated radiation levels above natural background exist along the 100-N Columbia River shoreline. The source term for these radiation levels is the 1301-N LWDF (116-N-1), which is described in Section 3.4.1 and shown in Figure 3-19.

During normal operation, sediments in the trench sections of the disposal facility became radiologically contaminated from the billion gallons of effluent that were discharged each year. Radiation emanating from the top of the trench sections during operation of the 1301-N LWDF was not significant because the sediments were normally under several meters of water, which provided the necessary shielding.

During operation, liquid effluent was present in the trench sections; the rate of percolation into the ground was offset by the rate of discharge of liquid effluent into the trench. Following retirement of the facility in 1985, the liquid normally present in the trench sections of the disposal facility percolated into the ground leaving the residual radioactively contaminated sediments unshielded along the bottom and sides of the trench sections. The radioactive constituents of the contaminated sediments include the gamma-emitting isotopes ^{60}Co and ^{137}Cs . Figure 5-26 shows the results of a 1990 radiation survey on the top of the 1301-N LWDF trench. Because of the lack of water covering, some of the gamma photons that are emitted upward above the trench sections are scattered downward because of the Compton interaction of these photons with atmospheric constituents. These downward-scattered gamma rays are present at the nearby Columbia River shoreline and increase the exposure rate above the ambient background rate as shown in Figure 5-27. This phenomenon is known as "skyshine."

5.6 NET EFFECT ON THE ENVIRONMENT

The net effect on the environment is 109 discrete sources of known environmental contamination. The soil is the medium that received most of the radioactive and hazardous waste at N Reactor through direct disposal of

liquids to the soil in cribs and trenches and spills and leaks from storage tanks. Soil and groundwater currently represent the primary source terms of radionuclide and hazardous substances that exhibit varying forms of mobility.

Radionuclide and hazardous substances in the soil can also be transported to groundwater. Groundwater monitoring has detected radionuclides in the groundwater under the site. Columbia River-groundwater interactions have also influenced contamination transport. Uptake of radionuclides from the soil and groundwater has also occurred, resulting in the transport of contaminants to both plants and animals.

The hazard proposed by radiation exposures depends to a large extent on the combination of radiation quality (alpha, beta, gamma) and the exposure pathway. External exposure to radionuclides is of concern only if it results from gamma emitters because they can penetrate tissue and deliver a deep dose of radiation. Alpha- and beta-emitting radionuclides only pose a significant hazard when inhaled or ingested because their energy is deposited locally in tissues and cells.

The potential for ingestion or inhalation of radiation through one or more of three general exposure pathways (soil, water, or air) compelled the EPA to place the 100 Area (and therefore, N Reactor) on the National Priority List (NPL) near the end of fiscal year 1987. The NPL was established as part of CERCLA (40 CFR 300, Appendix B); the 100 Area is within group numbers 6 and 30 listed in the Federal Facility NPL.

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Color Illustration 5-1. 116-N-2 Radioactive Chemical Waste
Treatment and Storage Facility.

Color Illustration 5-2. 116-N-4 Emergency Dump Basin.

Color Illustration 5-3. 1304-N Emergency Dump Tank.

Color Illustration 5-4. 105-N Reactor Spent Fuel Storage Basin (above water).

Color Illustration 5-5. 105-N Reactor Spent Fuel Storage Basin (below water).

Color Illustration 5-6. 120-N-2 Surface Impoundment.

Color Illustration 5-7. 100-N Regulatory-driven Milestones.

Figure 5-1. N Reactor Operational Area.

F5-1

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Figure 5-2. Waste Sources.

WEG\022293-G

Figure 5-3. Original 116-N-1 Crib Layout.

903 1275/26921/11-12-91

Figure 5-4. Regeneration Waste Transport System, 1977-1983.

29212025.31

Figure 5-5. Regeneration Waste Transport System, 1983-1986.

29212025.32

Figure 5-6. Regeneration Waste Transport System, 1986-1988.

29212025.33

Figure 5-7. 120-N-1 Percolation Pond Area as it existed from 1977 to 1983.

29212025.30

Figure 5-8. 120-N-1 Percolation Pond/120-N-2 Surface Impoundment Area as they existed from 1986 to 1988.

Figure 5-9. 120-N-2 Surface Impoundment Schematic.

29212025.34

Figure 5-10. Tritium Activity Levels in N Springs During 1988.

903-1276/27124/11-12-91

Figure 5-11. ^{90}Sr Activity Levels in N Springs During 1988.

903-1276/27122/11-12-91

Figure 5-12. ^{90}Sr Activity in Wells Near 116-N-1.

903 1276/27178/11-18-91

Figure 5-13. ^{90}Sr Activity in Wells Near 116-N-3.

903 1276/27179/11-18-91

Figure 5-14. Tritium Activity in Wells Between 116-N-3 and the Columbia River.

903 1276/27180/11-18-91

Figure 5-15. Tritium Activity in 100-N Area Groundwater During September-October 1989.

29212025.65

Figure 5-16. Tritium Activity in 100-N Area Groundwater During November-December 1989.

29212025.63

Figure 5-17. Tritium Activity in 100-N Area Groundwater During February 1990.

29212025.64

Figure 5-18. ^{90}Sr Activity in 100-N Area Groundwater During September-October 1989.

29212025.57

Figure 5-19. ⁹⁰Sr Activity in 100-N Area Groundwater During November-December 1989.

29212025.58

Figure 5-20. ^{90}Sr Activity in 100-N Area Groundwater During February 1990.

29212025.59

Figure 5-21. Sodium Concentration in 100-N Area Groundwater During September-October 1989.

Figure 5-22. Sulfate Concentration in 100-N Area Groundwater During September-October 1989.

29212025.61

Figure 5-23. Soil Sampling Locations in the 100-N Area.

Figure 5-24. Location of Monitoring Wells.

29212025.54

Figure 5-25. Areas of Inferred Soil Contamination in the 100-N Area.

Figure 5-26. Results of January 10, 1990, Survey along the Top of the 1301-N LWDF Trench Sections.

39009058.3

Figure 5-27. Net Exposure Rate (above local background) along the Columbia River Shoreline near 100-N Springs.

39009058.5

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Table 5-1. 100-N Area Sources. (9 Sheets)

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
1314-N Liquid Waste Loadout Facility Grouping			
---	1314-N	Receives spent radioactive internal decontamination solution from the 116-N-2 radioactive chemical waste storage facility and the 107-N basin recirculation facility. Effluent transferred by railway tank cars to 200 Area tank farms for processing and disposal.	Liquid waste loadout station.
UN-100-N-13	1314-N Loading Station	100 gal of spent reactor decontamination solution containing 11 mCi from 116-N-2 (1310-N) discharged to ground via dry well.	1314-N dry well overflow.
UN-100-N-26	Valve Pit at 1314-N Loading Station	1,000 gal of spent reactor decontamination solution containing phosphoric acid and diethylthiourea backflowed while being pumped into a tank car.	Rail car overflow.
119-N Air Sampling and Monitoring Building Grouping			
UN-100-N-9	119-N Cooling Water Drain Line	2,200 gal of contaminated water with a total activity of 4 mCi released to soil from punctured drain line.	Punctured drain line.
UN-100-N-14	Drain System at 119-N Building	70 gal of effluent water containing 0.8 mCi of beta/gamma activity was released to the ground.	Drain backflow release.
166-N Fuel Unloading and Storage Area Grouping			
---	Fuel Oil Unloading	No. 6 fuel oil.	Tank car unloading area and containment trench for piping
---	166-N Tank Farm	No. 6 fuel oil and No. 2 diesel oil.	One aboveground tank for No. 6 fuel oil and four aboveground tanks for No. 2 diesel oil.
UN-100-N-17	166-N Diesel Oil Supply Line	80,000 gal of diesel oil was released to the ground from the external corrosion of supply line.	Oil supply line leak. Trench dug along river used to intercept and burn off oil in the groundwater.
UN-100-N-20	2-in Diesel Oil Return Line	200 gal of diesel oil was released to the line ground as a result of a leak in a corroded return line.	Oil line leak in bermed storage tank area.
UN-100-N-24	166-N Oil Supply Line	Unknown amount of No. 6 fuel oil was released to the ground as a result of a leak in a heat transfer line.	Oil line leak in bermed storage tank area.

Table 5-1. 100-N Area Sources. (9 Sheets)

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
1301-N Crib and Trench Grouping			
116-N-1	1301-N	Liquid radioactive waste disposal system for N Reactor. Effluents from reactor coolant system, spent fuel storage basin, periphery coolant systems, and various radioactive drain systems in the reactor facility. Also disposal area for various laboratory chemicals. Historical average high flow rate of 2,100 gal/min.	Crib and trench.
---	1322-N and 1322-NA Sample Building	Irradiated cooling water and water samples from the river bank springs.	Pilot plant treatment facility with sampling points.
UN-100-N-4	1322-N Sump	Unknown amount of low-level radioactive wastewater with total activity of 0.5 mCi was released to the ground.	Sump overflow release.
UN-100-N-8	1322-NA Sump	50 to 100 gal of low-level radioactive wastewater with total activity of 0.5 mCi was released to the ground.	Sump overflow release.
UN-100-N-31	1301-N Crib	1,000 gal of radioactive coolant water.	Release through 6-in casing being installed in berm.
1310-N Radioactive Chemical Waste Treatment and Storage Grouping			
116-N-2	1310-N Waste Radioactive Chemical Waste Treatment and Storage Facility	Temporary storage of radioactive waste decontamination solution from N Reactor.	Radioactive chemical waste storage facility; waste transferred to 1314-N liquid waste loadout station after cooling and neutralization via piping.
UN-100-N-5	Leak in piping at 1310-N Silo	90,000 gal of low-level radioactive chemical waste from N-reactor decontamination was discharged to the ground.	Underground pipe leak.
UN-100-N-25	1310-N Storage Tank	500 gal of primary loop water and decontamination solution was released to the ground in the radiation zone surrounding the tank.	Vent line discharge on 116-N-2 storage tank.
---	Caustic spill at 1310-N Silo	Approximately 100 gal of sodium hydroxide.	Spilled during tanker truck unloading to 116-N-2.
124-N-4	Septic tank and drainfield	30,000 gal/day of sanitary sewage.	Septic tank and drainfield. Located east of 1310-N storage tank and south of 116-N-1 crib.

Table 5-1. 100-N Area Sources. (9 Sheets)

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
1325-N Crib and Trench Grouping			
116-N-3	1325-N	Liquid radioactive waste disposal system for N Reactor after 116-N-1 ceased operations. Effluent from reactor coolant system, spent fuel storage basin, periphery coolant systems, and various radioactive drain systems in the reactor facility. Also dispersal area for various laboratory chemicals. Historical average flow rate of 1,300 gal/min.	Crib and trench.
Burning Pit Grouping			
128-N-1	Burning Pit South of 1325-N Crib	Office and lunchroom trash, tumbleweeds were burned using various fuel oils as starters.	Burning pit.
181-N River Pumphouse Grouping			
---	102-in Outfall Line	Secondary cooling water containing a variety of radionuclides.	Discharge pipe extending approximately 400 ft into the Columbia River. NPDES Discharge Point No. 009.
---	102-in Outfall pH Violation	Acidic and caustic regeneration wastewater.	Testing of simultaneous acid and caustic wastewater releases resulted in NPDES pH violations.
---	Aboveground Waste oil Tank at 181-N	Waste oil.	Manages waste oil from pump oil changes.
---	181-N Inlet Screen Backwash Water Outfall	Backwash water and solids from raw water intake to 100-N. Analyzed for total flow and suspended solids per NPDES permit.	NPDES Discharge Point Number 007.
1304-N Emergency Dump Tank Grouping			
---	1304-N Emergency Dump Tank (EDT)	Cooling water containing small amounts of radionuclides.	1.3 Mgal storage tank intended to receive emergency dumpings of thermally hot primary reactor coolant water.
UN-100-N-1	EDT Overflow Line	30,000 gal of cooling water containing 0.2 Ci.	Temporary flow stoppage device malfunctioned during maintenance. Contaminated soil removed.
UN-100-N-29	EDT Bypass Line	100 gal of primary coolant water containing 100 mCi of radioactive materials, mostly ⁵⁴ Mn and ²⁴ Na.	Faulty check valve caused the leak. Contaminated soil removed.

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
UN-100-N-30	EDT Overflow	2,500 gal of irradiated water. Maximum reading of 500 counts per minute.	Overflowed through vacuum breaker vent at top of EDT during filling, stabilized the area. No documented removal.
UN-100-N-32	EDT Bypass Line	500-1,000 gal of primary coolant water. Sample of contaminated soil yielded 20,000 counts per minute.	Faulty check valve (similar to UN-100-N-29). Contaminated soil removed.
UN-100-N-2	FLV-858 valve body relief line	25,000-30,000 gal of radioactively-contaminated water. Less than 1 Ci of radioactivity.	Crack in relief line to 32-in low pressure flash line between EDT and 109-N. Contaminated soil removed.
UN-100-N-7	10-in Drain line between 105-N and EDT	504,000 gal of irradiated water with unknown levels of radioactivity.	Leak in drain line. Contaminated soil removed.
---	1300-N Emergency Dump Basin	Cooling and blowdown water and sludge containing radionuclides.	One million gal storage basin used for emergency dumping of thermally hot primary reactor coolant water and for blowdown water from 109-N steam generators.
Spacer Storage Silo Grouping			
118-N-1	Spacer Storage Silos	Irradiated fuel spacers.	The silos contained irradiated fuel spacers which came in contact with the reactor fuel rods.
UN-100-N-3	Spacer Transfer Line	360,000 gal of irradiated 105-N fuel storage basin water containing 70 mCi - ⁶⁰ Co, 80 mCi - ⁹⁰ Sr, 250 mCi - ¹³⁷ Cs, 140 mCi - ¹⁴⁴ CePr, and 0.4 mCi - ²³⁹ Pu.	Crack in line between 105-N and silos. Contaminated soil removed.
UN-100-N-12	Spacer Transfer Line	250,000 gal of irradiated 105-N fuel storage basin water containing 190 mCi - ⁶⁰ Co, 126 mCi - ⁹⁰ Sr, 396 mCi - ¹³⁷ Cs, 34 mCi - ¹⁴⁴ CePr, and 0.57 mCi - ^{239/240} Pu.	Similar to UN-100-N-3. Removal of soil undocumented.
124-N-3	107-N Septic System	Sanitary sewage.	Sewage system serving 2-3 employees at 107-N plus construction personnel.
---	Corridor 22 exit	Several hundred litres of irradiated filter water.	Discharge to ground. Undocumented.
---	105-N Lift Station Underground Station Tank	No. 2 diesel oil.	5,000 gal steel tank which has been removed. No soil contamination found during tank removal.

Table 5-1. 100-N Area Sources. (9 Sheets)

Table 5-1. 100-N Area Sources. (9 Sheets)

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
182-N Underground Storage Tank Grouping			
182-N-1-DT 182-N-2-DT 182-N-3-DT	182-N Underground Storage Tanks (3)	No. 2 diesel oil.	Three 10,000 to 19,000 gal USTs containing diesel oil for Emergency Diesel pumps, 124-N-3, which have been removed. The sites are scheduled for remediation under UST program.
105-N Spent Fuel Storage Basin Grouping			
---	105-N Spent Fuel Storage Basin	Irradiated cooling water.	Containment basin for storage of spent fuel rods and spacers.
UN-100-N-10	Zone I Gravity Drain Line	Approximately 100 gal of irradiated water containing 1 mCi of radionuclides.	Leaking temporary pump fitting spilled to the ground. Contaminated soil was removed.
UN-100-N-35	Leak in overflow weir drain line	Unknown amounts of contaminated water from the 105-N fuel storage basin.	Leaking clean out valve from overflow weir. Contamination found in groundwater monitoring wells by the fuel basin.
182-N High Lift Pumphouse Grouping			
124-N-2	182-N Septic Tank	Sanitary Sewage.	Serves personnel from 182-N building.
---	182-N Tank Farm Overflow	Overflow water analyzed for temperature, pH, total suspended solids, oil and grease, and chlorine per NPDES permit.	NPDES Discharge Point Number 005 via a 36-in raw water return line.
---	182-N Drain system	Primarily water analyzed for temperature, pH, total suspended solids, oil and grease per NPDES permit.	NPDES Discharge Point Number 006 via a 42-in raw water return line. Periodic release of low-level radionuclides from emergency core cooling system pumps.
---	Lube Oil Line Leak	5 gal of turbine oil.	Pinhole leak in lube oil line allowed oil to enter secondary steam system. Discharge to river with steam condensate.
Acid/Caustic Storage and Transport System Grouping			
---	108-N Chemical Unloading Facility	93 percent sulfuric acid and 50 percent sodium hydroxide.	Unloading area for trucks or railcars. Has three aboveground sulfuric acid tanks and one aboveground sodium hydroxide tank.
120-N-7	Unloading Station French Drain	93 percent sulfuric acid and 50 percent sodium hydroxide.	French drain for receiving incidental spills during railcar or tank truck unloading.

Table 5-1. 100-N Area Sources. (9 Sheets)

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
120-N-6	Sulfuric Acid Tank French Drains (5)	93 percent sulfuric acid.	French drains surrounding acid tanks for containment of incidental spills.
---	108-N Neutralization Pit	Waste sulfuric acid.	The unit was used to neutralize waste sulfuric from 108-N floor drains and acid transfer tank drainage.
UN-100-N-15	108-N Unloading Facility	Unknown amount of sulfuric acid and rinsewater.	Transfer line leak during pumping of liquid from 108-N to french drain.
UN-100-N-33	108-N Unloading Facility	Approximately 1,000 gal of sulfuric acid.	Spilled to ground during transfer from railcar to storage tank.
---	108-N Unloading Facility Spill	Approximately 10 gal of sodium hydroxide.	Spilled during transfer from railcar to storage tank.
120-N-5	Acid/Caustic Transfer Trench and Neutralization Unit	Sulfuric acid and sodium hydroxide.	Piping trench between 108-N and 163-N and containment vaults.
UN-100-N-34	Acid/Caustic Transfer Trench and Neutralization Unit	Approximately 3,400 gal of sulfuric acid.	Pipeline rupture filled containment vaults and spilled to ground. Acid was neutralized.
---	Acid/Caustic Transfer Trench	Unknown amount of sulfuric acid.	Acid had corroded away exposed trench area releasing to the soil.
---	Acid/Caustic Transfer Trench	Unknown amount of sodium hydroxide.	Leak in piping was contained in trench.
---	Acid/Caustic Transfer Trench	Approximately 200 gal of sulfuric acid spilled and approximately 15 to 30 gal released to ground.	Leak in piping escaped trench through a dry well. Contaminated soil was removed.
120-N-3	163-N Neutralization Pit and French Drain	Sulfuric acid and sodium hydroxide.	French drain and vault receiving drainage from 163-N acid and caustic day tank area.
120-N-8	163-N Sulfuric Acid Day Tank Vent French Drain	Sulfuric acid.	Tank overflows are vented to the french drain.
---	Regeneration Waste Transport System	Acid and caustic regeneration wastes.	Sump and pipeline delivering wastes from 163-N to 1324-N.
---	Regeneration Waste Transport System	Approximately 6,500 gal of acidic regeneration wastes.	Pipeline leak during transfer. Spill was neutralized and contaminated soil was removed.
---	Regeneration Waste Transport System	Approximately 1,000 gal of acidic regeneration wastes.	Pipeline leak during transfer. Spill was neutralized.

Table 5-1. 100-N Area Sources. (9 Sheets)

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
124-N-1	163-N Septic Tank	Sanitary sewage.	Serving 163-N, 183-N, 1127-N, and 1128-N buildings.
Mixed Waste Storage Area Grouping			
116-N-8	Mixed Waste Storage Pad	Radioactively contaminated oil and miscellaneous process chemicals.	Paved and curbed concrete pad for mixed waste storage in drums and miscellaneous containers.
184-N Plant Service Power House			
---	184-N Plant Service Power House	Hydrocarbons, particulates, sulfur dioxide, sulfur trioxide, carbon monoxide, nitrogen oxide, and aldehydes.	Routine and systematic releases from boiler stacks.
---	184-N Day Tanks	No. 6 (Bunker C) fuel oil and diesel oil.	Two 35,000 gal fuel oil tanks and one 8,000 gal diesel oil tank surrounded by a containment wall.
UN-100-N-19	Fuel Oil Day Tank at 184-N	Approximately 2,000 gal of fuel oil.	Tank overflowed during filling. Oil contained within walls and removed.
UN-100-N-21	Diesel Oil Day Tank at 184-N	Approximately 800 gal of diesel oil.	Tank overflowed during filling. Oil removed from containment area.
---	Diesel Oil Day Tank at 184-N	Unknown amount of diesel oil.	Tank overflowed during filling. Oil was removed.
---	166-N - 184-N Piping	No. 6 fuel oil and No. 2 diesel oil.	Underground fuel supply piping.
UN-100-N-18	Diesel oil supply line between 166-N and 184-N	Approximately 200 gal of diesel oil.	Line leak caused by external corrosion.
UN-100-N-22	Diesel oil supply line near 184-N	Approximately 1,000 gal of diesel oil.	Line leak caused by external corrosion. Contaminated soil removed. Oil detected in groundwater.
UN-100-N-23	Diesel oil supply line near 184-N	Approximately 200 gal of diesel oil.	Line leak caused by external corrosion. Oil detected in groundwater.
---	Fuel oil pipe fitting at 184-N Annex	Unknown amount of fuel oil.	Oil leaked from loose pipe fitting during transfer to boiler. Oil contained and removed.
---	Diesel oil supply line between 166-N and 184-N	A minimum of 300 gal of diesel oil.	Line leak in three places. 46 drums of contaminated soil removed.

Table 5-1. 100-N Area Sources. (9 Sheets)

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
Decon Drain Line Leak Grouping			
UN-100-N-6	1-1/2-in Chemical Decontamination Waste Drain Line between 105-N and 116-N-2	Approximately 1,800 gal of irradiated wastewater with 200 mCi - ⁶⁰ Co, 40 mCi - ⁵⁴ Mn, 3 mCi - ¹⁰³ Ru, and 3 mCi - ¹³⁷ Cs.	Four locations along line. Contaminated soil removed.
Nonhazardous and Nonradioactive Storage Area			
120-N-4	Storage area	Nonhazardous and low level radioactive containerized wastes.	Curbed concrete pad for container storage.
100-N-SS-27 100-N-SS-28	1716-N Service Station Underground Storage Tanks	Unleaded gasoline.	Two 1,000 to 4,000 gal underground storage tanks associated with service station. Tanks have been removed.
Regeneration/Filter Backwash Waste Disposal Area Grouping			
120-N-2	1324-N Surface Impoundment (formerly North Settling Pond)	Corrosive regeneration wastes and filter backwash water.	1977-1983 unlined settling pond; 1983-1986 out of service; 1986-1988 lined surface impoundment.
---	South Settling Pond	Corrosive regeneration wastes and filter backwash water. Unlined settling pond.	
120-N-1	1324-NA Percolation Pond	Corrosive regeneration wastes and filter backwash water. Currently receives nonregulated neutralized regeneration wastewater.	Unlined percolation pond.
130-N-1 (formerly 126-N-1)	Filter Backwash Discharge Pond	Filter backwash water.	Unlined percolation basin.
---	1143-N Paint Shop	Paint wastes and associated water, spent thinner, spent garnet sand and paint chips.	Paint shops with water scrubber in the paint booth, a solvent accumulation drum, and an outdoor sandblasting area.

Table 5-1. 100-N Area Sources. (9 Sheets)

WIDS Designation Number	Alias/Location	Waste Description	Unit or Release Description
Office Septic Tank Area Grouping			
124-N-5	1117-N Septic Tank (Sewer System V)	Sanitary sewage.	Septic tank and drainfield.
124-N-6	1113-N Septic Tank (Sewer System VI)	Sanitary sewage.	Septic tank and drainfield.
124-N-7	1115-N Septic Tank (Sewer System VII)	Sanitary sewage.	Septic tank and drainfield.
124-N-8	1134-N Septic Tank (Sewer System VIII)	Sanitary sewage.	Septic tank and drainfield.
N-17 Paint Shop Area Grouping			
---	N-17 Paint Shop	Waste paint, solvents, and oils.	Two waste accumulation drums (one for waste paint, the other for waste oil); sandblasting area.
1120-N Septic Tank Grouping			
124-N-9	1120-N Septic Tank	Sanitary sewage.	Septic tank and drainfield.
100-N Sewer System Grouping			
124-N-10	100-N Sewer System	Sanitary sewage.	Central sewer system with three lagoons, sewer trunk line and other pipelines, and lift stations.
Un-100-N-11	Corner of Route 4 north and access road	Radioactive soil and asphalt.	Valve bonnet fell from truck onto road and rolled into adjacent field. Valve bonnet, asphalt, and soil removed.

Source: DOE-RL 1990.

Table 5-2. Selected Radionuclide Inventory for 116-N-1 Crib and Trench for the 1301-N Liquid Waste Disposal Facility (WHC 1987b).

Radionuclide	Half-Life (Yr)	Inventory (Ci)
⁶⁰ Co	5.3	3,800
⁹⁰ Sr	29	1,800
¹⁰⁶ Ru	1	120
¹³⁴ Cs	2.1	51
¹³⁷ Cs	30	2,300
²³⁹ Pu	24,000	18

Table 5-3. Dangerous Waste Inventory for the 116-N-1 Crib and Trench for the 1301-N Liquid Waste Disposal Facility.

Compound	Amount, lb/yr
Hydrazine Test Solution	6,100
Ammonia Test Solution	6,100
Chloride Test Solution	7,800
Fluoride Test Solution	3,900
Lead-Acetate Battery Fluid	630*
Nickel-Cadmium Battery Fluid	270*
Hydrazine (Injection System)	350

*No actual spills reported, but possible because of common floor drains in the storage rooms.

Note: Routine monitoring of the influent to 116-N-1 did not reveal detectable levels of these chemicals (WHC 1987b).

Table 5-4. Selected Radionuclide Inventory from October 1983 to January 1, 1988 for 116-N-3 Crib and Trench for the 1325-N Liquid Waste Disposal Facility (WHC 1987a).

Radionuclide	Half-Life (Yr)	Inventory (Ci)
^{60}Co	5.3	1,300
^{90}Sr	29	200
^{106}Ru	1	66
^{134}Cs	2.1	14
^{137}Cs	30	350
^{239}Pu	24,000	2.6

Table 5-5. Dangerous Waste Inventory for 116-N-3 Crib and Trench for the 1325-N Liquid Waste Disposal Facility.

Compound	Amount, lb/yr
Hydrazine Test Solution	6,100
Ammonia Test Solution	6,100
Chloride Test Solution	7,800
Fluoride Test Solution	3,900
Lead-Acetate Battery Fluid	120*
Nickel-Cadmium Battery Fluid	80*
Hydrazine (Injection System)	10

*No actual spills reported, but possible because of common floor drains in the storage rooms.

Note: Routine monitoring of the influent to 116-N-3 did not reveal detectable levels of these chemicals (WHC 1987a).

Table 5-6. Average Annual Concentrations of Radionuclides (pCi/L) Detected in Water Samples from the 1300-N EDB for 1978 through 1985.

Radionuclide	1978	1979	1980	1981	1982	1983	1984	1985
⁴⁰ K	4.2 E1	---	---	---	---	---	---	---
⁵⁴ Mn	5.1 E1	1.5 E4	4.1 E3	1.0 E3	2.7 E3	7.1 E3	4.1 E2	---
⁵⁹ Fe	---	7.4 E3	1.0 E3	---	---	---	---	---
⁵⁸ Co	---	1.1 E3	4.8 E2	---	---	---	---	---
⁶⁰ Co	1.1 E3	4.8 E4	2.0 E4	1.3 E4	7.5 E4	3.4 E5	3.6 E4	3.1 E2
⁹⁵ ZrNb	---	1.6 E3	2.4 E3	---	---	---	9.9 E1	---
¹⁰³ Ru	---	2.0 E2	6.6 E2	---	---	3.5 E2	---	---
¹²⁴ Sb	---	3.4 E2	---	---	---	---	---	---
¹³¹ I	2.1 E2	3.8 E3	3.7 E2	5.5 E2	---	---	2.9 E2	---
¹³⁷ Cs	1.6 E2	2.0 E2	2.4 E2	4.2 E2	1.3 E3	8.8 E3	1.0 E3	9.0 E1
¹⁴⁰ BaLa	5.9 E2	4.7 E3	1.3 E3	5.6 E2	---	---	3.3 E2	---
Total	2.2 E3	8.2 E4	3.1 E4	1.6 E4	7.9 E4	3.5 E5	3.8 E4	4.0 E2

Source: DOE-RL 1990.

Table 5-7. 163-N Demineralization Plant Regeneration Effluent Waste Analysis Cation Regeneration Cycle. (2 Sheets)

Parameters (MDL)	Sample			Average
	1	2	3	
pH (standard units)	0.894	0.936	0.922	0.917
Conductivity (μ mhos)	37,000	40,100	35,000	37,367
Mercury (0.0001 p/m)	LD	LD	LD	LD
Ethylene glycol (10 p/m)	LD	LD	LD	LD
Enhanced thiourea (0.2 p/m)	LD	LD	LD	LD
TOC (1 p/m)	0.0013	0.0019	0.0018	0.024
Cyanide (0.01 p/m)	LD	LD	LD	LD
Barium (0.006 p/m)	0.030	0.023	0.020	0.024
Cadmium (0.002 p/m)	0.003	0.002	0.003	0.003
Chromium (0.01 p/m)	LD	LD	LD	LD
Lead (0.03 p/m)	LD	LD	LD	LD
Silver (0.01 p/m)	LD	LD	LD	LD
Sodium (0.1 p/m)	12.2	16.5	9.6	12.8
Nickel (0.01 p/m)	LD	LD	LD	LD
Copper (0.01 p/m)	LD	LD	LD	LD
Vanadium (0.005 p/m)	0.025	0.027	0.020	0.024
Antimony (0-1 p/m)	LD	LD	LD	LD
Aluminum (0.15 p/m)	0.725	0.842	0.655	0.741
Manganese (0.005 p/m)	0.027	0.035	0.027	0.030
Potassium (0.1 p/m)	12.2	15.5	14.8	14.2
Iron (0.05 p/m)	1.1	1.2	1.0	1.1
Beryllium (0.005 p/m)	LD	LD	LD	LD
Osmium (0.3 p/m)	LD	LD	LD	LD
Strontium (0.3 p/m)	1.3	1.4	1.2	1.3
Zinc (0.005 p/m)	0.016	0.024	0.067	0.036
Calcium (0.05 p/m)	282.6	347.4	324.92	318.3
Nitrate (0.5 p/m)	1.0	0.5	0.8	0.8
Sulphate	2,310	4,271	2,952	3,201

Table 5-7. 163-N Demineralization Plant Regeneration Effluent Waste
Analysis Cation Regeneration Cycle. (2 Sheets)

Parameters (MDL)	Sample			Average
	1	2	3	
Fluoride (0.5 p/m)	LD	LD	LD	LD
Chloride (0.5 p/m)	2.0	1.8	1.9	1.9
Phosphate (1 p/m)	LD	LD	LD	LD
Phosphorus	LD	LD	LD	LD
Pesticides (0.005 p/m)	LD	LD	LD	LD
Chlorinated Pesticides (0.001 p/m)	LD	LD	LD	LD
Enhanced ABN List	LD	LD	LD	LD
Citrus Red (1 p/m)	LD	LD	LD	LD
Arsenic (0.005 p/m)	LD	LD	LD	LD
Ammonium Ion (0.05 p/m)	LD	LD	LD	LD
Coliform (3 MPN)	LD	LD	LD	LD
Selenium (0.005 p/m)	LD	LD	LD	LD
Thallium (0.01 p/m)	LD	LD	LD	LD
Enhanced VOA (10 p/m)	26	28	26	27

LD = less than detectable

MDL = minimum detection limit

MPN = most probable number.

Data obtained from samples taken August 1985.

Source: WHC 1987c.

Table 5-8. 163-N Demineralization Plant Regeneration Waste Analysis Anion Regeneration Cycle. (2 Sheets)

Parameters (MDL)	Sample			Average
	1	2	3	
pH (standard units)	13.72	13.74	13.77	13.74
Conductivity (μ mhos)	62,000	60,000	70,000	64,000
Mercury (0.0001 p/m)	0.00018	0.00013	0.00019	0.00017
Ethylene glycol (10 p/m)	LD	LD	LD	LD
Enhanced thiourea (0.2 p/m)	LD	LD	LD	LD
TOC (1 p/m)	462	499	456	472
Cyanide (0.01 p/m)	0.010	0.015	LD	0.013
Barium (0.006 p/m)	LD	LD	LD	LD
Cadmium (0.002 p/m)	LD	LD	LD	LD
Chromium (0.01 p/m)	LD	LD	LD	LD
Lead (0.03 p/m)	LD	LD	LD	LD
Silver (0.01 p/m)	LD	LD	LD	LD
Sodium (0.1 p/m)	26,910	28,200	26,330	27,150
Nickel (0.01 p/m)	LD	LD	LD	LD
Copper (0.01 p/m)	LD	LD	LD	LD
Vanadium (0.005 p/m)	LD	LD	LD	LD
Antimony (0.1 p/m)	LD	LD	LD	LD
Aluminum (0.15 p/m)	LD	LD	LD	LD
Manganese (0.005 p/m)	LD	LD	LD	LD
Magnesium (5 p/m)	LD	LD	LD	LD
Potassium (0.1 p/m)	26.5	27.2	26.3	26.7
Iron (0.05 p/m)	LD	LD	LD	LD
Beryllium (0.005 p/m)	LD	LD	LD	LD
Osmium (0.3 p/m)	LD	LD	LD	LD
Strontium (0.3 p/m)	LD	LD	LD	LD
Zinc (0.005 p/m)	LD	LD	LD	LD
Calcium (0.05 p/m)	LD	LD	LD	LD
Nitrate (0.5 p/m)	1.0	1.4	0.9	1.1

Table 5-8. 163-N Demineralization Plant Regeneration Waste Analysis Anion Regeneration Cycle. (2 Sheets)

Parameters (MDL)	Sample			Average
	1	2	3	
Sulfate	30.9	30.6	30.6	30.7
Fluoride (0.5 p/m)	LD	LD	LD	LD
Chloride (0.5 p/m)	2.5	2.3	2.3	2.4
Phosphate (1 p/m)	LD	LD	LD	LD
Phosphorus	LD	LD	LD	LD
Pesticides (0.005 p/m)	LD	LD	LD	LD
Phosphorus Pesticides (0.005 p/m)	LD	LD	LD	LD
Chlorinated Pesticides (0.001 p/m)	LD	LD	LD	LD
Enhanced ABN List	LD	LD	LD	LD
Citrus Red (1 p/m)	LD	LD	LD	LD
Arsenic (0.005 p/m)	LD	LD	LD	LD
Ammonium Ion (0.05 p/m)	2.3	2.7	2.8	2.6
Coliform (3 MPN)	LD	LD	LD	LD
Selenium (0.005 p/m)	LD	LD	LD	LD
Thallium (0.01 p/m)	LD	LD	LD	LD
Enhanced VOA (10 p/m)	26	28	26	27

LD = less than detectable

MDL = minimum detection limit

MPN = most probable number.

Data obtained from samples taken August 1985.

Source: WHC 1987c.

Table 5-9. 183-N Filtered Water Plant Backwash
Effluent Analysis. (2 Sheets)

Parameters (MDL)	Sample			Average
	1	2	3	
pH (standard units)	7.08	7.65	7.64	7.46
Conductivity (μ mhos)	160	150	150	153
Mercury (0.0001 p/m)	LD	LD	LD	LD
Ethylene glycol (10 p/m)	LD	LD	LD	LD
Enhanced thiourea (0.2 p/m)	LD	LD	LD	LD
TOC (1 p/m)	0.00277	0.002175	0.002257	0.002404
Cyanide (0.01 p/m)	LD	LD	LD	LD
Barium (0.006 p/m)	0.030	0.031	0.030	0.030
Cadmium (0.002 p/m)	0.004	0.002	0.002	0.003
Chromium (0.01 p/m)	LD	LD	LD	LD
Lead (0.03)	LD	LD	LD	LD
Silver (0.01 p/m)	LD	LD	LD	LD
Sodium (0.1 p/m)	2.202	2.287	2.186	2.225
Nickel (0.01 p/m)	LD	LD	LD	LD
Copper (0.01 p/m)	LD	LD	LD	LD
Vanadium (0.005 p/m)	LD	LD	LD	LD
Antimony (0.1 p/m)	LD	LD	LD	LD
Aluminum (0.15 p/m)	0.392	0.389	0.376	0.386
Manganese (0.005 p/m)	0.020	0.015	0.014	0.016
Potassium (0.1 p/m)	0.799	0.814	0.762	0.792
Iron (0.05 p/m)	LD	LD	LD	LD
Beryllium (0.005 p/m)	LD	LD	LD	LD
Osmium (0.3 p/m)	LD	LD	LD	LD
Strontium (0.3 p/m)	LD	LD	LD	LD
Zinc (0.005 p/m)	LD	LD	LD	LD
Calcium (0.05 p/m)	17.340	17.720	17.020	17.360
Nitrate (0.5 p/m)	0.789	0.500	0.500	0.596
Sulphate	18.900	20.980	19.110	19.663

Table 5-9. 183-N Filtered Water Plant Backwash
Effluent Analysis. (2 Sheets)

Parameters (MDL)	Sample			Average
	1	2	3	
Fluoride (0.5 p/m)	LD	LD	LD	LD
Chloride (0.5 p/m)	2.846	2.671	2.901	0.2806
Phosphate (1 p/m)	LD	LD	LD	LD
Phosphorus	LD	LD	LD	LD
Pesticides (0.005 p/m)	LD	LD	LD	LD
Chlorinated Pesticides (0.001 p/m)	LD	LD	LD	LD
Enhanced ABN List	LD	LD	LD	LD
Citrus Red (1 p/m)	LD	LD	LD	LD
Arsenic (0.005 p/m)	LD	LD	LD	LD
Ammonium Ion (0.05 p/m)	LD	LD	LD	LD
Coliform (3 MPN)	0.24	2.400	0.2400	1.680
Selenium (0.005 p/m)	LD	LD	LD	LD
Thallium (0.01 p/m)	LD	LD	LD	LD
Enhanced VOA (10 p/m)	--	0.024	0.023	0.025

LD = less than detectable

MDL = minimum detection limit

MPN = most probable number.

Data obtained from samples taken August 1985.

Source: WHC 1987c.

Table 5-10. Average Radionuclide Concentrations (pCi/L) Detected in Groundwater Samples Collected in the 100-N Area During 1981.

Well No.	⁶⁰ Co	¹⁰³ Ra	¹⁰⁶ Ru	¹²⁵ Sb	¹⁴⁷ Nd	⁹⁰ Sr	Tritium
199-N-2	530	81	370	270	ND	2,300	2.5 x 10 ³
199-N-3	260	49	250	46	NE	305	1.9 x 10 ⁴
199-N-4	43	ND	75	6	570	3	1.7 x 10 ⁴
199-N-5	310	26	240	200	ND	3	1.8 x 10 ⁴
199-N-7	140	46	140	33	ND	NA	NA
199-N-14	200	54	150	40	ND	160	1.7 x 10 ⁴
199-N-15	60	ND	72	8	ND	6	2.1 x 10 ⁴
199-N-20	10	ND	ND	9	ND	78	1.9 x 10 ⁴

ND = Not detected.

NA = Not available.

Sources: DOE-RL 1990 and DOE-RL 1991

Table 5-11. Radionuclide Concentrations (pCi/L) in Wells 199-N-8P Through 199-N-8S.

Well	Depth into water table (ft)	Radionuclide				
		⁶⁰ Co	¹⁰³ Ra	¹⁰⁶ Ru	¹²⁵ Sb	¹³¹ I
199-N-SP	74 - 84	6	<6	<46	<19	9
199-N-8Q	34 - 44	10	<8	<54	<22	<11
199-N-8R	22 - 32	75	11	95	<24	<10
199-N-8S	12 - 22	78	20	87	66	<10

Note: Samples taken from 1/12/87 to 2/18/87.

Source: DOE-RL 1991.

Table 5-12. Selected Constituents Detected Above Drinking Water Standards in the 100-N Area Between April 1987 and November 1989. (2 sheets)

Well	Benzene	Cadmium (U)	⁶⁰ Co	Coliform	Gross beta	Iron (U/F)	Manganese (U/F)	Nitrate	Low/High pH	¹⁰⁶ Ru	Spec. cond.	Sulfate	⁹⁰ Sr	Tritium
199-N-2	1				9	2/0				2			9	9
199-N-3				1	10	6/0	5/0			1	4		11	10
199-N-4			2		7	8/0	4/0			2			8	12
199-N-5					4								6	6
199-N-6					6					2			4	3
199-N-14			2	1	16	3/0				2			10	13
199-N-15										1				5
199-N-16		1				4/2	4/3				10	3		
199-N-17		1			1	4/2	4/3			1	1		1	
199-N-18		1			5	1/0	1/0			1	1		8	6
199-N-19					3								6	
199-N-20										1			6	
199-N-21						4/0					7	1	6	
199-N-23		1				2/0	2/0			2	2			
199-N-24		1				2/0	2/0				2	1	2	
199-N-25		1				2/0	1/0		0/3	31	2	2	2	
199-N-26						2/0	2/0							
199-N-27			5		8					3	1		10	9
199-N-28			3		10			1					7	7
199-N-29			3		12					4			9	10
199-N-30			5		2					1				5
199-N-31			3		11			1	0/2	23			13	12
199-N-32			4	2	10			4		5			8	11
199-N-33			9		11			2		6			15	16
199-N-36			6		12	1/0		1		4	1		11	11
199-N-37			3		3			1		1			5	4
199-N-39			4	1	5	1/0		5		3			7	7
199-N-41					5	2/0		2						4
199-N-42					5	9/0	3/0				1			5

Table 5-12. Selected Constituents Detected Above Drinking Water Standards in the 100-N Area Between April 1987 and November 1989. (2 sheets)

Well	Benzene	Cadmium (U)	⁶⁰ Co	Coliform	Gross beta	Iron (U/F)	Manganese (U/F)	Nitrate	Low/High pH	¹⁰⁶ Ru	Spec. cond.	Sulfate	⁹⁰ Sr	Tritium
199-N-45			4		7			1		4			10	10
199-N-47						1/0					4	1		
199-N-49			1		5	1/0		6			1		1	6
199-N-50					2									6
199-N-51					1									6
199-N-52				1	6						1			10
199-N-54					1	1/0							1	
199-N-55					1			1					1	
199-N-56					1			1			2		1	1
199-N-57													1	1
199-N-58						1/0	1/1				25	13		
199-N-59							7/6		6/0	1	31	13		
199-N-60				1			3/3		3/0	1	29	14		
199-N-61				1		1/0	3/3		5/0		27	13		
199-N-66						3/1	1/0				4			2
199-N-67					5			1					5	5
199-N-69									0/1	1				5
199-N-70				1	2					1				6
Totals	1	6	54	9	186	61/5	43/19	27	14/6	54	156	61	184	223

U = Unfiltered.

F = Filtered.

NOTE: Values are the number of samples above the drinking water standard. A blank indicates constituent not analyzed for, or not detected above the standard.

Source: PNL 1991.

Table 5-13. Constituents Detected Above Drinking Water Standards in the 100-N Area During July/August 1989.

Parameter	Standard	Well in which exceedances occurred
Beta activity	50 pCi/L ¹	199-N-2-, -3, -14, -27, -29, -31, -32, -33, -36, -67
⁹⁰ Sr	8 pCi/L ^a	199-N-2, -3, -14, -27, -29, -31, -32, -33, -36, -67
Tritium	20,000 pCi/L ^a	199-N-2, -3, -4, -14, -42, -67, -69, -70
Nitrate	45 mg/L ^a	199-N-55
Sulfate	250 mg/L ^b	199-N-16, -21, -47, -58, -59, -60, -61

^aSecondary maximum contaminant levels given in WAC 248-54, "Radioactive Protection Standards."

^bSecondary maximum contaminant levels given in 40 CFR Part 143 (July 1987) "National Secondary Drinking Water Regulations."

Table 5-14. Estimated Background Levels for Selected Constituents in Hanford Site Groundwater. (2 sheets)

Constituent	Unit	Detection limit	Background concentration ^b
Aluminum	μg/L	2 ^a	<2 ^a
Ammonia	μg/L	50	<50
Arsenic	μg/L	0.2 ^a	3.9 ± 24 ^a
Barium	μg/L	6	42 ± 20
Beryllium	μg/L	0.3 ^a	<0.3 ^a
Bismuth	μg/L	0.02 ^a	<0.02 ^a
Boron	μg/L	50 ^a	<50 ^a
Cadmium	μg/L	0.2 ^a	<0.2 ^a
Calcium	μg/L	50	40,400 ± 10,300
Chloride	μg/L	500	10,300 ± 6,500
Chromium	μg/L	2 ^a	4.0 ± 2.0 ^a
Copper	μg/L	1 ^a	<1 ^a
Cyanide	μg/L	10	<10
Fluoride	μg/L	500	370 ± 100
Lead	μg/L	0.5 ^a	<0.5 ^a
Magnesium	μg/L	10	11,800 ± 3,400
Manganese	μg/L	5	7 ± 5
Mercury	μg/L	0.1	<0.1
Nickel	μg/L	4 ^a	<4 ^a
Nitrate	μg/L	500	<500
Phosphate	μg/L	1,000	1,000
Potassium	μg/L	100	4,950 ± 1,240
Selenium	μg/L	2 ^a	<2 ^a
Silver	μg/L	10	<10
Sodium	μg/L	10	18,260 ± 10,150
Strontium	μg/L	20	236 ± 102
Sulfate	μg/L	500	34,300 ± 16,900
Tritium	pCi/L	300	<300
Uranium	pCi/L	0.5	1.7 ± 0.8

Table 5-14. Estimated Background Levels for Selected Constituents in Hanford Site Groundwater. (2 sheets)

Constituent	Unit	Detection limit	Background concentration ^b
Vanadium	$\mu\text{g/L}$	5	17 ± 9
Zinc	$\mu\text{g/L}$	5	6 ± 2
Alkalinity	$\mu\text{g/L}$	NA	$123,000 \pm 21,000$
pH	Unitless	NA	7.64 ± 0.16
Total organic carbon	$\mu\text{g/L}$	200	586 ± 347
Conductivity	$\mu\text{mhos/cm}$	1	380 ± 82
Gross alpha	pCi/L	0.5	2.5 ± 1.4
Gross beta	pCi/L	4	19 ± 12
Radium	pCi/L	0.2	<0.2

^aBased on inductively coupled plasma/mass spectrometry data.

^bAverage $\pm$ 2 standard errors of the calculated mean.

NA = Not applicable.

Sources: DOE-RL 1990

Table 5-15. 1980 Select Radionuclide Concentrations Detected in Soil Samples Adjacent to the 116-N-1 Facility and in the 116-N-1 Trench Sediment Samples (pCi/g).

Soil samples (adjacent areas)						
Sample Location	⁵⁴ Mn	⁶⁰ Co	¹³⁴ Cs	¹³⁷ Cs	¹⁴⁴ CePr	¹⁵⁵ Eu
T-1	0.26	2.62	ND	0.43	ND	0.09
T-2	5.17	33.10	0.29	4.76	1.73	ND
T-3	2.07	8.31	0.24	4.43	0.56	0.16
T-4	1.83	9.93	0.25	4.66	0.48	ND
T-5	2.99	11.40	0.37	6.03	ND	0.12
T-6	0.10	1.00	ND	0.21	ND	ND
T-7	0.37	1.70	ND	0.74	ND	ND
T-8	ND	0.30	ND	0.21	ND	ND
T-9	ND	0.39	ND	0.84	ND	ND
Avg*	1.83	7.64	0.27	2.48	0.92	0.12

Soil samples (trench)					
Sample Location	⁵⁴ Mn	⁶⁰ Co	⁹⁵ N6	¹³⁷ Cs	¹⁴⁴ CePr
TS-1	4.4 E+06	1.3 E+07	3.6 E+06	2.7 E+05	1.1 E+07
TS-2	2.8 E+06	8.8 E+06	1.5 E+06	2.1 E+05	4.1 E+06
TS-3	1.4 E+06	8.4 E+06	2.2 E+05	1.2 E+05	1.1 E+06
TS-4	1.0 E+06	5.1 E+06	2.6 E+05	2.2 E+05	8.0 E+05
TS-5	6.1 E+05	3.1 E+06	1.4 E+05	2.6 E+05	5.1 E+05
TS-6	1.1 E+06	5.6 E+06	2.7 E+05	2.1 E+05	8.6 E+05
TS-7	3.5 E+05	1.7 E+06	9.2 E+04	2.4 E+05	4.1 E+05
TS-8	4.3 E+05	7.6 E+06	ND	6.3 E+05	ND
TS-9	7.0 E+05	4.3 E+06	1.2 E+05	3.5 E+05	3.3 E+05
Avg	1.4 E+06	6.4 E+06	7.6 E+05	2.8 E+05	2.4 E+06

ND = Not Detected

*Average determined from samples with detectable results.

Note: In addition to the radionuclides listed, sample TS-1 contained 2.5×10^5 pCi/g of ⁵⁸Co, 1.98×10^6 pCi/g of ⁹⁵Zr, and 2.7×10^6 pCi/g of ¹⁰⁶Ru; sample TS-2 contained 3.3×10^5 pCi/g of ⁵⁹Fe, 7.9×10^5 pCi/g of ⁹⁵Zr, 1.1×10^5 pCi/g of ¹⁰³Ru, and 8.7×10^5 pCi/g of ¹⁰⁶Ru; and sample TS-5 contained 4.1×10^4 pCi/g of ¹³⁴Cs.

Source: DOE-RL 1990

Table 5-16. Average Radionuclide Concentrations (pCi/g)
Detected in Soil Samples near the 116-N-1 Crib
and Trench from 1980 through 1988.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239/240} Pu
1980	2.5 E+0	1.3 E-1	3.5 E-1	4.1 E+0	NR	2.5 E-2
1981	6.6 E+0	4.0 E+0	7.0 E-1	6.1 E+0	NR	4.4 E-2
1982	6.6 E-1	6.3 E+0	2.7 E-1	2.7 E+0	NR	1.8 E-2
1983	4.1 E-1	5.4 E+0	1.3 E+0	3.8 E+0	NR	4.3 E-2
1984	1.8 E-1	2.8 E+0	2.1 E-1	1.1 E+0	NR	1.7 E-2
1985	1.5 E+0	1.3 E-1	6.5 E-1	3.9 E+0	NR	3.2 E-2
1986	1.6 E-1	4.5 E+0	2.2 E-1	2.5 E+0	NR	1.7 E-2
1987	3.2 E-1	5.1 E+0	3.4 E-1	1.6 E+0	5.4 E-3	2.2 E-2
1988	1.4 E-1	7.8 E+0	3.5 E-1	2.0 E+0	2.3 E-3	1.7 E-2

NR = Not Reported

Table 5-17. Hydrophilic Organics in Trench Sediments.

Parameter	Sample No. 2 μg/kg	Sample No. 6 μg/kg	Sample No. 9 μg/kg
Tricarboxylic Acids			
Citric Acid	34	159	80
Dicarboxylic Acids			
Oxalic Acid	13	1,971	347
Malonic Acid	8	903	141
Malbic Acid	3	375	31
Succinic Acid	33	1,992	328
2-Methyl-Succinic Acid	80	94	80
Pentanedioic Acid	80	282	80
Hexanedioic Acid	3	193	34
Heptanedioic Acid	20	80	80
Octanedioic Acid	41	592	87
Nonanedioic Acid	91	557	163
Carboxylic Acids			
Tetradecanoic Acid	3	66	34
Hexadecanoic Acid	49	292	55
Octadecenoic Acid	45	190	39
Oxygenated Acids			
2-Hydroxy-Propanoic Acid	80	138	80
3-Hydroxy-Butanoic Acid	12	80	80
4-Methoxy-Butanoic Acid	80	18	80
2-Methoxy-2-Butanoic Acid	49	80	80
4,4-Dimethoxy-2-Pentenedioic Acid	21	80	80
2-Methoxy-Benzonic Acid	80	274	80
2-OXO-Propanoic Acid	80	10	3
4-OXO-Pentanoic Acid	2	169	39
Aromatics			
Benzeneacetic Acid	80	222	79
Furancarboxylic Acid	80	120	20
Benzoic Acid	80	362	45
Dimethyl Phthalate	34	188	68
Dibutyl Phthalate	21	80	80
Benzaldehyde	80	86	14
2,5-Pyridinecarboxylic Acid	92	80	80
Pyridinecarboxylic Acid	80	4	80
Nitrobenzoic Acid	80	115	80
Nitro-Hydroxybenzoic Acid (Methyl Ester)	80	300	57

BD = Below Detection limit.

Note: All samples taken from dried sediments in manways.

Source: DOE-RL 1990

Table 5-18. Average Radionuclide Concentrations (pCi/g)
Detected in 100-N Area Vegetation Samples.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1980	4.8 E-01	1.0 E+00	NR	2.8 E-01	NR	NR
1981	1.8 E+00	2.5 E+01	5.8 E-01	7.1 E-01	NR	2.1 E-02
1982	4.9 E-01	1.5 E+00	2.0 E-01	1.3 E-01	NR	7.8 E-03
1983	3.6 E-01	1.0 E+00	2.9 E-01	9.0 E-02	NR	8.6 E-03
1984	1.3 E-01	4.6 E-01	8.1 E-02	9.0 E-02	NR	1.3 E-03
1985	3.6 E-01	1.4 E+00	5.1 E-02	1.6 E-01	NR	8.7 E-04
1986	2.6 E-01	9.5 E-01	2.2 E-01	7.9 E-01	NR	1.1 E-03
1987	1.1 E-01	7.0 E-01	2.6 E-01	9.4 E-02	1.3 E-04	5.8 E-04
1988	1.3 E-01	8.0 E-01	2.5 E-01	1.6 E-01	1.7 E-04	6.6 E-04

Source: DOE-RL 1990.

NR = Not Reported.

Table 5-19. Average Radionuclide Concentrations (pCi/g)
Detected in Vegetation Samples near
116-N-1 Crib and Trench.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1980	1.4 E+00	4.0 E+00	NR	1.1 E-00	NR	NR
1981	2.5 E+00	1.2 E+01	1.8 E+00	1.8 E+00	NR	7.1 E-03
1982	4.6 E-01	1.6 E+00	1.2 E-01	2.6 E-01	NR	2.6 E-03
1983	4.5 E-01	1.9 E+00	6.0 E-01	3.9 E-01	NR	3.2 E-03
1984	2.9 E-01	1.0 E+00	1.2 E-01	8.3 E-02	NR	8.5 E-04
1985	5.9 E-01	1.7 E+00	1.9 E+00	1.0 E-01	NR	1.5 E-03
1986	6.8 E-01	3.5 E+00	7.3 E-02	6.5 E-01	NR	2.6 E-03
1987	4.9 E-01	2.8 E+00	6.3 E-02	2.0 E-01	1.2 E-03	5.6 E-03
1988	1.5 E-01	2.0 E+00	1.2 E-01	1.3 E-01	4.3 E-04	1.7 E-03

Source: DOE-RL 1990.

NR = Not Reported.

Table 5-20. Average Radionuclide Concentrations (pCi/g)
Detected in N Springs Vegetation Samples.

Year	⁵⁴ Mn	⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	²³⁸ Pu	^{239,240} Pu
1980	1.5 E-01	5.6 E+00	NR	4.4 E-01	NR	NR
1981	NR	3.3 E+00	2.0 E+02	NR	NR	3.7 E-03
1982	1.5 E-01	2.8 E+00	4.8 E+02	NR	NR	8.3 E-03
1983	7.0 E-02	3.0 E+00	3.3 E+02	4.0 E-02	NR	8.0 E-03
1984	NR	NR	NR	NR	NR	NR
1985	7.6 E-02	1.2 E+00	4.2 E+02	1.7 E-01	NR	4.4 E-04
1986	1.6 E-01	1.1 E+00	2.2 E+02	2.1 E-01	NR	4.2 E-04
1987	2.0 E-01	9.0 E-01	2.9 E+02	1.1 E-01	<1.1 E-04	7.6 E-04
1988	2.4 E-01	1.4 E+00	1.2 E+02	2.0 E-01	8.5 E-05	2.0 E-04

Source: DOE-RL 1990.

NR = Not Reported.

Table 5-21. Sampling Results of N Springs Vegetation.

Sample Type	Sample Number	Location	90 _{sr} (dpm/g)* wet	Gamma Results bq/g wet (+%)			
				7 _{ss}	40 _z	60 _{ss}	137 _{cs}
Mulberry Samples:							
Mulberries	90182 53289-2	1 (Below 100-N stack on near shoreline)	NA	<0.0085	<0.01	<0.0017	<9.2 E-4
Mulberry leaves	90185 53289-5	2 (Approximately 50 m upstream of N-8* groundwater well near shoreline)	NA	0.024 (8.1)	<0.14	4.40 E-4 (37)	1.23 E-3 (35)
Mulberries	90183 53289-3	2 (Approximately 50 m upstream of N-8* groundwater well near shoreline)	NA	0.0047 (28)	<0.11	0.0037 (5.9)	<3.0 E-4
Mulberry leaves	90181 53289-1	3 (Approximately 50 m downstream of N-8* groundwater well near shoreline)	171	0.025 (9.8)	0.195 (28)	8.59 E-4 (23)	8.20 E-4 (50)
Mulberries	90184 53289-4	3 (Approximately 50 m downstream of N-8* groundwater well near shoreline)	41.9	0.0046 (26)	<0.091	8.42 E-4 (16)	5.08 E-4 (50)
Curly dock sample:							
Curly dock, plant and root	90186 53289-6	(Approximately 15 m downstream of N-8* groundwater well at shoreline)	181	0.0035 (35)	<0.067	1.21 E-3 (18)	<5.0 E-4

*Decays per minute

*bq (becquerel) = 1 decay per second

*The analytical uncertainty is the one-sigma value expressed as a percent.

NA = Not analyzed

*Well number prefixed by "199-"

Table 5-22. 1979 Concentrations of Radionuclides in Swallow Nests Compared to N Area and Hanford Soil Sample (pCi/g).

Radionuclide	Swallow Nest				Surface Soil	
	#1	#2	#3	#4	N-Area	Hanford
⁵⁴ Mn	1.9	0.14	--	0.27	0.90	--
⁶⁰ Co	15	1.2	0.64	1.5	2.7	--
⁹⁵ Nb	--	--	--	--	--	0.05
¹³⁷ Cs	5.5	0.28	--	0.19	0.61	0.70
¹⁴⁷ Nd	--	--	0.45	--	--	--
Total Activity	22	1.6	1.1	2.0	4.2	0.75

Source: DOE-RL 1990

Table 5-23. 1985 Radionuclide Concentrations (pCi/g) of Cliff Swallow Nests, Excrement Samples, and Shell/Embryo Samples Collected Near the 1304-N EDB During 1985.

Nuclide	Swallow Nest		Excrement	Shell/Embryo
	#1	#2		
⁵⁴ Mn	0.26	0.29	--	--
⁶⁰ Co	1.2	1.1	5.1	4.2
¹³⁷ Cs	0.31	0.29	--	--

Source: DOE-RL 1990

Table 5-24. Radionuclides Detected in Rabbits Collected
Around the 116-N-Facility, 1981 Concentrations
in pCi/g (wet weight). (2 Sheets)

	Tissue	⁵⁴ Mn	⁶⁰ Co	⁶⁵ Zn	¹³⁴ Cs	¹³⁷ Cs	⁹⁰ Sr	²³⁸ Pu	^{239/240} Pu
Inside 1301-N Security Fence									
#1	Muscle	ND	0.2	ND	0.55	8.9	NA	NA	NA
	Bone	ND	ND	0.46	ND	3.2	73	ND	ND
#2	Muscle	6.1	13	6.2	320	3,700	NA	NA	NA
	Bone	46	13	13	98	1,100	6,000	ND	0.14
	Liver	210	120	ND	160	2,300	5.2	0.07	0.35
#3	Muscle	4.2	2.2	2.1	270	3,400	NA	NA	NA
	Bone	21	5.2	ND	77	1,200	1,300	0.01	0.06
	Liver	330	60	ND	190	3,400	5.6	0.005	0.02
#4	Muscle	1.5	9.0	0.53	9.1	120	NA	NA	NA
	Bone	1.4	0.57	ND	3.0	51	200	ND	0.15
	Liver	11	12	8.7	9.9	160	13	0.13	0.08
#5	Muscle	2.2	3.4	0.42	9.4	140	NA	NA	NA
	Bone	2.5	1.7	ND	3.1	43	180	0.07	0.04
	Liver	26	22	ND	7.8	130	1.4	0.03	0.05
Average	Muscle	2.8	5.6	1.9	120	1,500	NA	NA	NA
	Bone	14	5.1	2.7	30	480	1,600	0.02	0.08
	Liver	140	54	2.2	92	1,500	6.3	0.06	0.13
Rock Pile outside Fence									
#1	muscle	ND	0.36	ND	ND	0.07	NA	NA	NA
	Bone	ND	0.29	0.73	ND	0.51	11	ND	ND
	Liver	ND	0.36	ND	ND	0.25	ND	ND	0.005
#2	Muscle	ND	0.06	ND	ND	0.02	NA	NA	NA
	Bone	1.2	0.44	ND	1.9	0.16	1.4	ND	ND
	Liver	ND	0.22	ND	2.7	0.13	ND	ND	ND
#3	Muscle	ND	0.07	ND	ND	ND	NA	NA	NA
	Bone	ND	0.22	0.16	ND	ND	4.9	**	**
	Liver	ND	0.13	ND	0.33	0.15	ND	**	**
#4	Muscle	2.4	**	0.59	ND	9.5	NA	NA	NA
	Bone	ND	0.72	ND	ND	0.19	1.5	ND	ND
	Liver	ND	0.18	ND	ND	0.17	ND	ND	0.02

Table 5-24. Radionuclides Detected in Rabbits Collected
Around the 116-N-Facility, 1981 Concentrations
in pCi/g (wet weight). (2 Sheets)

	Tissue	⁵⁴ Mn	⁶⁰ Co	⁶⁵ Zn	¹³⁴ Cs	¹³⁷ Cs	⁹⁰ Sr	²³⁸ Pu	^{239/240} Pu
Average	Muscle	0.60	0.16	0.15	ND	2.4	NA	NA	NA
	Bone	0.30	0.42	0.22	0.48	0.26	1.6	ND	ND
	Liver	ND	0.22	ND	0.76	0.18	ND	ND	0.008
Radionuclides Detected in Rabbit Feces Collected Around the 1301-N Facility, 1981 Concentration in pCi/g (dry weight).									
		⁵⁴ Mn	⁶⁰ Co	¹³⁴ Cs	¹³⁷ Cs	¹⁴⁴ Ce			
East of Trench		1,300	340	63	740	Not detected			
West of Trench		650	870	19	270	120			

ND = Not Detected

NA = Not Analyzed

**Cross Contamination Suspected.

Source: DOE-RL 1990

Table 5-25. Concentrations of Gamma-Emitting Radionuclides Detected in Deer Mice Collected Around the 116-6-1 Trench, 1981 (pCi/g-wet/wt).

Deer Mouse Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Avg.
51 ^{cr}	ND	74	50	ND	ND	470	ND	12	150	430	210	320	ND	ND	ND	610	ND	81	250
54 ^m	63	240	510	32	90	2,600	18	ND	18	41	630	1,000	15	13	270	4,000	37	360	580
58 ^{co}	12	23	71	ND	ND	250	ND	ND	280	530	1,500	140	ND	ND	380	4,900	75	490	110
59 ^{ra}	130	440	960	110	150	11,000	31	54	480	2,700	2,400	3,300	22	24	380	17,000	190	1,600	2,400
60 ^{co}	260	570	1,700	260	340	460	ND	60	23	69	180	97	ND	ND	1,100	1,800	ND	42	260
95 ^{md}	ND	41	130	ND	20	430	ND	ND	26	83	160	100	ND	ND	ND	1,600	ND	38	260
95 ^{ir}	ND	42	110	ND	25	ND	ND	ND	ND	23	22	20	ND	ND	ND	130	ND	ND	50
103 ^{md}	ND	8.0	8.0	ND	8.0	ND	ND	ND	11	15	ND	51	ND	ND	ND	140	11	27	29
124 ^{so}	58	39	340	390	ND	350	22	8.4	18	25	320	18	9.8	13	24	220	29	19	110
131 ⁱ	8.6	17	75	15	5.9	230	4.8	ND	ND	33	110	120	3.5	7.1	130	200	ND	26	52
134 ^{ca}	78	110	410	190	71	2,300	52	25	94	380	1,200	1,300	33	120	1,700	2,000	110	240	610
137 ^{ca}	84	140	ND	ND	83	84	7.1	2.1	120	ND	820	120	31	ND	26	220	22	29	130
140 ^{la}	ND	130	130	ND	ND	1,600	ND	ND	37	430	220	190	ND	ND	100	3,600	ND	160	590
144 ^{ca}	ND	ND	130	ND	44	ND	ND	ND	100	430	220	190	ND	DN	ND	250	ND	ND	61
154 ^{eu}	ND	5.9	24	ND	ND	11	ND	ND	ND	29	41	31	DN	DN	ND	160	ND	ND	61

ND = Not detected
 In addition to the above, the following radionuclide concentrations were detected: 170 pCi/g of ⁶⁵Zn, 600 pCi/g of ¹⁰⁶Ru, and 5,300 pCi/g of ¹³²I in deer mouse #6; 180 pCi/g of ¹⁰⁶Ru and 18 pCi/g of ¹⁴⁴Ce in deer mouse #10; 21 pCi/g of ¹⁴⁴Ce in deer mouse #11; 56 pCi/g of ⁶⁵Zn in deer mouse #12; and 220 pCi/g of ⁶⁵Zn, 1,200 pCi/g of ¹⁰⁶Ru, and 69 pCi/g of ¹⁴⁴Ce in deer mouse #16.
 Source: DOE-RL 1990

Table 5-26. Deer Mice Collected at N Springs, 1982
(pCi/g-wet wt.).

Deer Mouse Number	⁵⁴ Mn	⁶⁰ Co	¹³⁷ Cs	¹⁵⁵ Eu
1	ND	2.1	ND	ND
2	ND	2.6	ND	0.59
3	ND	2.9	ND	ND
4	0.78	8.1	ND	ND
5	ND	1.0	1.5	ND
6	ND	2.4	0.55	1.2
7	ND	3.0	ND	ND
8	ND	1.4	ND	1.4
9	ND	0.35	ND	ND
10	ND	4.6	0.39	1.5
11	ND	3.5	ND	ND
12	3.7	14	ND	ND

ND = Not Detected

Source: DOE-RL 1990

Table 5-27. Whole Body Radionuclide Concentrations (nCi/g, wet wt.)
Detected in Deer Mice Collected Near the 1301-N LWDF.

Trap #	Weight (g)	Sex	⁵¹ Cr	⁵⁴ Mn	⁵⁸ Co	⁵⁹ Fe	⁶⁰ Co	⁹⁵ Zr/Nb	¹³¹ I	¹³⁷ Cs	¹⁴¹ Ce	¹⁴⁴ Ce
1	20.3	M	0.82	3.3	0.25	3.1	7.1	1.1	0.29	2.5	0.035	0.49
6	16.3	M	0.68	1.7	0.23	2.1	5.7	0.64	0.16	0.70	0.044	0.35
9	19.8	F	0.98	3.5	0.35	3.3	11	1.1	0.17	0.37	0.040	0.42
10	16.1	F	0.053	0.22	0.021	0.30	0.74	0.077	0.054	0.18	<u>0.0028</u>	<u>0.046</u>
11	15.8	F	0.77	2.5	0.34	2.6	9.7	0.80	<u>0.31</u>	0.35	0.058	0.50
12	21.7	M	0.23	0.47	0.075	0.65	1.7	0.18	0.047	0.24	0.014	0.073
14	18.2	F	0.26	0.95	0.081	0.75	2.6	0.52	0.19	0.23	0.037	0.29
25	19.6	M	<0.014	<0.0019	<0.0017	<0.0029	<u>0.0083</u>	<0.0047	<0.0026	<u>0.0022</u>	ND	<0.0097
30	20.1	M	<0.021	0.041	<u>0.0045</u>	0.059	0.098	<u>0.012</u>	<u>0.028</u>	0.10	<0.0025	<0.011
39	16.2	F	<u>0.019</u>	0.10	0.011	0.11	0.24	0.019	0.037	0.053	<0.0041	<0.017
40	17.4	F	1.2	4.1	0.48	4.3	15	1.4	0.20	0.97	0.15	0.86
42	14.0	F	<u>2.7</u>	<u>12</u>	<u>0.99</u>	<u>13</u>	<u>36</u>	3.6	0.25	1.0	0.30	<u>1.7</u>
44	19.3	M	0.59	2.0	0.20	2.5	4	0.93	0.039	0.045	0.064	0.30
45	14.4	F	<.026	<u>0.016</u>	<0.0039	<u>0.013</u>	0.081	<0.0097	<0.0048	0.017	<0.0033	<0.015
47	17.7	F	0.93	4.5	0.30	4.7	11	1.6	0.23	2.7	0.049	0.56
<u>50</u>	<u>15.2</u>	<u>M</u>	2.0	9.1	0.76	11	23	<u>5.3</u>	0.23	0.76	0.29	1.6
Average	17.6		0.86	3.0	0.29	3.2	8.0	1.2	0.16	0.64	0.090	0.60
S.D.	±2.3		±0.77	±3.5	±0.29	±3.9	±9.9	±1.5	±0.10	±0.83	±0.10	±0.54

SD = Standard Deviation

ND = Not Detected.

Underline values indicate the range (high and low value) for each radionuclide.

Source: DOE-RL 1990

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6.0 N REACTOR CLOSURE SCOPE

The N Reactor closure scope is divided into the following work elements, each with its own criteria and/or cleanup performance levels:

- N Reactor deactivation
- RCRA closures
- Site remediation
- D&D.

6.1 N REACTOR DEACTIVATION

According to the *N Reactor Deactivation Program Plan*, WHC-SP-0615 (WHC 1992a), deactivation includes activities to:

- Deactivate the facility in a manner that will require only minimal S&M until final D&D
- Stabilize the facility to preclude any inadvertent environmental releases.

Accomplishment of N Reactor deactivation will entail the following activities (A through E):

- A. Document the remaining industrial safety, radiological safety, and environmental hazards of the facility.
 - Prepare the final radiological/hazardous materials survey records, final configuration and S&M requirements, and identify available drawings, specifications, procedures, manuals, and unplanned occurrence records applicable to the facility.
 - Prepare all available data and reports that describe N Reactor conditions, nature, and extent of contamination. Also, identify any known assessment requirements.
 - Prepare or update a S&M plan or monitoring plan, including a cost estimate, consistent with the final condition of the facility at turnover.
- B. Place structures at the facility in a safe condition in compliance with regulatory requirements.
 - Maintain structures and existing radiation surveillance systems in a physical condition adequate to contain and detect potential release of any radioactive contamination, in accordance with DOE Order 5400.1, *General Environmental Protection Program* (DOE 1988). Conduct a radiation contamination/hazardous materials survey of the facility and surrounding areas.
 - Maintain security systems and procedures adequate to prevent unauthorized entry to any structures at the facility.

- Remove all SNM, reactor fuels, high-level waste, contaminated liquid wastes, and hazardous chemicals or materials/wastes that are stored at the facility. The most significant activity in this category is the removal from N Basin of 90,700 kg (200,000 lb) of radiologically contaminated hardware and over 3,785,000 L (1,000,000 gal) of radiologically contaminated water currently being used for shielding.
- C. Assess the compliance of the facility with respect to environmental, health, and safety regulatory requirements.
- Assess facility for compliance with Occupational Safety and Health Administration (OSHA), RCRA, and *Toxic Substances Control Act of 1976* (TSCA) requirements and other applicable environmental regulatory requirements.
- D. Ensure that any structures at the facility and their required systems are structurally sound to permit deferred final decommissioning of these structures (develop a S&M plan to ensure facility and environmental safety pending initiation of decommissioning activities).
- E. Satisfy specific environmental regulatory requirements.
- Replace the 1325-N LWDF with a waste water treatment system satisfying best available technology (BAT) requirements by 1995 and treat waste water at the Liquid Effluent Treatment Facility in the 200 Area with subsequent disposal of the treated effluent to a soil column disposal site. Alternatively, this waste water may be treated at N Reactor with discharge of the treated effluent to the Columbia River through an NPDES permitted outfall.
 - Prepare environmental documentation and secure approvals as necessary (e.g., NEPA and notification to Washington State Department of Health (WDOH) concerning air emissions)
 - Upgrade effluent surveillance systems commensurate with the DOE Regulatory Guide, DOE/EH-0173T (DOE 1991).

The criteria governing this work are discussed further in Section 9.0. The major N Reactor deactivation activities are summarized in Table 6-1.

6.2 RESOURCE CONSERVATION AND RECOVERY ACT CLOSURES

There are four RCRA facilities at 100-N (see Section 3.0):

- 1301-N LWDF (Mixed Waste)
- 1325-N LWDF (Mixed Waste)
- 1324-N Surface Impoundment (Hazardous Waste)
- 1324-NA Percolation Pond (Hazardous Waste).

Figure 6-1 is a flowchart of the RCRA closure process. The RCRA closure work element consists of satisfying Ecology's "Dangerous Waste Regulations" (WAC 173-303), which require submitting a RCRA closure plan for each facility

and maintaining a groundwater monitoring program until closure is complete. The individual RCRA closure plans are required to contain a description of the site characterization process through sampling and analysis of soils and groundwater.

Draft closure plans for the four RCRA facilities were submitted to Ecology in 1987 and are scheduled to be revised and resubmitted in 1994 in accordance with the Tri-Party Agreement (DOE-RL 1991).

Groundwater monitoring began at the four RCRA sites in December 1987 using at least one upgradient and two downgradient wells (see Color Illustration 2-2). This monitoring is based on requirements for interim-status facilities, as defined by the RCRA and amended by the *Hazardous and Solid Waste Amendments of 1984* (HSWA). These regulations are promulgated by the EPA in 40 CFR 265, Subpart F, as implemented by Ecology in WAC 173-303-400. Only at the 1324-N and 1324-NA facilities is there a significant statistical difference between upgradient and downgradient wells. Because of this difference, an assessment monitoring program has begun that will investigate the cause of the elevated total organic halogen and total organic carbon in downgradient wells, as required by 40 CFR 265.93 (D) (5).

The scope of work is to be integrated with other cleanup programs in accordance with the Tri-Party Agreement (Ecology et al. 1992); see Section 6.3. The strategy being used in the RCRA closure process is adopted from the Tri-Party Agreement, which allows for a land disposal unit being closed in conjunction with an operable unit. If initial investigation shows that the unit no longer contains hazardous waste or constituents, the unit may be "clean closed" with no physical closure action. Any remaining CERCLA-only materials (radionuclides) would be addressed as part of the past-practice process as designated for the operable unit.

6.3 SITE REMEDIATION

Remediation of the 100-N site entails the cleanup of past spills and releases to the soil and groundwater. Remediation of these waste management units is discussed in the scope of the Tri-Party Agreement (DOE-RL 1991). The Tri-Party Agreement designates the 100-N Area as a RPP site pursuant to HSWA, which addresses releases of RCRA facilities regardless of time of release.

These units include various types of liquid waste disposal sites, underground tanks, and unplanned release sites. The wastes disposed of in these units include nonhazardous solid, hazardous radioactive, and mixed waste. Section 7.0 describes these waste units in more detail. To comply with CERCLA regulations, the four aggregate areas (100, 200, 300, and 1100) were divided into 78 operable units. Two of these units are located at N Reactor (Figure 6-2).

- 100-NR-1 Source Operable Unit
- 100-NR-2 Groundwater Operable Unit.

The Tri-Party Agreement requires that the cleanup programs at the N Reactor integrate the requirements of CERCLA, RCRA, and Washington State's dangerous waste program (the State's RCRA equivalent) (Ecology et al. 1992).

The EPA maintains authority for CERCLA, and Ecology implements RCRA under the authority of the State's dangerous waste program. The State has also received authorization to implement the EPA's radioactive mixed waste program. The State does not yet have authority to implement HSWA, the most recent amendments to RCRA; EPA retains this authority. Corrective action at N Reactor is also subject to the Washington State *Model Toxics Control Act* (MTCA) [Chapter 70.105D, Revised Code of Washington (RCW)]. Pursuant to the Tri-Party Agreement, the 100-NR-1 and 100 NR-2 source operable units are subject to RCRA corrective action authority. The EPA and Ecology have determined that the EPA guidance for conducting a remedial investigation/feasibility study (RI/FS) under CERCLA may be used at the N Reactor in the performance of a RFI/CMS. Therefore, although RCRA terminology has been used where appropriate, the content and format of the 100-NR-1 and 100-NR-2 operable units conform to EPA guidance for CERCLA activities.

Cleanup of N Reactor past-practice units will be conducted pursuant to the RPP process. Figure 6-3 highlights the major steps involved in both the CERCLA Past Practice (CPP) and RPP programs and indicates how each of these steps corresponds with the other (i.e., the steps of the RPP program are functionally equivalent to steps in the CPP program).

Before the investigative process starts, an operable unit scoping activity will be used to support the initial planning phase for each operable unit's RFI/CMS. Such activity and planning result in an overall management strategy for each of the N Reactor operable units. The DOE assembled and evaluated existing data and information about the individual waste management units and release sites within each operable unit. This scoping activity was not intended to be a mechanism for generating new information, but a thorough and complete evaluation of existing data. If during the scoping activity, a situation is determined by Ecology to present an imminent and substantial danger to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance or waste at an operable unit, the lead regulatory agency may require DOE to immediately initiate activities to abate the danger or threat. RCRA includes provisions to quickly respond to such situations. DOE is currently preparing a work plan for initiating an ERA. Operable unit work plans have already been prepared for the 100-NR-1 and -2 operable units and were transmitted to EPA and Ecology for approval (DOE-RL 1990 and DOE-RL 1991). Following the RFI/CMS the lead regulatory agency (i.e., Ecology) will issue a ROD, designating what cleanup actions are required.

The EPA is implementing a nationwide program to facilitate response actions at NPL sites through the expedited response actions (ERA-2) process. The purpose of the ERA is to accomplish rapid cleanup by streamlining the RI/FS process for operable units or sites where the most effective mitigation effort is readily evident. The release of ⁹⁰Sr to the Columbia River along an area of N Reactor's shoreline termed N-Springs is a candidate ERA proposed by both EPA and Ecology.

Color Illustrations 6-1 and 6-2 present three-dimensional computerized representations of past and predicted groundwater ⁹⁰Sr concentration levels that have been and could be released to the Columbia River.

6.4 DECONTAMINATION AND DECOMMISSIONING

The purpose of D&D is to isolate any remaining radioactive or hazardous waste to minimize environmental impact, especially potential health and safety impacts, on the public. These activities can be accomplished through several actions:

- Ongoing S&M of the facility
- Dismantling and burial at another Hanford site
- Dismantling and burial at 100-N.

The scope of work for purposes of this Closure Report is assumed to be the dismantling of all 100-N facilities and burial at another Hanford site. This assumption is based on the Hanford Site EIS *Decommissioning of Eight Surplus Production Reactors at the Hanford Site* (DOE/EIS 1993). The actual means of decommissioning the reactor and other facilities at the 100-N site will depend on future engineering studies and the NEPA process, which will evaluate alternative actions and will be followed by a ROD.

It is estimated that dismantling and burial of N Reactor will involve more than 9,500 m³ (111,000 yd³) of concrete and 9,900 metric tons (11,000 tons) of structural steel.

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Color Illustration 6-1. Strontium-90 Concentrations for 1990.

Color Illustration 6-2. Projected Strontium-90 Concentrations for 2020.

Figure 6-1. RCRA Closures.

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Figure 6-2. Operable Unit Designations.

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Figure 6-3. Comparison of Resource Conservation and Recovery Act Corrective Action and Comprehensive Environmental Response, Compensation, and Liability Act Remedial Processes.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act

RCRA = Resource conservation and Recovery Act

Note: Interim remedial actions or interim measures can be performed at any point in the remedial/corrective action process.

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Table 6-1. Summary of Major N Reactor Deactivation Activities. (2 Sheets)

Generic Activities for all Facilities
<ol style="list-style-type: none"> 1. Repair any roof leaks and/or deteriorated roof panels. 2. Remove all spare parts/tools/equipment. 3. Remove all unattached hazardous materials. 4. Remove or stabilize loose and/or damaged asbestos. 5. Conduct final radiological status surveys. 6. Drain all tanks, vessels, drums, etc., and characterize for radionuclides and hazardous materials according to applicable Federal and State regulations. 7. Drain elevator systems after they are in their respective bottom position and documented to the type, weight, and class of fluid required to obtain operational status in the event it is desirable for future use. 8. Reduce electrical and water supply services to that which may be required for surveillance and maintenance. 9. Ensure that zero energy checks were made on all de-energized electrical circuits. 10. Where appropriate, centralize the electrical services left for S&M to one location. 11. Shut down all air supply and exhaust air systems. 12. Remove all special nuclear material; reactor fuel; high-level waste; contaminated liquids, hazardous chemicals, materials, or wastes; and the combination of hazardous radioactive materials stored at the facility. 13. Reduce surface contamination levels to minimize resuspension and/or migration of loose contamination for all permanent radiation zones outside of 105-N/109-N Zone I (innermost radiation zone around reactor core). 14. Isolate all effluent flow routes to disposal sites by sealing or valving off at the facility and the outlet end of the pipe screened. 15. Seal drains that fed N Reactor NPDES permitted outfall structures and/or valved off to each facility and screen at the outlet for vermin control. 16. Seal all building penetrations (i.e., louvers and open piping) to prevent bird and animal intrusion. 17. Secure all doors by bolting shut from the inside except those required for entrance by S&M. 18. Dispose of over 500 truckloads of assets, such as nonhazardous salvageable material and equipment and office equipment.

Table 6-1. Summary of Major N Reactor Deactivation Activities. (2 Sheets)

Specific Activities - 105-N Reactor Building (Excluding N Basin)	
1.	Position all control and safety rods in a full-in position and drain their drive and cooling systems.
2.	Provide objective evidence to show that all locations where fuel elements were handled, used, and stored were thoroughly examined (i.e., reactor core, fuel charge/discharge area, charged monotubes, fuel storage basin handling and shipping areas). Also included in this effort is providing documented evidence that the underground dummy storage silos are empty and do not contain any fuel elements.
3.	Provide objective evidence that all irradiated lithium slugs have been removed from the building, including any that may have been in the horizontal control rods.
4.	Seal the normal exhaust of 105-N/109-N Zone I through the 117-N filters and the 116-N stack.
5.	Install an intrusion alarm on all doors of the 105-N building that are not secured (bolted shut) from the inside.
6.	Install a waste water treatment system to process N Reactor radiologically contaminated effluent before it is discharged to the Columbia River.
7.	Remove and dispose of spacers used to space fuel elements in the reactor core from three 5.1-m-dia. by 6-m-deep (17-ft-dia. by 20-ft-deep) underground and shielded silos.
Specific Activities - N Reactor Fuel Storage Basins	
1.	Remove all hardware and debris (approximately 154 m ³ [5,400 ft ³]).
2.	Characterize and remove sediment (approximately 2 m ³ [154 ft ³]).
3.	Remove basin water (approximately 4.5 ML [1.2 M gal]).
4.	Stabilize basin surfaces to ensure that no resuspension of contaminants occurs.
5.	Ensure no special nuclear material pieces remain.

7.0 PROPOSED CLEANUP SCHEDULE

The N Reactor cleanup schedule has been prepared with consideration to regulatory-driven milestones, which are contained in either the Tri-Party Agreement, the Liquid Effluent Consent Order, or individual lower-tier documents (e.g., RCRA closure plans). Additional related milestones have been proposed in the 100-N Area Operable Unit Work Plans but have not yet been agreed to by the three parties. The applicable milestones for N Reactor and the 100-N site are listed in Table 7-1.

The N Reactor Deactivation Program schedule is shown in Figure 7-1 (WHC 1992). The schedule for site remediation and the D&D is shown in Figure 7-2 (DOE-RL 1992).

DOE/RL 91-59

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Figure 7-1. N Reactor Deactivation Program Schedule.
(Sheet 1 of 3)

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Figure 7-1. N Reactor Deactivation Program Schedule.
(Sheet 2 of 3)

29401033.2

Figure 7-1. N Reactor Deactivation Program Schedule.
(Sheet 3 of 3)

100N Facility Deactivation List	
11N = Change Room	1112NB = Badge House (SEA) Temporary
13N = Storage Building	* 1300N = Emergency Dump Basin
104N = Metal Storage Building	* 1303N = Spacer Burial Silos
* 105N = Reactor Facility	* 1304N = Emergency Dump Tank
105NA = Emergency Diesel Building	1310N = Chemical Waste Storage Facility
105NB = Mechanical Shop Addition	1313N = Change and Control Building
107N = Recirculation Cooling Building	* 1314N = Liquid Waste Loadout Station
108N = Chemical Unloading Facility	1315N = Effluent Diversion System Valve House
109N = Heat Exchange Building	1316N = Valve House
109NA = Steam & Flow Instrument Building	1316NA = Valve Vault Building
109NB = Hydro Power Unit Building	1316NB = Valve House Annex
117NVH = Valve Control House	1316NC = Valve House Annex
153N = Switchgear Building	1322N = Waste Treatment Pilot Plant Facility
163N = Demineralization Plant Building	1322NA = Effluent Water Pilot Plant Facility
163NA = Waste Pad	1322NB = Crib Effluent Iodine Monitoring Facility
166N = Fuel Oil Storage Tank Pump House	1322NC = Sample Pit
181N = River Water Pump House	1327N = Valve Vault
181NA = Pump House Guard Tower	1705N = Instrument & Electrical Facility
181NB = No. 3 Diesel Enclosure	1705NA = Motor Shop
182N = High Lift Pump House Building	1706N = Storage Building
183N = Water Filter Plant Building	1707N = Patrol Boat House
183NB = Clear Well Overflow	1712N = Insulation Shop & Storage Building
183NC = Filter Back Wash Sump	1714N = Stores
183N POND = Filter Back Wash Pond	1714NA = Receiving/Inspection Facility
184N = Plant Services Boiler House	1714NB = Tool Storage Shed
184NA = Auxiliary Power Annex Building	1715N = Oil Storage Tanks
184NB = Air Handler Main Building	1722N = Decontamination Hot Shop Building
184NC = Air Handler Annex Building	1723N/NX = Warehouse & Laydown Storage Yard
184ND = Oil Day Tanks	1734N = Gas Bottle Storage Building
185N = Turbine Generator Building (HGP) (Contamination Only)	1802NE = Piping Trestle
1102N = Office Building	1900N = Water Supply Tanks
1112N = Guard Station	1908N = Seal Well (Outfall)

Remain in Service	
116N = Air Stack	
117N = Air Filter Building Confinement	
119N = Air Sampling Monitor	
119NA = Air Sampling Monitor Annex	
151N = 230 KV Electrical Substation	
1112NA = Microwave Tower Annex	
1120N = Storage & Training Facility	
1143N = Carpenter Shop	
1702N = Vehicle Inspection Building	
1904N = New Sewage Lagoon	
1904N/NB/NC = Sewage Lift Stations No. 1, 2, 3	

Ready for D&D	
128N = 100N Burning Pit	
1100N = Office Facility - D&D in Process	
1101N = Office Building - D&D in Process	
1312N = Liquid Effluent Retention Facility	
1706NA = Old Sewer Lift Station	
1903N = Old Septic System	

Excluded Facilities	
MO's = 100N Mobile Offices	
155N = BPA Switchyard	
181NE = River Pump House (HGP)	
1515N = Fixed Metal Shop (KEH)	
1516N = Fixed Metal Shop (KEH)	
1517N = Fixed Metal Paint Shop (KEH)	
1518N = Fixed Metal Electrical Shop (KEH)	
1519N = Fixed Metal Filters Shop (KEH)	
1524N = Hazardous Waste Pad (KEH)	
1525N = Laydown Storage Area (KEH)	
1526N = Gas Bottle Storage Area (KEH)	
1701NE = Badge House (HGP)	
1703N = Washington Public Power Supply System Building (HGP)	
1716NE = Maintenance Shop (HGP)	
1908NE = Seal Well (HGP)	

RCRA Sites	
1301N = Soil Column	
1324N = Surface Impoundment	
1324NA = Percolation Pond	
1325N = Soil Column	

Legend	
*	= Operable Unit High Priority Waste Site
BPA	= Bonneville Power Administration
D&D	= Decontamination & Decommissioning
KEH	= Kaiser Engineers Hanford
RCRA	= Resource Conservation Recovery Act
SEA	= Security Entrance Authorization

29401033.3

Figure 7-2. Site Remediation and Decommissioning Schedule.

(proposed)

* = Dates have not been agreed to by the three parties and are only proposed at this time.

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Milestone No.	Milestone Description	Milestone Date
M-20-35	Submit 1301-N LWDF closure plan Submit 1325-N LWDF closure plan	May 1994
M-20-31	Submit 1324-N-NA Surface Impoundment/Percolation Pond closure plan	September 1994
OPERABLE UNIT REMEDIATION		
M-12-12	Submit 100-NR-1 Operable Unit Work Plan	December 1990c*
M-12-14	Submit 100-NR-2 Operable Unit Work Plan	December 1990c*
M-15-00	Complete RFI/CMS process for all operable units	September 2005
M-16-00	Complete the remedial actions for all operable units	September 2016
LIQUID EFFLUENTS		
	Limit discharges to 1325-N to less than 2 gpm	April 1991c
	Develop a plan to reroute N Reactor effluent after treatment by BAT to river	January 1992c
	Submit 216 Application for 100-N Sanitary Waste Disposal Facility and 183-N Filter Backwash	June 1994
100-N REGULATORY DRIVEN MILESTONES		
M-17-00	Complete liquid effluent treatment facilities for all Phase I streams	June 1995
M-17-10c	Cease all discharges to hazardous land disposal units unless such units have been clean closed in accordance with RCRA	June 1995c
M-17-15a	Limit discharges to 1325-N to less than 2 gpm	April 1991c
M-17-15b	Submit N Reactor BAT/ACART evaluation	January 1992c
M-17-15c	Submit plan to cease discharge to 1325-N	January 1992c
M-17-15d	Submit NPDES permit modification	June 1992c

*Newer versions have been submitted.

C = complete.

Table 7-1. RCRA Facility Closure Schedule.

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8.0 ESTIMATED COST FOR CLOSURE

The estimated cost for ER and other remediation and cleanup efforts at the facility are divided into the following work breakdown structure (see Figure 8-1).

- N Reactor deactivation
- RCRA facility closures
- RPP site remediation
- D&D.

The level of confidence behind these cost estimates is commensurate with the engineering and planning currently available. Cost estimates for near-term activities have more detailed planning as a basis than outyear activities (e.g., site remediation and D&D).

A significant reduction to the estimated deactivation costs is expected to be realized. The effort to revise the cost estimate is ongoing because the deactivation program is refined and optimized based on the outcome of value engineering analyses and other planning activities that are currently being performed (see Table 8-1).

8.1 N REACTOR DEACTIVATION

Table 8-1 summarizes the estimated cost for the N Reactor deactivation tasks planned between fiscal year 1992 through fiscal year 1997. A detailed description of the tasks and estimated cost are contained in the *N Reactor Deactivation Program Plan* (WHC 1992a).

8.2 RCRA FACILITY CLOSURE

Table 8-2 summarizes the estimated cost for RCRA closure of the 1301-N LWDF, the 1325-N LWDF, the 1324-N surface impoundment, and the 1324-NA percolation pond as hazardous waste treatment, storage, and disposal facilities (TSDF), pursuant to Washington State "Dangerous Waste Regulations" (WAC 173-300) and the Tri-Party Agreement. If initial investigation shows that the unit no longer contains hazardous waste or constituents, the unit may be clean-closed with no physical closure action. Any remaining materials (radionuclides) would be addressed as part of the past-practices process as designated for an operable unit. The estimated cost for those RCRA closures includes activities such as preparing RCRA closure plans, responding to regulatory comments during the review and approval cycle, and site characterization for determining the absence of hazardous waste to support clean closure under RCRA. This estimate does not include any remedial action, post-closure monitoring, or groundwater monitoring costs.

8.3 RCRA PAST PRACTICE SITE REMEDIATION

Table 8-3 presents the estimated cost for remediation of the 100-NR-1 and 100-NR-2 operable work units, which includes the remedial action and post-closure monitoring at the 1301-N LWDF, 1325-N LWDF, 1324-N surface impoundment, and 1324-NA percolation pond (i.e., the RPP facilities at 100 N). Cost estimates for remediation of the RPP sites were developed by the U.S. Corps of Engineers. Estimates assumed complete removal of all contaminated soils and are based on preliminary volume and contaminant data from CPP and RPP sites. These sites include radiologically and chemically contaminated soils from cribs, trenches, ditches, spills, and leaks from past operations. Wastes are assumed to be removed to a disposal facility near the Hanford Site 200 Area. Assessment and remediation costs represent the total estimated costs for site remediation. Estimates for remediation are very preliminary and will be adjusted as more specific data is received to narrow the input parameters to the estimate model.

8.4 DECONTAMINATION AND DECOMMISSIONING

Table 8-4 presents the estimated cost for D&D based on the premise that the N Reactor and all ancillary buildings will be demolished. Figure 8-2 is the cost breakdown for the 105N and 109N buildings. The cost, which is 89 percent of the total D&D effort, has been broken into elements to illustrate the impact of radioactive and hazardous waste disposal on the demolition of these structures.

The cost of removing the reactor core is based on dismantling it and transporting it to the burial site in pieces. This method is described in *Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington* (DOE/EIS 1993).

An alternative method is to move the reactor core in one piece, which is also described in the DOE environmental impact statement (EIS) (1993) and which is the preferred transport method for the eight deactivated reactors at the Hanford Site. However, because the N Reactor sits on a pedestal and the thermal and radiation shielding are not integrated into the core structure, the preferred option may not be feasible.

Figure 8-1. N Reactor Closure Costs.

Costs are in millions of dollars

* = not escalated

29304014.4

Figure 8-2. 105N and 109N Decontamination and Decommissioning.

Costs are in million of dollars

29304014.3

Table 8-1. N Reactor Deactivation Cost Estimate Summary
for Tasks Planned Between FY 1992 and FY 1999.

Title	Subtotals (\$M)	Totals (\$M)
PROGRAM MANAGEMENT		\$7.9
SHUTDOWN EXECUTION AND PLANNING		218.8
Continuity of Operations	93.7	
Waste Handling	12.8	
Waste Disposal	34.7	
Asset Disposal	8.7	
Facility Shutdown Execution	23.8	
Basin Hardware Cleanup	40.2	
N Reactor Patrol Assessment	3.8	
N Reactor SAS	1.1	
REGULATORY RESPONSE		41.7
TOTAL		268.4

Table 8-2. 100-N Area RCRA Facility Closure Cost Estimate Summary.

Facility	Cost (\$M)
1301-N Liquid Waste Disposal Facility	5
1325-N Liquid Waste Disposal Facility	4
1324-N/NA Surface Impoundment/ Percolation Pond	3

Table 8-3. N Reactor RCRA Past Practice Site Remediation.

Activity	Cost (\$M)
100-N Operable Unit Assessment	14,600
100-N Operable Unit Remediation	585,500
Total	600,100

Table 8-4. N Reactor Decontamination and Decommissioning
Cost Estimate Summary. (2 sheets)

105-N Reactor	\$445,600,000
Asbestos Removal	2,119,000
107-N Basin Waste Recirculation Facility	20,500,000
108-N Chemical Pumping Facility	639,000
109-N Heat Exchanger Building	196,000,000
109-NA Steam Flow Instrument Building	18,000
109-NB HU building (Hydraulic Power Unit)	25,000
1100 Building	500,000
1101-N Administrative Office	1,396,000
1102-N Administrative and Training Facilities	158,000
1112-N Badge House	241,000
1120-N Administrative Training Building	250,000
1143-N Carpenter Painters Maintenance Shop	289,000
116-N Stack Explosive Demolition	210,000
117-N Filter Building	3,726,000
117-NVH Valve Control House	17,000
1303-N Fuel Spacers Silos (3)	9,710,000
1304-N Dump Tank	5,400,000
1310-N Liquid Waste Storage Tank	6,716,000
1310-N Chemical Waste Storage Building	357,000
1313-N Change and Control Building	247,000
1314-N Liquid Waste Loadout	1,294,000
1315-N Effluent Valve Housing	265,000
1316-N Valve Housing	77,000
1316-NA Valve Vault Building	77,000
1316-NB Magnetic Flow Meter	77,000
1322-N Waste Treatment Pilot Plant	543,000
1322-NA Effluent Water Pilot Annex	331,000
1322-NB Crib Effluent Iodine Sample Building	330,000
1322-NC Crib Sample Pump Pit	201,000

Table 8-4. N Reactor Decontamination and Decommissioning
Cost Estimate Summary. (2 sheets)

151-N Area Electrical Switchgear Building	183,000
153-N Area Electrical Switchgear Building	497,000
163-N Demineralization Plant	861,000
166-N Fuel Oil Storage Pumphouse	132,000
1705-N Instrument and Electrical Facility	152,000
1705-NA Motor Shop	194,000
1707-N Boat House and Boat Launching Facility	105,000
1712-N Mechanical Maintenance Insulation Shop	85,000
1714-N Warehouse for Small Tools and Parts	144,000
1714-NA Receiving and Inspection Building	75,000
1714-NB Tool Storage and Ground Maintenance Building	136,000
1722-N Decon - Hotshop Repair Radioactive Parts and Equipment	671,000
1723-N Shipping and Receiving	230,000
1734-N Gas Bottle Storage Building	114,000
181-N River Pump House	687,000
182-N High Lift	2,678,000
183-N Water Filter Plant	735,000
184-N Plant Service Power Building	3,211,000
184-NA Auxiliary Power Annex	388,000
184-NB Air Handler	351,000
1900-N Steamline and Pipe Trestle	7,304,000
1908-N Outfalls	6,063,000
Total	\$722,309,000

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9.0 REGULATORY AND U.S. DEPARTMENT OF ENERGY ORDER COMPLIANCE

This section identifies requirements considered applicable or relevant to the closure of N Reactor and its support facilities. In preparing supporting documents for RCRA and CERCLA activities (e.g., the Hanford Site operable unit work plans [DOE-RL 1990 and 1991]), while ARAR is a term normally associated with environmental remediation documentation, it will be used inclusively for all regulatory and DOE Order requirements associated with the N Reactor closure. The potential ARARs are based on current State and Federal regulations, DOE Orders, and U.S. Nuclear Regulatory Commission (NRC) regulatory guides, NUREGS, and other compliance documents, such as the Tri-Party Agreement and the Liquid Effluent Consent Order.

The identification of potential ARARs will be reassessed during the operable unit RFI/CMS process. As data and information regarding site characterization, future land use, and remedial alternatives become available, the process of identifying potential ARARs will continue.

Tables 9-1 through 9-4 list potential ARARs based on whether they are contaminant-specific (Table 9-1), action-specific (Table 9-2), location-specific (Table 9-3), or pertain to D&D (Table 9-4). The tables are organized by codes to describe both the type of requirement and to what part of the N Reactor closure scope they apply.

The first code grouping, ARAR code, defines the potential ARAR in one of four categories of requirements:

ARAR CODES

1. Applicable promulgated regulation
2. Relevant and appropriate promulgated regulation
3. Applicable nonpromulgated requirement (e.g., DOE Orders, Secretary of Energy Directives)
4. Relevant and appropriate nonpromulgated requirement (e.g., NRC Regulatory Guides)

The second code grouping, scope code, defines the part of the N Reactor closure scope to which the potential ARAR applies. Within the scope code grouping are the following categories:

SCOPE CODES

1. N Reactor deactivation activities
2. RCRA closure activities related to specific treatment and disposal facilities
3. RPP site remediation activities related to past spills and releases to the soil and groundwater
4. D&D activities related to the dismantling of N Reactor.

The tables contain additional information including the number and title of the regulation or requirement (Citation), a summary description of the scope and content of the citation (Requirement), specific or unique requirements that would affect the N Reactor closure (Comment), and applicable actions that must be taken to satisfy the regulation (Resolution).

Table 9-1. Potential Contaminant-Specific ARARs. (4 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
1	Environmental Protection Agency Rules for controlling Polychlorinated Biphenyls under the Toxic Substances Control Act (40 CFR 761)	1 or 2	These regulations control the manufacture, processing, storage, disposal, and cleanup of PCBs present in quantity greater than 50 ppm.	Applicable for spills that occurred on or after May 4, 1987. Relevant and appropriate for spills that occurred prior to May 4, 1987.	If sampling indicates the presence of PCBs in excess of 50 ppm, and the spill pre-dates May 4, 1987, these regulations provide guidance for the cleanup and disposal of PCB-contaminated material. If the spill post-dates May 4, 1987, these regulations are applicable to any cleanup and disposal activities.	2 3
2	Nuclear Regulatory Commission Standards for Protection Against Radiation (10 CFR 20)	1	These regulations apply to activities licensed by the Nuclear Regulatory Commission and specify radiation dose standards for individuals in restricted and unrestricted areas. (See Table 2 for emission concentration limits.)	Relevant and appropriate standards for the emission of specific radionuclides.	Managing remediation activities in a manner to ensure emission standards are not exceeded. Monitoring remediation activities in a manner to verify emission standards are not exceeded.	1 2 3 4
3	Resource Conservation and Recovery Act of 1976 (42 USC 6901), Subtitle C Requirements (40 CFR 260-270 and 280)	1 or 2	Governing standards for owners and operators of hazardous waste treatment, storage, and disposal facilities, and for generators and transporters of hazardous wastes.	Applicable to any RCRA-designated hazardous waste (and the hazardous components of mixed waste) generated, transported, treated, stored, or disposed of as a result of remedial actions. Specific provisions also would be applicable to any treatment, storage, or disposal facilities (TSDFs) located in the 100 Areas.		1 2 3 4

Table 9-1. Potential Contaminant-Specific ARARs. (4 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
3 (cont)	Groundwater Protection Standards (40 CFR 264.94) Alternate Concentration Limits (ACLs)	1 or 2	<p>ACLs may be used to establish standards for the cleanup of groundwater under the following conditions:</p> <p>1. There are known and projected points of entry of such groundwater into surface water.</p> <p>2. On the basis of measurements or projections, there is or will be no statistically significant increase of such constituents from such groundwater in such surface water at the point of entry or at any point where there is reason to believe accumulation of constituents may occur downstream.</p> <p>3. The remedial action includes enforceable measures that will preclude human exposure to the contaminated groundwater at any point between the facility boundary and all known and projected points of entry into surface water.</p>	ACLs are applicable to existing RCRA-regulated operating units, and may be relevant and appropriate for non-RCRA sources of groundwater contamination in accordance with CERCLA 121 (d)(2)(B)(ii)	Treatment or stabilization (where applicable) of RCRA wastes before landfill disposal.	1 2 3 4
3 (cont)	Land Disposal Restrictions (40 CFR 268)	1	<p>Regulations contain specific provisions for restricting the land disposal of RCRA hazardous wastes. Listed wastes (defined in Subpart D CFR 261) and materials with the following codes:</p> <p>F waste code (Part 261.31), K waste code (Part 261.32), P waste code (Part 261.33(e)), U waste code (Part 261.33(f)).</p> <p>Or, the presence of a waste exhibiting one or more of the following characteristics, as defined in 40 CFR 261: ignitability, corrosivity, reactivity, Extraction Procedure (EP)</p>	The regulations are applicable for intrusive investigation actions and remedial actions requiring the disposal of a listed RCRA waste.		1 2 3 4

Table 9-1. Potential Contaminant-Specific ARARs. (4 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
4	Safe Drinking Water Act (42 U.S.C. (F)) and the regulations issued pursuant to the act in 40 CFR 141.11 Subpart B and 40 CFR 143.3; Maximum Contaminant Levels (MCLs); Maximum Contaminant Level Goals (MCLGs)	1 or 2	MCLs are applicable at the tap where the water will be provided directly to 25 or more people or will be supplied to 15 or more service connections. Otherwise, where surface water or groundwater is or may be used for drinking, MCLs are generally relevant and appropriate as cleanup standards for surface water or the groundwater. (MCLs and MCLGs are presented in Table 1.)	Groundwater is not used for drinking, and institutional controls can prevent future use. However, there is potential for and actual discharge of contaminated groundwater to the Columbia River, which is used as a drinking water source by downstream communities. MCLs are not legally enforceable; however, they may be relevant and appropriate to provide guidance for cleanup levels.		2 3 4
5	Clean Air Act (42 U.S.C. 7401) a) National Primary and Secondary Ambient air Quality Standards (40 CFR 50) b) New Source Performance Standards (40 CFR 60) c) National Emission standards for Hazardous Air Pollutants (40 CFR 61)	1	a) 40 CFR 50 provides for the establishment of nonradionuclide air emission standards. b) 40 CFR 52 provides for the establishment of air quality districts and State air quality plans c) 40 CFR 61 provides for the establishes air emission standards for radionuclides at DOE owned/operated facilities			1 2 3 4
6	Clean Water Act (33 U.S.C. 1251)	1	Establishes water quality standards for surface waters and pretreatment standards for waste waters released to public-owned treatment works (POTWs).			1 2 3
7	DOE Order 5400.5, Radiation Protection of the Public and the Environment	3	Specifies criteria for protection of the public (e.g., 100 mrem/yr EDE resulting from DOE operations for all exposure pathways). Establishes residual radioactive materials criteria.	Nonpromulgated.		1 2 3 4

Table 9-1. Potential Contaminant-Specific ARARs. (4 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
8	Health Advisories, EPA Office of Drinking Water	3	Health advisories should be considered to determine risk when promulgated standards are not available or for multiple contaminants and routes of exposure when ARARs are not sufficiently protective.		Standards to provide guidance for development of cleanup levels.	2 3
9	Washington Standards for Protection Against Radiation (WAC 402-24)	1	State regulations specifying radiation dose standards for permissible levels of radiation in unrestricted areas. Table II of Appendix A itemizes the allowable concentrations in air above natural background. The values in Table II are the same as the values in Table II, appendix B, Nuclear Regulatory Commission Standards (10 CFR 20).		Managing remediation activities in a manner to ensure emission standards are not exceeded. Monitoring remediation activities in a manner to verify emission standards are not exceeded.	1 2 3 4
10	Washington Ambient Air Quality Standards and Emission Limits for Radionuclides (WAC 173-480)	1	Ambient air quality standards and radionuclide emission limits mandate that radionuclides in the air must not cause a maximum accumulated dose equivalent of more than 25 millirem to the whole body or 75 millirem/year to a critical organ of any member of the public (excluding doses from radon and radon decay products). (NOTE: These standards were adopted by the Washington State Department of Social and Health Services by reference to WAC-402-80-050.)		Managing remediation activities in a manner to ensure emission standards are not exceeded. Monitoring remediation activities in a manner to verify emission standards are not exceeded.	1 2 3 4
11	Washington Model Toxics Act (Ch 70.105 RCW) and the regulations issued pursuant to it under Model Toxics control Act Cleanup Regulations (Ch 173-340 WAC)	1	Regulations for contaminated-site cleanup. Contains standards and methods for establishing cleanup levels groundwater, surface water, soil, and air emissions.			1 2 3 4

Table 9-2. Potential Action-Specific ARARs. (3 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
1	Occupational Safety and Health Standards (OSHA) (29 CFR 1910)	1	United States Department of Labor Standards for Workplace Health and Safety.	Applicable for investigation and remedial action.	Development of workplans and methods for site investigation and remediation that will meet OSHA standards for health and safety.	1 2 3 4
2	Radiation Protection Standards for Managing and Disposing of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes (40 CFR 191)	1	Standards for the management and disposal of spent nuclear fuel, high-level, and transuranic radioactive wastes. <div> <u>Isotope</u> ¹³⁷Cs ^{239,240}Pu ⁹⁰Sr ⁹⁹Tc Uranium </div> <div> <u>Ci/Unit of Waste</u> 1,000 100 1,000 10,000 100 </div>	Applicable for actions requiring the management and disposal of spent nuclear fuel, high-level or transuranic radioactive wastes.		1 3 4
3	Underground Injection Control Regulations (40 CFR 144-147)	1	Define the standards for the placement of treated groundwater into an aquifer.	May be applicable for remedial action requiring the reinjection of treated groundwater.		2
4	Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are ALARA (PNL-65577)	3	DOE guidance for the implementation of As Low As Reasonably Achievable (ALARA) policy with respect to exposure.	Nonpromulgated.		1 2 3 4
5	DOE Order 5820.2A, Radioactive Waste Management	3	Establishes the criteria for the required radioactive waste activities associated with a DOE operation including action to minimize and stabilize waste. Addresses the management, treatment and disposal of low level radioactive waste.	Nonpromulgated.		1 2 3 4
6	DOE Order 5480.3, Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes	3	Specifies requirements for the labeling and packaging of hazardous materials, hazardous substances and hazardous wastes in addition to those specified under 49 CFR (U.S. Department of Transportation regulations for transportation of hazardous materials).	Nonpromulgated.		1 2 3 4

Table 9-2. Potential Action-Specific ARARs. (3 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
7	DOE Order 5480.11, Radiation Protection of Occupational Workers	3	Mandates implementation of ALARA policy. specifies radiation exposure standards for occupational workers.	Nonpromulgated.		1 2 3 4
8	Washington State Water Pollution Control Act and the pursuant regulations issued under Ch 90.46 RCW	1	Regulations do not contain specific numeric standards, but require the surface water and groundwater of the State to be protected for maximum beneficial uses. Requires all known available and reasonable treatment of discharges.			1 2 3 4
9	Washington NPDES program (WAC 173-220)	1	Regulations require a permit to discharge liquid wastes to surface water from a point source.	Washington State's NPDES program: applicable for remedial alternatives requiring liquid discharge to surface water, e.g., response action to Tri-Party Agreement milestone M-17-15.		1 2 3 4
10	Washington Waste Discharge Program (WAC 173-216)	1	Washington State Waste Discharge Program, for solid waste.	Applicable ... remedial alternatives requiring liquid discharge to the ground, e.g., sanitary waste disposal facility and filter backwash pond.		1 2 3 4
11	Washington Dangerous Waste Regulations (WAC 173-303)	1	Requirements equivalent to RCRA for groundwater protection standards; established requirements for approved TSDs and priorities for hazardous waste management.	Applicable to the extent they are more stringent than Federal standards for remedial alternatives requiring the management of solid wastes.		1 2 3 4
12	Washington Air Pollution Control Regulations (WAC 173-400)	1	Regulation establishes air quality and emission standards	May be applicable to the extent they are more stringent than Federal regulations for remedial actions with air emissions.		1 2 3 4
13	Washington Solid Waste Management Recovery and Recycling Act (70.95 RCW) and Washington Minimum Functional Solid Waste Handling Standards (WAC 173-304)	1	Regulations establish standards for solid waste disposal facilities.	May be applicable to the extent the regulations are more stringent than Federal standards for remedial alternatives requiring the management of solid wastes.		1 2 3 4

Table 9-2. Potential Action-Specific ARARs. (3 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
14	Washington Minimum Standards for construction and Maintenance of Water Wells (WAC 173-160)	1	Regulations include minimum standards for the construction of resource protection wells and water supply wells.	Applicable for monitoring wells and remedial alternatives requiring extraction wells.	Construction of monitoring wells and extraction wells to meet standards set forth in this regulation.	1 2 3
15	40 CFR 61 Subpart M, revised by 55 FR 48414, November 20, 1990	1	Regulations contain standards for the removal and disposal of asbestos-fiber-containing material.	Applicable for remedial actions involving the removal and disposal of asbestos-fiber-containing material.		4

Table 9-3. Potential Location-Specific ARARs. (5 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
Flora and Fauna						
1	Endangered Species Act of 1973 (16 USC 470 <u>et seq.</u>); 50 CFR 402; 50 CFR 10 <u>et seq.</u> ; Fish and Wildlife Coordination Act (16 USC 661 <u>et seq.</u>); 33 CFR 320.3	1	Determination of presence of endangered or threatened species. Action to conserve endangered or threatened species, including consultation with the U.S. Fish and Wildlife Service.	<p>Applicable to facilities authorized, for, or actions carried out by the Federal Government where critical habitat is present upon which endangered or threatened species depend.</p> <p>FLORA: There are no known plants on the Federal list of <u>Endangered and Threatened Wildlife and Plants</u> that are known to occur on the Hanford Site.¹</p> <p>FAUNA: Identified as endangered: American Peregrine falcon (<u>Falco peregrinus anatum</u>): does not nest at the Hanford Site, but is a casual migrant.¹</p> <p>Identified as threatened: bald eagle (<u>Haliaeetus leucocephalus</u>): a regular winter resident in areas where it forages on dead salmon and waterfowl along the Columbia River; does not nest on the Hanford Site.¹</p>	Determination of the presence of a threatened or endangered species require the approval of a plan to mitigate damage to that species critical habitat.	2 3 4
2	Fish and Wildlife Coordination Act (16 USC 661 <u>et seq.</u>); 40 CFR 6.302(g)	1	Requires action to protect fish or wildlife, in areas affecting stream or river.	Applicable to diversion, channeling, or other activity that modifies a stream or river and affects fish or wildlife. Fish and Wildlife Coordination Act (16 USC 661 <u>et seq.</u>); 40 CFR 6.302(g).		1 2 3 4

Table 9-3. Potential Location-Specific ARARs. (5 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
3	Wild and Scenic Rivers Act (16 USC 1271)	1	Protection of rivers designated as wild or scenic or designated as a "study" river on the National Rivers Inventory. Requires action to protect the free-flowing characteristics or scenic, recreational, or fish and wildlife values of a Wild and Scenic River or Study River.	Applicable to action involving construction of a water-resource project, broadly defined to include construction or development on adjacent shorelines. Draft EIS has been prepared for designation of the Hanford Reach of the Columbia River.		1 2 3 4
4	Fish and Wildlife Improvement Act 16 USC 742)	1	Requires action to conserve and promote conservation of fish and wildlife and their habitat.	Applicable to actions that will have an adverse effect on fish and wildlife or their habitat.		1 2 3 4
5	Fish and Wildlife Conservation Act (16 USC 2901)	1	Within an area that may impact nongame fish and wildlife, requires action to conserve and promote conservation of nongame fish and wildlife and their habitat.	Applicable to actions that will have an adverse effect on nongame fish and wildlife habitat.		1 2 3 4
6	40 CFR 6, App. A; Fish and Wildlife Coordination Act (16 USC 661 <u>et seq.</u>): 40 CFR 6.302(b). 40 CFR 6 Subpart A sets EPA policy for carrying out Executive Orders 11988 and 11990, which are binding on the level of government for which they are issued. 10 CFR 1022 is DOE's policy.	1	Requires action to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values within floodplain.	Applicable to actions that occur in a floodplain, such as lowlands and relatively flat areas adjoining inland waters and other flood-prone areas.		1 2 3 4
7	40 CFR 6, Appendix A; Executive Order 11990, Protection of Wetlands; 10 CFR 1022 (DOE policy)	1	Requires action to the extent possible to avoid adverse effect, minimize potential harm, and preserve and enhance wetlands.	Applicable to action involving construction of facilities or management of property in wetlands, as defined by 40 CFR 6, App. A, Section 4(j).		1 2 3 4

Table 9-3. Potential Location-Specific ARARs. (5 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
8	16 USC 668dd <u>et seq.</u> ; 50 CFR 27	1	Only actions allowed under the provisions of 16 USC 668dd(c) may be undertaken in areas that are part of the National Wildlife Refuge System.	Applicable to areas designated as part of National Wildlife Refuge System. 16 USC 668dd <u>et seq.</u> ; 50 CFR 27.	(1) Determination of work area located within the boundary of a part of the National Wildlife Refuge System. (2) Minimization of adverse effects of remedial action to a National Wildlife Refuge System site, for work area located outside System boundaries.	2 3
9	Clean Water Act, Section 404: 40 CFR 230, 33 CFR 320-330	1	Requires action to prohibit discharge of dredged or fill material into wetlands without permit.	Applicable to discharge of dredged or fill material; wetlands as defined by U.S. Army Corps of Engineers.		1 2 3 4
10	Endangered, Threatened or Sensitive Wildlife Species Classification (WAC 232-12-297)	1	Requires action to protect wildlife or plants classified as endangered, threatened or sensitive through the development of a site management plan.	Applicable when wildlife classified as endangered, threatened or sensitive are present. In addition to the American peregrine falcon and the bald eagle, the State of Washington identifies the white pelican (<u>Pelecanus erythrorhynchos</u>) and sandhill crane (<u>Grus canadensis</u>) as endangered, and the ferruginous hawk (<u>buteo regalis</u>) as threatened. The presence of the ferruginous hawk has been noted at the Hanford Site. Little is known about the visitation frequencies of the white pelican and sandhill crane, although their presence has been noted.	Determination of the presence of a endangered, threatened or sensitive species require the approval of a plan to mitigate damage to the critical habitat of that species.	2 3 4
11	Bald Eagle Protection Rules (WAC 232-12-292)	1	Requires action to protect bald eagle habitat, such as nesting or roosting sites.	Applicable in an area that contains bald eagle habitat.	Determination of the presence of bald eagle habitat requires the development of a site-management plan.	2 3
12	Shoreline Management Act (RCW 90.58)	1	Requires actions to restrict activities or limit the concentration of contaminants to ensure no adverse environmental or health effects in shoreline, wetlands, or floodplain.	Applicable to sites located in floodplain or wetlands.		1 2 3 4

Table 9-3. Potential Location-Specific ARARs. (5 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
Historical						
1	National Historical Preservation Act (16 USC 469); 36 CFR 65; 25 CFR 261; 43 CFR 3; 43 CFR 7	1	Action to recover and preserve artifacts required.	Applicable to actions where alteration of terrain threatens significant scientific, prehistorical, historical, or archaeological data, or where actions may cause irreparable harm, loss, or destruction of significant artifacts.	Cultural Survey to determine the presence of archeological artifacts within the subject work area.	2 3 4
2	National Historic Preservation Act, Section 106 (16 USC 470 <u>et seq.</u>); 36 CFR 800	1	Requires action to preserve historic properties; planning of action to minimize harm to National Historic Landmarks.	Applicable to property included in or eligible for the National Register of Historic Places.	Cultural Survey to determine if site is subject for eligibility for inclusion in the National Register of Historical Places.	2 3 4
3	The American Indian Religious Freedom Act (42 USC 1996)	1	Requires action to mitigate the effects of disturbance within areas designated as sacred lands subject to recognized spiritual rights of American Indians.	Applicable to actions that may occur that restrict or alter burial grounds or monuments on land areas sacred to the religious practices of tribes previously inhabiting subject land. Separate and distinct from considerations of archaeological protection and activities.	Cultural survey to determine the presence of land within the work area that is subject to recognized spiritual rights of Native Americans.	2 3
4	Historic Sites, Buildings and Antiquities Act (16 USC 461)	1	Requires action to undertake the recovery, protection and preservation of data at historic sites, buildings, or objects of national significance.	Applicable to the alteration of terrain that threatens significant scientific, prehistorical, historical, or archaeological sites.	Cultural survey to determine presence of historic, scientific, or archaeological sites within the subject work area.	2 3 4
5	Archeological Sites and Resources (RCW 27.53)	1	Requires action to recover and preserve artifacts, where action may impact archeological sites and resources.	Applicable to any site, object, artifact, or location of prehistoric or archaeological interest located in, on, or under lands of waters under possession or control of State, county, city, or political subdivision.	Cultural survey to determine presence of archaeological sites, relics, or objects within the subject work area.	2 3 4

Table 9-3. Potential Location-Specific ARARs. (5 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
6	Indian Graves and Records (RCW 27.44)	1	No material may be removed from the site unless it is destined for reburial or perpetual preservation in a recognized archaeological repository. Permission to remove material is granted by the State historic preservation officer after notification of the affected Indian tribe or tribes.	Applicable to intrusive actions that may occur in the area of burial grounds or tribes that previously inhabited the subject land.	Cultural survey to determine the presence of Native American burial sites within the subject work area.	2 3 4
Miscellaneous						
1	RCRA (40 CFR 264.18(b))	1	Facility within 100-year floodplain must be designed, constructed, operated, and maintained to avoid a washout.	Applicable to treatment, storage, or disposal of RCRA hazardous waste within 100-year floodplain.		1 2 3 4

Table 9-4. Decontamination and Decommissioning Potential ARARs. (4 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
1	Nuclear Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors.	4	NA	Establishes limits for surface contamination on materials and equipment and general procedures for decommissioning. Specifically contains a table of acceptable surface contamination levels for release for unrestricted use.	Release limits will have to be proposed and accepted in order for decommissioning to proceed. The guidance in Reg Guide 1.86 and ancillary documents provide guidance for this process.	1 4
2	"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use of Termination of License for Byproduct, Source, or Special Nuclear Material." 7-82	4	NA	Provides guidance for acceptable contamination levels for release of facilities following decontamination.	NA	1 4
3	NUREG/CR-5512; PNL-7212, Residual Radioactive Contamination for Decommissioning. Technical Basis for Translating Contamination Levels to Annual Dose.	4	NA		The draft NUREG was issued in January 1990 for public comment. Following final issuance, methods and guidance may be useful.	4
4	Radioactive Waste Below Regulatory Concern; policy statement. 5/FR-30839-01, Friday, August 29, 1986.	4	NA	The policy statement implements the NRC mandate in the Low Level Waste Policy Amendments Act of 1985 (42 USC 2021b et seq.) to establish procedures for acting expeditiously or petitions to exempt specific radioactive waste streams from the commissions regulations. Some of the referenced NUREGs may be useful in deriving target levels of decontamination during decommissioning. The implementation of the policy is currently on hold until a consensus-building process is completed.	NA	4

Table 9-4. Decontamination and Decommissioning Potential ARARs. (4 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
5	10 CFR 20, Standards for Protection Against Radiation.	2	NA	Establish standards for protection against radiation hazards from activities performed by NRC licensees and establishes limits for disposal of certain categories of waste. Since DOE is not an NRC licensee, this regulation is not mandatory. It may provide additional guidance in areas of worker protection and waste disposal. The NRC has announced that it will issue residual contamination limits that must be met before facilities lands and materials may be released for unrestricted use (56 FR 18354, 4/22/91). Interim criteria are to be issued 4/92.	NA	1 2 3 4
6	40 CFR 61, Subpart H, National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities.	1	This regulation provides radioactive emissions monitoring guidance for DOE facilities.	The regulation is aimed at stacks and release points from DOE facilities. The application to potential releases during decommissioning would appear prudent.	Monitor for potential releases during decommissioning.	1 4
7	40 CFR 191, Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High Level and Transuranic Radioactive Wastes.	1	These regulations supply environmental standards for the management, storage, and disposal of various classes of radioactive waste.	Applicable if DOE decides to bury waste from D&D that meets the definition of the regulation. Further discussion of NRC's definition of high-level waste can be found in the Federal Register, 52 FR 5992-01, Friday, February 27, 1987. The EPA will promulgate generally applicable environmental standards for the management and disposal of wastes regulated by 40 CFR 191, and establish limits for the release of radioactive materials to the environment (56 FR 18012, 4/22/91). Notice of proposed rule making scheduled for 12/91.	Classify the waste to determine if 40 CFR 191 applies.	1 2 3 4

Table 9-4. Decontamination and Decommissioning Potential ARARs. (4 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
8	NUREG/CR-5517, IMPACTS-BRC Version 2.0, Program User's Manual	4	NA	The IMPACTS-BRS computer code user's guide and code are available. The code provides capability of calculating radiation doses to individuals and target groups as a result of various D&D activities (e.g., transportation and disposal). The code may be useful in assessing appropriate levels of cleanup.	NA	1 2 3 4
9	10 CFR 30, Rules of General Applicability to Domestic Licensing of Byproduct Material.	4		This regulation sets out requirements for NRC licensees with regard to the need for a license, applying for a license, recordkeeping, and decommissioning. Section 30.36 contains guidance on preparing a decommissioning plan and applying for ultimate termination of the license and unrestricted release of the facility or site. The guidance in this section is not mandatory but may be useful.	NA	4
10	10 CFR 61, Licensing Requirements for Land Disposal of Radioactive Waste.	1	These regulations supply guidance for land disposal of radioactive waste.	10 CFR is applicable when DOE would wish to dispose of D&D material from M Reactor and may be applicable if it is desired to leave some level of radioactivity in situ.	Determine if the classification of waste is low-level (i.e., not high-level).	1 2 3 4
11	Regulatory Guide 3.64, Standard Format and Content of Decommissioning Plans for Licenses Under 10 CFR Parts 30, 40, and 70.	4	The guide discusses the content of a decommissioning plan.	NA	NA	4
12	General Requirements for Decommissioning Nuclear Facilities (Amendments to 10 CFR 30, 40, 50, 51, 70, 72) 53 FR 24018.	4	NA	The amended regulations address decommissioning, planning, timing, funding methods, and environmental review requirements.	NA	4

Table 9-4. Decontamination and Decommissioning Potential ARARs. (4 sheets)

ITEM NUMBER	CITATION	ARAR CODE	REQUIREMENT	COMMENT	RESOLUTION	SCOPE CODE
13	10 CFR 60, Disposal of High-Level Radioactive Wastes in Geologic Repositories.	1	10 CFR 60 establishes guidance for the establishment of High-Level Radioactive Waste Repositories and defines the waste that must be placed there.	The States of Washington and Oregon have requested a revision of the definition of "high-level radioactive waste" (56 FR 51732, 12/17/90). A rulemaking decision is expected by 12/91. 10 CFR 60 is applicable when DOE would wish to dispose of D&D material from N Reactor that meets the high-level waste criteria.	Determine if the classification of waste is high-level or not.	1 2 3 4
14	Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement or TPA), Executive Summary, Section 3.0.	1	NA	The parties agreed that whenever D&D activities result in generation of hazardous waste, it shall be subject to the Tri-Party Agreement. In addition, if any contaminated structure is found to be a source of a hazardous release (or substantial threat of a release), remediation of such a release where subject to RCRA or CERCLA, shall be subject to the Tri-Party Agreement.	Assess hazardous constituents of waste or structures subject to D&D and determine if subject to TPA.	1 2 3 4
15	Joint NRC/EPA Guidance - Conceptual Design Approach for Commercial Mixed Low Level Radioactive and Hazardous Waste Disposal Facilities - 1987.	4	NA	Document provides a conceptual design approach for a disposal facility handling mixed low-level waste (mixed LLW).	Development of a mixed LLW disposal facility may be necessary to decommission N Reactor.	1 2 3 4

10.0 NATIONAL ENVIRONMENTAL POLICY ACT STRATEGY

10.1 GENERAL

The implementing regulations of NEPA were promulgated by the Council on Environmental Quality from 40 CFR, parts 1500 through 1508, which establish national environmental policy and goals for the protection, maintenance, and enhancement of the environment. It also provides a process for implementing these goals within the Federal agencies (40 CFR 1502.1). For DOE, this process is contained in 10 CFR 1021, "National Environmental Policy Act Implementing Procedures."

10.2 EXISTING NATIONAL ENVIRONMENTAL POLICY ACT DOCUMENTATION

The following describes the NEPA documents currently in effect for the performance of 100-N Area activities:

- Memorandum-to-File, dated February 16, 1988, which documents that the proposed action to discontinue N Reactor operations will have a clearly insignificant impact on the environment, and therefore, no environmental assessment (EA) or EIS is required to curtail operations.
- Categorical Exclusion, dated January 15, 1992, which documents that the work performed during the routine maintenance of buildings, facilities, and structures, does not require an EA or an EIS.

10.3 FUTURE NATIONAL ENVIRONMENTAL POLICY ACT DOCUMENTATION

10.3.1 N Reactor Deactivation

On August 15, 1991 the decision was announced to cease preservation of N Reactor as a defense materials production contingency and to proceed with activities leading to the ultimate decommissioning of the reactor. To comply with this decision, the N Reactor Deactivation Program was established. The primary objective of the program is to place all N Reactor facilities in an environmentally safe condition for ultimate decommissioning at a later date. The *N Reactor Deactivation Program Plan* (WHC-SP-0615) defines the basic methodology and identifies the transition activities required to effect the program's objective (see Table 6-1) (WHC 1992a).

The transition activities have been categorized as being of either a routine or nonroutine nature. Therefore, a NEPA strategy for each activity category will be implemented.

10.3.1.1 Routine Activities. The existing NEPA documentation described above will be used to allow the performance of routine activities that are not part of a set of unique activities that also include nonroutine-type activities.

10.3.1.2 Nonroutine Activities. An action description memorandum (ADM) was submitted to DOE in December 1992 to determine the appropriate level of NEPA documentation (EA or EIS) required for the program's transition activities. After receiving formal direction on December 7, 1993, an EA is now being prepared.

The proposed actions within the EA include activities such as hardware removal, relocation of the basin's residual materials to a central location for sampling and characterization, packaging and removal of residual materials, draining the basin, and painting. The EA will include an in-depth review and analysis of the nuclear and radiological safety issues associated with the performance of the activities; appropriate alternatives to the proposed actions will be thoroughly evaluated.

10.3.2 Environmental Remediation

An ADM prepared in 1989 described the program impacts of the environmental remediation activities required at the Hanford Site. Later, it was determined that an EIS would be the appropriate level of NEPA documentation for these activities.

A Notice of Intent was published in the Federal Register in August 1992 informing the public that the Hanford Remedial Action EIS (HRA-EIS) will be prepared. The HRA-EIS will focus on remediating the Hanford Site to goals that support varying degrees of future use (e.g., restricted or unrestricted use); it will evaluate technologies that are representative of those that could be used for Hanford Site remediation. The HRA-EIS will address the environmental remediation of areas associated with N Reactor and will evaluate alternative classes of future land use for the 100 Area.

10.3.3 Decontamination and Decommissioning

An EIS was prepared and issued in 1993 for the D&D of the surplus reactors located in the 100 Areas of the Hanford Site (DOE/EIS 1993). The N Reactor at the Hanford Site is not within the scope of this EIS because it is currently being shut down and will likely take several years before it is available for decommissioning. Once shutdown is completed, the appropriate NEPA documentation will be developed for decommissioning N Reactor.

11.0 DISPOSITION OF SPECIAL NUCLEAR MATERIAL

An inventory of SNM remains as either unirradiated or irradiated nuclear fuel, also known as spent nuclear fuel (SNF), from operation of N Reactor. The SNM inventory includes 1,800 metric tons of unirradiated uranium and 2,100 metric tons of irradiated uranium materials SNF. The unirradiated uranium consists of billets, unfinished nuclear fuel elements, finished nuclear fuel assemblies (some of which are contaminated), and scrap fuel stored in wooden boxes at the 300 Area Fuel Fabrication Facility. The irradiated uranium materials consist of nuclear fuel assemblies and elements stored in both open and sealed canisters under water in two 100-K Area fuel storage basins, 105 KE and 105 KW.

The irradiated N Reactor fuel consists of slightly enriched metallic uranium bonded to a layer of zirconium alloy (Zircaloy-2), hereinafter referred to as the cladding. The cladding provides the primary barrier against the escape of fission products and fissile materials from the fuel assembly. The fuel assembly (see Color Illustration 3-3) includes two components: an inner and an outer tube-shaped element, assembled into a tube-in-tube arrangement.

The irradiated nuclear fuel was discharged from N Reactor between 4 and 21 years ago, and has had sufficient decay time to essentially eliminate ^{131}I , as well as other short-half-life radionuclides. Upon its discharge, the fuel was allowed to cool for a minimum of 150 days in the N Reactor fuel storage basin. The fuel was then either placed in open-top (MK 0, I and II) canisters and transported to 105-KE Basin or in sealed (MK I and II) canisters and transported to 105-KW Basin (see Figure 11-1) for temporary storage. Temporary storage was originally planned for no more than 3 years, until the fuel could be processed at the Plutonium-Uranium Extraction (PUREX) Plant. As a result of the discharge and subsequent handling operations, the cladding integrity was occasionally lost. The loss of cladding integrity ranged from a crack to the complete separation of an element (or both elements) into two, or sometimes more parts. If the cladding was intact, radionuclides remained in the fuel assembly. However, once the cladding integrity was lost, the water gained access to the metallic uranium, starting the corrosion of the metallic uranium and the leaching of radionuclides into the basin cooling water. It has been estimated that about 6 percent of the fuel currently stored in the 105-KE and 105-KW Basins has lost its cladding integrity.

The 105-KE Basin currently contains 3,668 open-top canisters filled with N Reactor fuel and two baskets (the equivalent of five canisters) filled with aluminum-clad fuel assemblies from the retired single-pass reactors. The fuel was not originally encapsulated because the PUREX Plant operations in the 200 Area had been scheduled to process the fuel in the mid 1980s. The shutdown of PUREX precluded the fuel's processing and the existing inventory at 105-KE was never encapsulated. Since the primary barrier (cladding) on approximately 6 percent of the stored fuel had been breached, fission products have escaped from these fuel assemblies, contaminating the basin cooling water and exposing workers to increased amounts of radiation.

A recent Tiger Team Assessment of the Hanford Site stated that continued storage of fuel in the 105-KE Basin constitutes a safety problem because the fuel is not encapsulated and thus allows fission products to continue to leach out of the damaged fuel elements into the basin cooling water.

The fuel stored in the 105-KE Basin needs to be encapsulated in sealable canisters to provide a new primary barrier that will eliminate the continuing contamination of the basin cooling water. The basin's water filtration and ion exchange systems will then gradually reduce the current contamination level of the basin cooling water, which will result in reduced levels of radiation exposure to the workers. Once the fuel is encapsulated, the basin cooling water will provide a secondary barrier against a potential breach of containment resulting in release of radioactive materials to the environment.

The 105-KW Basin currently contains 3,821 sealed (MK I and II) canisters filled with N Reactor fuel. The 1,773 MK I canisters include 777 aluminum canisters and 996 stainless steel canisters. The MK I and II canisters provide the primary barrier for the fission products escaping from the damaged fuel assemblies, and the basin cooling water provides a secondary barrier to the potential release of radioactive materials to the environment. Because the fuel has been stored in sealed canisters in this basin the contamination of the basins's cooling water has been substantially less than that experienced in the 105-KE Basin where the fuel is stored in open-top canisters.

The strategy for the disposition of the inventory of SNM consists of near-term and long-term actions, which will be commensurate with the *Atomic Energy Act of 1954* and applicable DOE Orders.

- Near-Term Actions: Existing SNM inventories will continue to be stored in the 105-KE and 105-KW Basins. The fuel stored in the 105-KE Basin will be encapsulated to provide a new primary barrier between the damaged fuel assemblies and the basin cooling water to eliminate the continuing contamination of the basin's cooling water and to maintain the integrity of present irradiated nuclear fuel storage systems.

Upgrades to the irradiated nuclear fuel storage facilities are planned as part of Project N-032, KE/KW Life Extension because maintaining the existing storage of irradiated nuclear fuel at 105-KE and 105-KW will likely be extended 20 years.

- Long-Term Actions: The SNF inventory described above and other SNF inventories at the Hanford Site and across the DOE complex are the focus of studies that are being conducted to determine how to disposition the material. To implement a fully integrated strategy, a programmatic implementation plan (Idaho EIS) will be prepared to determine the NEPA evaluation alternatives required for dispositioning the SNF at these facilities.

Irradiated N Reactor Fuel and Canisters

N Reactor Fuel
Length
 26 inches (max)
 2.435-inch outer
 diameter (max)

Weight
 52 pounds

Fuel
 assemblies
 consist of
 inner and outer
 elements in a
 tube-in-tube
 configuration

14 Fuel
 assemblies per
 canister

**Mark 0
Canister**

**Mark I
Canister**

**Mark II
Canister**

- Open
- Aluminum

- Closed and open
- Aluminum
- Stainless steel

- Closed and open
- Stainless steel

KE: 1400 (est.)
 KW: 0

1400 SS (est.)
 1800 inc. 800 Al, 1000 SS

900 open
 2000 closed

Totals
 3700
 3800

29101033.1

Figure 11-1. Irradiated N Reactor Fuel Canisters.

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12.0 INSTITUTIONAL ISSUES

The HGP is located on the DOE-owned Hanford Site in south-central Washington State adjacent to the south end of the 100-N Area. The HGP was the first nuclear power project in the Pacific Northwest and the fourth in the Nation to generate electricity using a nuclear heat source. At one time, it was the largest nuclear steam electric generating plant in the world, with a capacity of 860,000 kW.

After extensive studies, the AEC in 1961 requested Congress to appropriate funds to add a steam electric generating plant, but the request was denied.

The Supply System proposed to finance and build the steam plant. The proposal was accepted, and a bill authorizing the AEC to sell the steam from N Reactor, which otherwise would have been dissipated as waste heat, was signed into law on September 26, 1962. The law stipulated that no Federal funds could be spent to build the plant. It also specified that 50 percent of the electricity produced would be offered for sale to investor-owned utilities and 50 percent would be offered to consumer-owned utilities. With the proceeds from a \$122-million revenue bond issue, the Supply System financed and built the generating facility.

The first nuclear-produced electricity from one of the HGP's two 430,000-kW turbines was synchronized into the Northwest power pool and sent into the BPA transmission grid system. On June 12, 1966, the second turbine generator went into operation, with power generation rising to 800,000 kW.

In August of 1991, DOE decided to cease preservation of N Reactor as a defense materials production contingency and to proceed with activities leading to the eventual decommissioning of that facility. As part of this process, the U.S. Department of Energy, Richland Operations (RL), was authorized by the Secretary of Energy to take all necessary and appropriate steps to cancel contractual obligations with the Supply System regarding the use of the Supply System's HGP. The Supply System has taken the necessary steps to retire all outstanding HGP revenue bonds that were issued by the Supply System to finance the original construction.

Representatives of RL and the Supply System are holding a series of preliminary discussions regarding the rights and obligations of the parties pertinent to final disposition of HGP. HGP and associated BPA facilities currently occupy land adjacent to the 100-N Area under provisions of a 1962 lease agreement. Of particular concern has been the parties' responsibilities for surveying, cleaning up, and restoring the HGP site. During operation of the N Reactor, the steam generators suffered tube leaks, which allowed reactor coolant to enter the steam system. The steam generators were retubed, which eliminated the tube leaks, but the leaks did carry radioactive contamination into several portions of the steam system. Radiation surveys indicate that the 96.5-cm (38-in.)-diameter steam lines from the N Reactor up to the first steam drain station are contaminated and two steam blowdown tanks and their related sumps are radiologically contaminated. A water disposal pond near the Columbia River shoreline has also been contaminated and will require stabilization and remediation. A radiation

survey of the HGP facility was performed in fiscal year 1993 to determine the extent of contamination and estimated cost to clean up the affected piping and equipment. This data will be used to finalize liability issues between the DOE and the Supply System. In support of the aforementioned discussions, a preliminary cost estimate was prepared to dismantle the HGP facilities and return the site to its original condition; that estimated cost is \$30,000,000. For purpose of this closure report, these costs are not included because negotiations between DOE and the Supply System have not been concluded.

BPA occupies a portion of the HGP site, which contains a high-voltage switch yard and a 500-kV powerline transmission corridor. It is planned that this facility will remain in operation for the foreseeable future, and hence discussion of cleanup and D&D is not included in this closure report.

13.0 CLOSURE MANAGEMENT AND PROGRAMMATIC INTERFACE

The DOE's ER Program was established in 1987 to plan, execute, and control its remediation efforts. This program is assigned to the DOE's Office of Environmental Restoration within the Office of Environmental Restoration and Waste Management.

The ER program for the Hanford Site has been designated as a major system acquisition requiring a project management system pursuant to DOE Order 4700.1, *Project Management System*. The Hanford ER major system acquisition Work Breakdown Structure is shown in Figure 13-1.

DOE's Office of Environmental Restoration and Waste Management has instituted a planning process for achieving compliance with all applicable laws and regulations, in addition to cleanup of existing waste sites, using agreements with Federal and State agencies as input to the planning process. This planning process is culminated in a 5-year plan based on activity data sheets prepared by the respective field offices.

The activity data sheets provide detailed information describing items such as work scope, funding requirements, and regulatory drivers. The following activity data sheets cover the scope of ER and other remediation and cleanup efforts at N Reactor.

ADS	SCOPE
RL-4120	N Reactor Deactivation (FY92)
RL-3600	N Reactor Deactivation (FY93-FY99)
RL-3600	RCRA Facility Closures
RL-5282, 5284	RCRA Past Practice Site Remediation
Not Available	Decontamination and Decommissioning

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Hanford Environmental Restoration MS

Figure 13-1. Hanford Environmental
Restoration IISA Work Breakdown
Structure.

29301050.16

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