0051875

INTERIM REMEDIAL ACTION RECORD OF DECISION

DECLARATION

4 OCT 1999 RECEIVED EDMC

SITE NAME AND LOCATION

U.S. Department of Energy / Hanford 100 Area
100-NR-1 and 100-NR-2 Operable Units
Hanford Site
Benton County, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected interim remedial actions for a portion of the U.S. Department of Energy (DOE) Hanford 100 Area, Hanford Site, Benton County, Washington. These actions were chosen in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act of 1986*, and to the extent practicable, the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP). Specifically, the selected remedial actions will address *Resource Conservation and Recovery Act* (RCRA) past-practice waste sites, unplanned releases (UPRs), spills, and associated piping in the 100-NR-1 Operable Unit (OU) as listed in Appendix B, and the underlying groundwater, designated as the 100-NR-2 OU. These sites are located next to the Columbia River at the Hanford Site near Richland, Washington. The 100-NR-1 and 100-NR-2 OUs are within the Hanford Site's 100 Area, which is a National Priorities List (NPL) site. The decisions documented in this Interim Remedial Action Record of Decision (ROD) are based on the Administrative Record for the Hanford Site and for the 100-NR-1 and 100-NR-2 OUs.

The State of Washington, acting through and by the State of Washington Department of Ecology (Ecology), concurs with the remedies selected in this document.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances in the waste sites and groundwater, if not addressed by implementing the response actions selected in this Interim Action ROD, may present an imminent and substantial endangerment to the public health, welfare, or the environment.

INTEGRATION OF CERCLA AND RCRA REQUIREMENTS

DOE, Ecology, and the U.S. Environmental Protection Agency (EPA) (referred to as the Tri-Parties) recognize the similarities between RCRA corrective action and CERCLA remedial action processes and their common objective of protecting human health and the environment from potential releases of hazardous substances, wastes, or constituents. As such, the Tri-Parties are electing to combine response actions under RCRA corrective action and CERCLA remedial action. The RCRA corrective action authorities have clear jurisdiction over waste with chemical constituents (in particular, hazardous waste and hazardous constituents), and mixed wastes (i.e., mixtures of hazardous waste and radiological contaminants), but not over waste with radiological contaminants only. The CERCLA authorities provide jurisdiction over hazardous substances, including radiological contaminants. The Tri-Parties agreed in the *Hanford Federal Facility Agreement and Consent Order* (referred to as the Tri-Party Agreement) that they intend for all

Facility Agreement and Consent Order (referred to as the Tri-Party Agreement) that they intend for all remedial and corrective actions conducted under the Tri-Party Agreement to address all aspects of contamination so no further action will be required under federal and state law. In particular, the Tri-Parties agreed that any units managed under RCRA corrective action shall address all CERCLA hazardous substances for the purposes of corrective action. Therefore, actions taken to remediate these OUs will comply with the provisions of both CERCLA and RCRA. By applying CERCLA authority jointly with that of RCRA, additional options for disposal of corrective action and remedial action wastes at the Hanford Environmental Restoration Disposal Facility (ERDF) are possible. DOE shall comply with all permit conditions stated in the Hanford Facility RCRA Permit for any site covered by this ROD, and issuance of this ROD does not effect DOE's obligation to comply with those permit conditions.

It is the intent of the Tri-Parties to select the same remedy for sites requiring RCRA corrective action as selected for those sites requiring CERCLA interim remedial actions. The *Hanford Facility RCRA Permit* has been modified to include the RCRA past practice waste sites in Modification E, as specified in Washington Administrative Code (WAC) 173-303-830. The public has commented on the Permit conditions relevant to these actions in accordance with the Tri-Party Agreement and applicable state and federal regulations.

DESCRIPTION OF THE SELECTED REMEDIES (100-NR-1 OU)

The selected interim remedial actions will reduce potential threats to human health and the environment at 100-NR-1 source waste sites. In addition, the remedial actions are intended to ensure that contaminants present at these waste sites will not adversely impact existing groundwater quality beneath the sites or beneficial uses of the Columbia River.

The future land use for the 100 Area of the Hanford Site has not been determined. The selected interim remedial actions are intended to not preclude any future land use (other than for the shoreline site). Remedial action objectives and cleanup standards will be re-evaluated if future land use and groundwater use determinations are inconsistent with the selected remedy.

The selected remedies for the various waste site groups are listed in Table 1. The source waste sites were organized into five (5) waste groups based on their suspected primary contaminants and characteristics: radioactive, petroleum (near-surface and deep contamination), inorganic, burn pit, and surface solid. A brief summary of the major components of each remedy follows.

Institutional Controls at the Shoreline Site

Application of institutional controls by themselves is not a final remedy, but is necessary under this interim action to protect human health and the environment pending a final ROD for the 100-N Area.

Table 1 – Waste Groups for the Source Waste Sites in the 100-NR-1 Operable Unit and Selected Remedial Actions for Each Waste Group

Waste Group		Selected Remedy				
		Institutional Controls	Remove /Dispose	Remove/Ex-Situ Bioremediation/Dispose	In-Situ Bioremediation	Number of Source Waste Sites[a]
Radioactive			X			37
Petroleum	Near Surface			X		20
	Deep				X	2
Inorganic			X			6
Burn Pit			X			6
Surface Solid and Miscellaneous Source Waste Sites			X			9
Shoreline		X				1

[a] Buried pipelines associated with waste sites will be remediated with those waste sites.

Institutional controls (IC) consist of the following elements:

- DOE will continue to use a badging program and control access to the sites associated with this ROD for the duration of the interim action. Visitors (i.e., persons not employed on the Hanford Site who
- are granted access for discussions on project related matters, employment interviews, or tours) entering any of the sites associated with this ROD are required to be escorted at all times.
- DOE will utilize the on-site excavation permit process to control well drilling and excavation of soil within the 100 Area OUs to prohibit any drilling or excavation except as approved by Ecology.
- DOE will maintain existing signs prohibiting public access to the shoreline site.
- DOE will provide notification to Ecology upon discovery of any trespass incidents.
- Trespass incidents will be reported to the Benton County Sheriff's Office for investigation and evaluation for possible prosecution.
- DOE will take the necessary precautions to add access restriction language to any land transfer, sale, or lease of property that the U.S. Government considers appropriate while institutional controls are compulsory, and Ecology will have to approve any access restrictions prior to transfer, sale, or lease.
- Until final remedy selection, DOE shall not delete or terminate any institutional control requirement established in this ROD unless Ecology have provided written concurrence on the deletion or termination.
- DOE will evaluate the implementation and effectiveness of ICs on an annual basis. DOE shall submit a report to Ecology by July 31 of each year summarizing the results of the evaluation for the preceding calendar year. At a minimum, the report shall contain an evaluation of whether or not the OU IC requirements continue to be met, a description of any deficiencies discovered, and what measures have been taken to correct problems.

Remove/Dispose for Radioactive, Inorganic, Burn Pit, and Surface Solid Groups

- Remove contaminated soil, structures, debris, and pipelines to a depth of 4.6 m [15 ft] below surrounding grade or to the bottom of the engineering structure, whichever is deeper.
- Treat these waste as required to meet ERDF acceptance criteria.
- Dispose of soil, structures, debris, and pipelines at ERDF.
- Backfill excavated areas with clean material, grade, and re-vegetate the areas.
- Maintain ICs as described above for this group.

Remove/Ex-Situ Bioremediation/Dispose for Petroleum Waste Group with Near-Surface Contamination

- Remove contaminated media (soil/debris) down to a depth of 4.6 m [15 ft] below surrounding grade or the bottom of the engineering structure, whichever is deeper. The depth of removal (15 ft) may be adjusted if field conditions warrant and with Ecology approval.
- Remove contaminated media (soil/debris) below 4.6 m [15 ft] as necessary if field conditions warrant and Ecology approves.
- Ex-Situ bioremediate contaminated media within the 100-N OU boundary.
- Dispose of residual contaminated media, if required, to an Ecology approved facility.
- Collect and dispose of leachate to the Effluent Treatment Facility (ETF) or as approved by Ecology.
- Backfill excavated areas with clean material, grade, and re-vegetate the areas.
- Maintain ICs as described above for this group.

In-Situ Bioremediation for Petroleum Waste Group with Deep Contamination

- In-Situ bioremediate contaminated media below 4.6 m [15 ft] of surrounding grade, bottom of engineering structure, or at the stopping point of Ex-Site bioremediation, whichever is greater.
- Install necessary injection wells and infrastructure.
- Maintain groundwater monitoring wells to monitor bioremediation and impacts to groundwater.
- Grade and re-vegetate the areas.
- Maintain ICs as described above for this group until remediation is complete.

This Interim Action ROD also provides a decision framework to evaluate leaving some contamination in place at a limited number of sites, specifically where contamination is located at depths greater than 4.6 m (15 ft). The decision to leave contamination wastes in place at such sites will be a site-specific determination made during remedial design and remedial action activities that will balance the extent of remediation with protection of human health and the environment, disturbance of ecological and cultural resources, worker health and safety, remediation costs, operation and maintenance costs, and radioactive decay of short-lived radionuclides (half lives less than 30.2 years [e.g., cesium-137]). The application of the balancing factors criteria and the process for determining the extent of remediation at deep sites will be made by EPA and Ecology. Any decision to leave waste in place will occur after the public has been asked to comment on the proposal to leave waste in place.

DESCRIPTION OF THE SELECTED REMEDY (100-NR-2 OU)

The selected interim remedial actions will reduce potential threats to human health and the environment at the 100-NR-2 OU.

The selected remedies for the 100-NR-2 groundwater is continued operation of an existing pump and treat system using an ion exchange resin to remove Sr-90. Furthermore, petroleum hydrocarbons have been observed in two monitoring wells and free-floating product will be removed if observed during future monitoring activities.

The pump and treat system has been in operation since September 1995 at the 100-NR-2 OU under the N-Springs expedited response action and associated Action Memorandum. The system removes Strontium-90 (Sr-90) contaminated groundwater, treats it by ion exchange, and returns treated groundwater to the unconfined aquifer using upgradient injection wells. The selected interim action also provides some control over movement of Sr-90 to the Columbia River and will not preclude possible final remedies at this OU. In addition, an evaluation of groundwater remediation and river protection technologies for Sr-90 contamination and evaluation of aquatic and riparian receptor impacts will be accomplished as part of this interim action. The duration for completing an evaluation of ecological impacts shall be approximately 5 years. During this interim action, DOE will continue to monitor the network of wells within the 100-N Area groundwater system of interest (the uppermost, unconfined shallow system that has been contaminated by the source waste sites) for all contaminants of concern. A brief summary of the major components of the selected groundwater interim remedy follows:

- Remove Sr-90 contaminated groundwater through extraction and treatment with ion exchange and discharge treated groundwater upgradient into the aquifer. The system shall operate continuously, excluding maintenance operations, system modifications, and other approved shutdowns. Any shutdown period greater than one (1) week shall require notification to Ecology.
- Maintain Ecology approved groundwater monitoring well networks to monitor pump and treat operations and impacts to groundwater.
- Evaluate technologies for Sr-90 removal and submit information to Ecology (by October 2004).
- Evaluate aquatic and riparian receptor impacts from contaminated groundwater and submit information to Ecology (by October 2004).
- Remove Petroleum Hydrocarbons (free-floating product) from any monitoring well and purge into an on-site tank for disposal to an approved off-site or on-site facility.
- Remove Petroleum contaminated solid waste, treat if necessary, and dispose to ERDF.
- Dispose of non-hazardous wash/rinse waters to the Hanford Effluent Treatment Facility or other facilities approved by Ecology.

IMPACT OF THE REMEDIAL ACTION DECISION ON THE RCRA PERMIT

This ROD addresses sites that require corrective action under RCRA Section 3004(u) (as implemented through WAC 173-303). Section 3004(u) of RCRA requires that RCRA permits include corrective action conditions as necessary to protect human health and the environment, including schedules of compliance for work not completed at the time of permit issuance. Thus, the selected CERCLA remedy and the RCRA corrective actions documented in this ROD have been incorporated into the Hanford Facility RCRA Permit as the RCRA corrective action. Implementation of the corrective measures in the 100-NR-1 OU will begin upon completion of remedial actions for the 100-NR-1 treatment, storage, and disposal units and will follow

the schedule identified in the *Engineering Evaluation/Cost Analysis for the 100-N Area Ancillary Facilities and Integration Plan*, DOE/RL-97-28, Rev. 1. This schedule will be incorporated into the *Remedial Design and Remedial Action* (RD/RA) *Workplan*.

The schedule for the interim measure at 100-NR-2 is an ongoing operation of the existing pump and treat system. This system will operate continuously as described above.

STATUTORY DETERMINATIONS

The selected interim remedial actions for the 100-NR-1 waste sites (except the shoreline site) are protective of human health and the environment, comply with federal and state requirements that are legally applicable, or relevant and appropriate (ARAR) for this action, and are cost effective.

The selected interim remedial actions for the 100-NR-2 groundwater are protective of human health and the environment and are cost effective. However, they do not comply with some federal and state requirements that are ARARs. This interim action ROD hereby grants a waiver to the following regulations: (1) *Safe Drinking Water Act of 1974* (SDWA) (40 U.S.C. 300, et seq.), "National Primary Drinking Water Regulations" (40 Code of Federal Regulations [CFR] 141) due to the treated groundwater that will be re-injected into the aquifer may/will exceed the drinking water standard or maximum contaminant level of 8 picocuries/liter (pCi/L) for Sr-90, based on system design, as well as 20,000 pCi/L for Tritium, and 45 milligrams/liter (mg/L) for nitrate; and (2) WAC 173-218, "Underground Injection Regulation" due to the treated groundwater may exceed the drinking water standard or maximum contaminant level for Sr-90, tritium, and nitrate. Although this interim remedial action is designed primarily for Sr-90, a waiver is still necessary for tritium and nitrates based on the co-existence of the contaminants in the groundwater. A final remedy for the groundwater shall address all ARARs.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The Tri-Parties have determined that the selected remedy for the 100-NR-1 source OU utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. Of the alternatives analyzed, the selected remedy provides the best balance of tradeoffs in terms of long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; short-term effectiveness; implementability; cost; and also considers the statutory preference for treatment as a principal element and considering state and community acceptance. The 100-NR-2 OU selected remedy is considered an interim action that will require further evaluation and final remedy selection. Remediation of the shoreline site of the 100-NR-1 OU is closely tied to the determination of a final remedy for the 100-NR-2 OU. Permanent solutions for this site will be defined at the time that the final remedy for the 100-NR-2 OU is determined.

Five (5) Year Review Requirement

Because this remedy may result in hazardous substances remaining on-site above levels that allow for unlimited use, a review will be conducted to ensure that the remedies continue to provide adequate protection of human health and the environment within five (5) years after the commencement of the interim remedial actions. This is an Interim Action ROD; therefore, review of these sites and these remedies will be on-going as the Tri-Parties continue to develop final remedial measures for the 100 Area.

On-Site Determination

The preamble to the National Contingency Plan states that when non-contiguous facilities are reasonably close to one another and wastes at these sites are compatible for a selected treatment or disposal approach, CERCLA Section 104(d)(4) allows the lead agency to treat these related facilities as one site for response purposes and, therefore, allows the lead agency to manage waste transferred between such non-contiguous facilities without having to obtain a permit. The 100 Area NPL waste sites addressed by this ROD are reasonably close to ERDF and compatible for disposal of excavated waste at ERDF. Therefore, the sites addressed by this Interim Action ROD and ERDF are considered to be a single site for the response purposes under this ROD.

Signature sheet for the Interim Action Record of Decision for the U.S. Department of Energy Hanford 100-NR-1 and 100-NR-2 Operable Units Interim Remedial Actions between the U.S. Department of Energy, the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Keith Klein
Manager, Richland Operations Office
U.S. Department of Energy

9/29/99
Date

Signature sheet for the Interim Action Record of Decision for the U.S. Department of Energy Hanford 100-NR-1 and 100-NR-2 Operable Units Interim Remedial Actions between the U.S. Department of Energy, the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Dana A Moore

for Chuck Clarke
Regional Administrator, Region 10
U.S. Environmental Protection Agency

9/29/97
Date

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Michael A. Wilson

Michael Wilson
Program Manager, Nuclear Waste Program
Washington State Department of Ecology

9/30/99
Date

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I. DECISION SUMMARY

Site Name and Location

The Hanford Site, a federal facility managed by the U.S. Department of Energy (DOE), was established in 1943 to produce plutonium for nuclear weapons using reactors and chemical processing. The Hanford Site occupies approximately 1,456 km^2 (560 mi^2) along the Columbia River in Benton County, which is in southeastern Washington. The Hanford Site is situated north and west of the cities of Richland, Kennewick, and Pasco, an area commonly known as the Tri-Cities (Figure 1). The Hanford Site is divided into areas based on the primary use during operation. The Site's nine (9) plutonium production reactors were located in the 100 Area. The 100-N Area is situated in the 100 Area in the north-central part of the Hanford Site on a broad strip of land along the Columbia River about forty-eight (48) km northwest of the city of Richland.

Demographics

The Tri-Cities constitutes the nearest population center to the 100-N Area, with an estimated population of about 111,000 in 1997. The surrounding communities of Benton City, Prosser, and West Richland were estimated to have a combined population of nearly 14,000 in 1997. Industries in the Tri-Cities are mostly related to agriculture and electric power generation.

Land Use

Pre-Hanford uses included Native American usage and agriculture. Existing land use in the 100 Area includes facilities support, waste management, and undeveloped land. Facility support activities include operations such as water treatment and maintenance of the reactor buildings. The contaminated waste site land area resulted from releases and former disposal activities in areas now known as "past-practice waste sites" which are located throughout the 100 Area. Lastly, there are undeveloped lands that comprise approximately 90% of the land area within the 100 Area. The undeveloped areas are the least disturbed and contain minimal infrastructure. A 29 km (18 mi) stretch of the Columbia River is located within the 100 Area. The shoreline of the Columbia River is a valued ecological area within the Hanford Site. Portions of the shoreline within the 100 Area are within the 100-year flood plain of the Columbia River. Semi-arid land with a sparse covering of cold desert shrubs and drought-resistant grasses dominates the Hanford Site's landscape. Approximately 40% of the area's annual average rainfall of 6.25 in. occurs between November and January. Wetlands along the Columbia River are contained within the boundaries of the 100 Area National Priorities List (NPL) site.

In 1992, The Hanford Future Site Uses Working Group recommended that the 100 Area be considered for the following four (4) future land use options:

- Native American uses;
- Limited recreation, recreation-related commercial use, and wildlife use;
- 105-B Reactor as a museum and visitor center; and
- Wildlife and recreational use.

The working group report was submitted to DOE as a formal scoping document for development of DOE's *Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan* (HRA-EIS). A draft of the HRA-EIS, released to the public in August 1996, generated a variety of comments on a number of issues. In response, DOE made significant revisions to the draft document. A revised draft HRA-EIS was made available for public comment on April 23, 1999. This document evaluated five (5) "action alternatives," each of which represented a federal, state, local agency, or

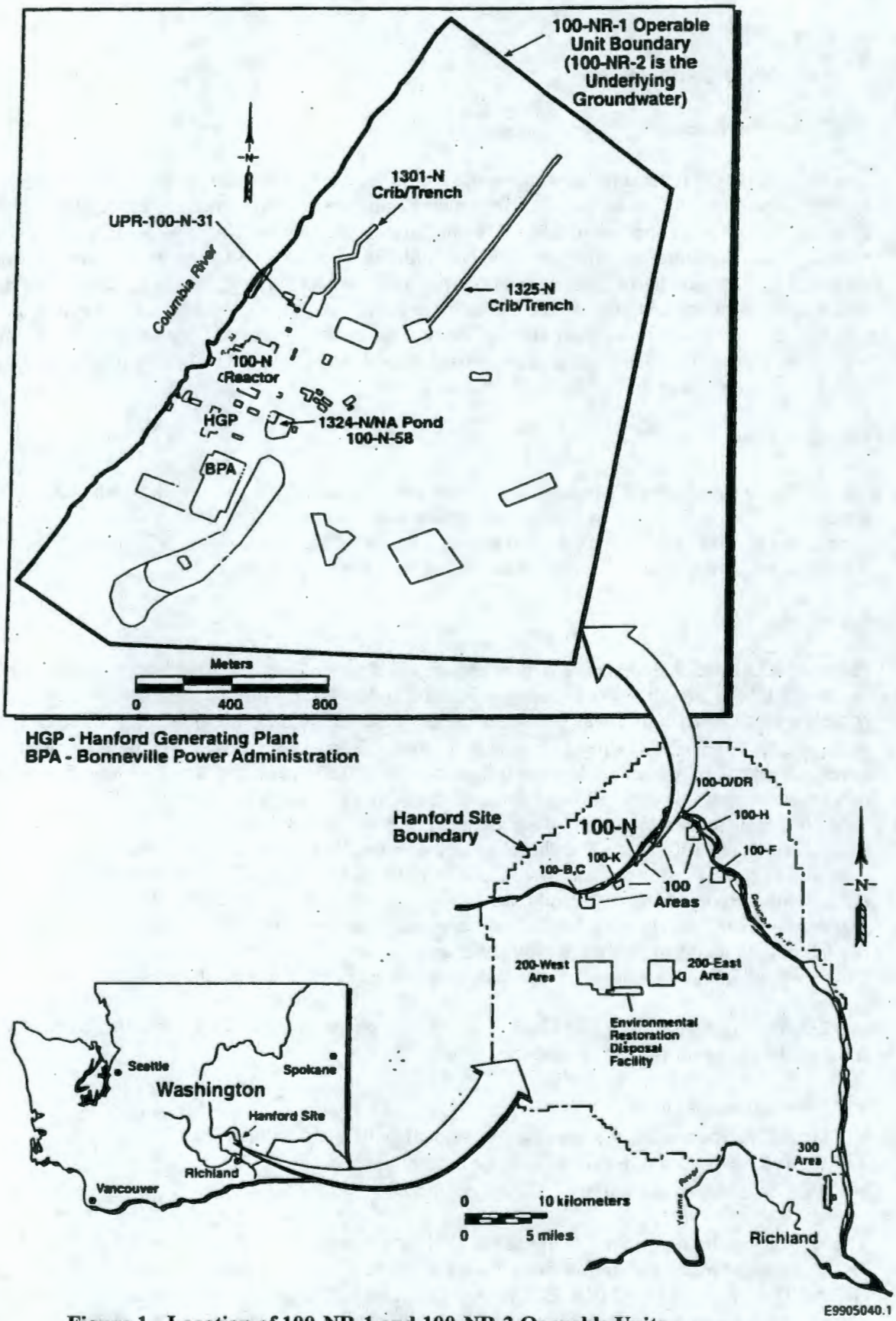


Figure 1 - Location of 100-NR-1 and 100-NR-2 Operable Units Surface Water and Groundwater

Tribe's preferred land use alternative. Preferred land uses for the 100 Area included varying degrees and combinations of preservation, conservation, research and development, and recreation. The public comment period on the revised draft HRA-EIS ended on June 7, 1999. DOE is currently evaluating comments in preparation for issuance of a land use determination.

At this time, a future land use for the 100 Area has not been established. For the purposes of this interim action, the remedial action objectives (RAOs) are to make interim action consistent with "unrestricted use" and consistent with the previous 100 Area soil cleanup decisions.

The Columbia River is the second largest river in North America and is the dominant surface-water body on the Hanford Site. The existence of the Hanford Site has precluded development of this section of river for irrigation and power. The Hanford Reach is now being considered for designation as a National Wild and Scenic River as a result of congressional action in 1988. The uses of the Columbia River include the production of hydroelectric power, extensive irrigation in the Mid-Columbia Basin, and as a transportation corridor for barges. Several communities located on the Columbia River rely on the river as their source of drinking water. Water from the Columbia River along the Hanford Reach is also used as a source of drinking water by several on-site facilities and for industrial uses. In addition, the Columbia River is used extensively for recreation, including fishing, hunting, boating, sailboarding, waterskiing, diving, and swimming.

Groundwater is found in both an upper unconfined aquifer system and deeper basalt-confined aquifers. The upper aquifer system has portions that are locally confined or semi-confined. Groundwater in the upper aquifer generally flows from recharge areas in the elevated region near the western boundary of the Hanford Site toward the Columbia River on the eastern and northern boundaries. Fluctuations in river stage, because of dam operations and seasonal variations, can impact the flow direction, hydraulic gradients, and groundwater levels within the upper unconfined aquifer. The uses of groundwater will depend on the future land use designation.

Potential beneficial uses of groundwater in the 100-N Area include a source of drinking water, irrigation, and industrial uses. Seepage of groundwater into the Columbia River occurs through riverbank seeps. Seeps in the 100-N Area, called N-Springs, include overland discharges as well as upwelling of groundwater into the river. Contaminants from the past 100-N Area activities may be impacting biota exposed to these seeps.

The shoreline area has not been designated as a wetland. A wetlands review was conducted in 1992 (DOE 1992) in which no significant wetlands conditions were identified. During implementation of the selected remedy, efforts will be made to prevent and minimize any impacts to the shoreline and riverine habitats.

Columbia River floods have occurred in the past, but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood control and water storage dams upstream of the Hanford Site. Major floods on the Columbia River typically result from rapid melting of the winter snowpack over a wide area augmented by above-normal precipitation. The maximum historical flood on record occurred June 7, 1894, with a peak discharge at the Hanford Site of 21,000 m3/s. The largest recent flood took place in 1948 with an observed peak discharge of 20,000 m3/s at the Hanford Site (Cushing 1995).

Evaluation of flood potential is conducted, in part, through the concept of the probable maximum flood, which is determined from the upper limit of precipitation falling on a drainage area, and other hydrologic factors (e.g., antecedent moisture conditions, snowmelt, and tributary conditions) that could result in maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated at 40,000 m3/s, and is greater than the 500-year flood. This flood would

inundate parts of the portions of the 100 Area that are located adjacent to the Columbia River; the central portion of the Hanford Site would remain unaffected (Cushing 1995).

The Corps of Engineers has derived the Standard Project Flood with both dam-regulated and un-regulated peak discharges given for the Columbia River below Priest Rapids Dam (Cushing 1995). The regulated Standard Project Flood for this part of the river is given as 15, 200 m3/s, and the 100-year regulated flood as 12,400 m3/s.

Cultural Resources

The Hanford Reach is one of the most cultural resource-rich areas in the western Columbia Plateau. Pre-Hanford uses of the area included agriculture and use by Native American tribes. Archaeological evidence demonstrates the importance of this area to Native American tribes, whose presence can be traced for more than 10,000 years. The near-shore areas of the rivers (Columbia, Snake, and Yakima) contained many village sites, fishing and fish processing sites, hunting areas, plant-gathering areas, and religious sites. Upland areas were used for hunting, plant gathering, religious practices, and overland transportation.

Biota

Bisected by the last free-flowing stretch of the Columbia River, semi-arid land with a sparse covering of cold desert shrubs and drought-resistant grasses dominates the Hanford landscape. Only about 6% of the Hanford Site has been disturbed and is actually used. The disturbed areas are surrounded by large areas of pristine shrub-steppe habitat. Several endangered and threatened plant species are found on and around the Hanford Site. The waste sites identified in the 100-NR-1 Operable Unit (OU) are within the disturbed portions of the Hanford Site. Invasive or non-native plant species have replaced many native plant species in these areas. Predominant species of wildlife in the area include mule deer, coyotes, Great Basin pocket mice, black-billed magpies, and various species of raptors. The Hanford Site is located in the Pacific Flyway, and the Hanford Reach serves as a resting area for migratory waterfowl and shorebirds. The bald eagle is a regular winter resident in the area.

The Hanford Reach supports a large and diverse community of plankton, benthic invertebrates (including insect larvae, limpets, snails, sponges, and crayfish), forty-four (44) fish species, and other communities. Of the fish community, the chinook salmon, sockeye salmon, coho salmon, and steelhead trout use the river as a migration route to and from upstream spawning areas and are of economic importance.

Table 2 provides the current list of threatened or endangered species occurring or potentially occurring on the Hanford Site.

Climate

The Hanford Site and surrounding area is located in a semi-arid region of the Columbia Basin. The Cascade Mountains to the west greatly influence the dry, hot climate of the area by creating a "rain shadow" effect. Forty percent of the area's average annual rainfall (6.25 inches) occurs between November and January. Ranges of daily maximum temperatures vary from normal maxima of 2 degrees C° (35 degrees F°) in late December and early January to 35 degrees C° (95 degrees F°) in late July. The Cascade Mountains also serve as a source of cold air drainage, which has a considerable effect on the wind regime of the area. Prevailing winds are from the northwest in all months of the year.

Table 2 - Federally or Washington State Listed Threatened (T) and Endangered (E) Species Occurring or Potentially Occurring on the Hanford Site

Common Name	Scientific Name	Federal	State
Plants			
Columbia milk-vetch	*Astragalus columbianus*		T
Columbia yellowcress	*Rorippa columbiae*		E
Dwarf evening primrose	*Oenothera pygmaea*		T
Hoover's desert parsley	*Lomatium tuberosum*		T
Loeflingia	*Loeflingia squarrosa* var. *squarrosa*		T
Northern wormwood [a]	*Artemisia camperstris borealis* var. *wormskioldii*		E
Umtanum desert buckwheat	*Eriogonum codium*		E
White Bluffs bladderpod	*Lesquerella tuplashensis*		E
White eatonella	*Eatonella nivea*		T
Birds			
Aleutian Canada goose [b]	*Branta canadensis leucopareia*	T	E
American white pelican	*Pelecanus erythrorhuchos*		E
Bald eagle	*Haliaeetus leucocephalus*	T	T
Ferruginous hawk	*Buteo regalis*		T
Peregrine falcon [b]	*Falco peregrinus*	E	E
Sandhill crane [b]	*Grus canadensis*		E
Mammals			
Pygmy rabbit [a]	*Brachylagus idahoensis*		E
Fish			
Steelhead	*Oncorhynchus mykiss*		
Upper Columbia River ESU		E	
Middle Columbia River ESU [b]		T	
Snake River Basin[b]		T	
Chinook	*Oncorhynchus tshawytscha*		
Upper Columbia River ESU		E	
Snake River Fall Run[b]		T	
Snake River Spring/Summer Run[b]		T	

(a) Likely not currently occurring on the site.
(b) Incidental occurrence.
ESU = Evolutionary Significant Unit

II. SITE HISTORY AND ENFORCEMENT ACTIONS

The Hanford Site was established in 1943 to produce plutonium for some of the nuclear weapons tested and used in World War II and has remained under the control of DOE or its predecessor since that time. In recent years, efforts at the Hanford Site have shifted from a national defense mission to the cleanup of contamination remaining after historical operations.

In November 1989, the U.S. Environmental Protection Agency (EPA) designated the 100 Area of the Hanford Site as a Superfund site and placed it on the NPL because of soil and groundwater contamination that resulted from past operation of the nuclear facilities. To effectively address the

threats associated with the NPL sites and to integrate the requirements of *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) and the *Resource Conservation and Recovery Act of 1976* (RCRA), DOE, EPA, and the Washington State Department of Ecology (Ecology), also known as the Tri-Parties, entered into the *Federal Facility Agreement and Consent Order* (Tri-Party Agreement) in May 1989. This agreement, among other things, established a procedural framework and schedule for developing, implementing, and monitoring remedial response actions at the Hanford Site. The Tri-Party Agreement grouped more than 1,000 inactive waste disposal and unplanned release sites and contaminated groundwater, including the 100-NR-1 and 100-NR-2 OUs, at that time. The 100-NR-1 and 100-NR-2 OUs were designated as units subject to RCRA Section 3004(u) corrective action (RCRA Past Practice units – RPPs). Milestones for completion of a limited field investigation (LFI) report and corrective measures studies (CMS) for the 100-NR-1 and 100-NR-2 OUs were established in the Tri-Party Agreement under Milestone M-15-12.

Signatories to the Tri-Party Agreement developed a coordinated CERCLA/RCRA site characterization and remediation strategy to expeditiously address environmental concerns associated with the Hanford Site. This strategy is known as the *Hanford Past-Practice Strategy,* DOE/RL-91-40. The *Hanford Past-Practice Strategy* emphasizes integration of the results of ongoing site characterization activities into the remedy decision-making process as soon as practicable and expedites the remedial action process by emphasizing the use of interim actions.

In 1994, the *Limited Field Investigation Report for the 100-NR-1 Operable Unit*, DOE/RL-93-80, and the *Limited Field Investigation Report for the 100-NR-2 Operable Unit*, DOE/RL-93-81, on the nature and extent of contamination at these OUs were published. In 1995, data generated from the LFI reports were used to establish a qualitative risk assessment (QRA) for each OU. The *Qualitative Risk Assessment for the 100-NR-1 Source Operable Unit*, BHI-00054, identified risks at some source waste sites in the 100-N Area that may warrant remedial action. That same year, the *Qualitative Risk Assessment for the 100-NR-2 Operable Unit*, BHI-00055, determined that some contaminant concentrations in groundwater exceed health-based risk levels. The 100-NR-2 LFI and QRA resulted in the expedited response action and associated action memorandum (dated September 23, 1994) for interim control of strontium-90 (Sr-90) movement in the groundwater through operation of a pump and treat system.

In 1998, DOE published the results of a CMS, DOE/RL-95-111, that was conducted to gather information to support selection of a remedial alternative to address contamination at the 100-NR-1 and 100-NR-2 OUs. The CMS, which is functionally equivalent to a CERCLA feasibility study, described the known characteristics of the waste sites and the distribution and extent of the primary contaminants, presented RAOs, and developed risk reduction goals. In addition, a QRA, comprised of both human health and ecological risk assessments, was conducted to evaluate current and potential effects of contaminants in the 100-NR-1 OU on human health and the environment.

The structures and buildings associated with the 100-NR-1 OU currently have a CERCLA Removal Action Memorandum issued on January 6, 1999 to authorize cleanup of these sites. A CERCLA Removal Action Memorandum allows the pump and treat system to operate in the 100-NR-2 OU and will be superceded by the issuance of this ROD and subsequent Remedial Design and Remedial Action (RD/RA) Workplan.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Both CERCLA and RCRA establish a number of public participation activities that must be conducted prior to implementing a remedial action. Potentially affected individuals and members of the public must be notified of the plans that are being proposed by DOE and regulatory agencies, and these individuals must be given the opportunity to review alternatives that were evaluated by the agencies. Before making a remedial action decision, the agencies must consider comments and concerns raised by the public and stakeholders. This section describes how the CERCLA requirements for public participation have been met. Since this ROD addresses sites that also must meet RCRA corrective action requirements, this section also describes how the RCRA public participation requirements were met. Appendix A of this ROD contains the responsiveness summary to specific comments submitted to Ecology by the public.

In April 1990, the Tri-Parties developed a Community Relations Plan (CRP) as part of the overall Hanford Site restoration. The CRP was designed to promote public awareness of the investigations and public involvement in the decision-making process. The CRP summarizes known concerns based on community interviews. Since that time, several public meetings have been held and numerous fact sheets have been distributed in an effort to keep the public informed about Hanford cleanup issues.

On March 16, 1998, the *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units*, DOE/RL 95-111, and the *Proposed Plan for Interim Remedial Action at the 100-NR-1 Source Sites Operable Unit and the 100-NR-2 Groundwater Operable Unit*, DOE/RL-96-102 (or Proposed Plan), were made available to the public. The CMS develops a set of potential remedial alternatives for the 100-NR-1 source sites and the 100-NR-2 Groundwater OUs, and performs a detailed analysis of these alternatives. The CMS also contains the recommended corrective measures and permit conditions. The Proposed Plan summarizes the results of the analyses performed in the CMS and presents the Tri-Parties' preference for interim remedial action. These documents were issued as part of the Tri-Parties' public participation responsibilities under Section 117(a) of CERCLA and pursuant to Class 3 Permit Modification public notice requirements of Washington Administrative Code (WAC) 173-303-830. The public participation process concurrently satisfied the requirements of both authorities.

The specific activities that were completed to address the public participation responsibilities included mailing a fact sheet explaining the proposed action to approximately 2,000 people. In addition, an article appeared in the bi-monthly newsletter, the *Hanford Update*, detailing the start of the public comment process. The *Hanford Update* was mailed to over 5,000 people. The Proposed Plans were mailed to all of the members of the Hanford Advisory Board.

The notice of the availability of these documents was published in the *Seattle PI/Times,* the *Spokesman Review-Chronicle*, the *Tri-City Herald,* and the *Oregonian* on March 15, 1998. Additional advertisements ran in the *Tri-City Herald* on April 2, 1998. The public comment period was held on March 16 through April 29, 1998. A combined public meeting and public hearing was held April 2, 1998, at Ecology's office in Kennewick, Washington. At the meeting, representatives from DOE and Ecology answered questions about the project. A response to the comments received during the public comment period, including those raised during the public meeting, is included in the Responsiveness Summary, which is attached as Appendix A to this ROD. The decision for these waste sites and groundwater is based on the Administrative Record. The locations of the Administrative Record and the information repositories are listed below.

ADMINISTRATIVE RECORD (contains all project documents)

U.S. Department of Energy
Richland Field Office
Administrative Record Center
740 Stevens Center
Richland, Washington 99352

INFORMATION REPOSITORIES (contain limited documentation)

University of Washington
Suzzallo Library
Government Publications Room
Box 3529000
Seattle, Washington 98195

Gonzaga University
Foley Center
East 502 Boone
Spokane, Washington 99258

Portland State University
Branford Price Millar Library
Science and Engineering Floor
SW Harrison and Park
P.O. Box 1151
Portland, Oregon 97207

DOE Richland Public Reading Room
Washington State University, Tri-Cities
Consolidated Information Center, Room 101L
P.O. Box 99, MSIN: H2-53
Richland, Washington 99352

IV. SCOPE AND ROLE OF RESPONSE ACTION WITHIN SITE STRATEGY

The Hanford Site was divided and listed as four (4) NPL Sites: the 100 Area, the 200 Area, the 300 Area, and the 1100 Area with DOE as the responsible agency for remedial actions. Each of these areas was further divided up into numerous OUs. Within the 100 Area, the Tri-Party Agreement assigned EPA as the lead regulatory agency for the 100-B, C, K, and F Area OUs. Ecology was assigned as the lead regulatory agency for the remainder of the 100 Area operable units, including 100-N, D, and H Area OUs. The lead regulatory agency approach was selected to minimize duplication of effort and maximize productivity. The role of the lead regulatory agency is to oversee the activities at an operable unit to help ensure that all applicable requirements are met. DOE is responsible for performing the remedial actions selected for the OU.

The 100-NR-1 OU encompasses all the soil waste sites including the associated structures and pipelines in the 100-N Area (Figure 2). The 100-NR-2 OU is the groundwater underlying the 100-NR-1 OU.

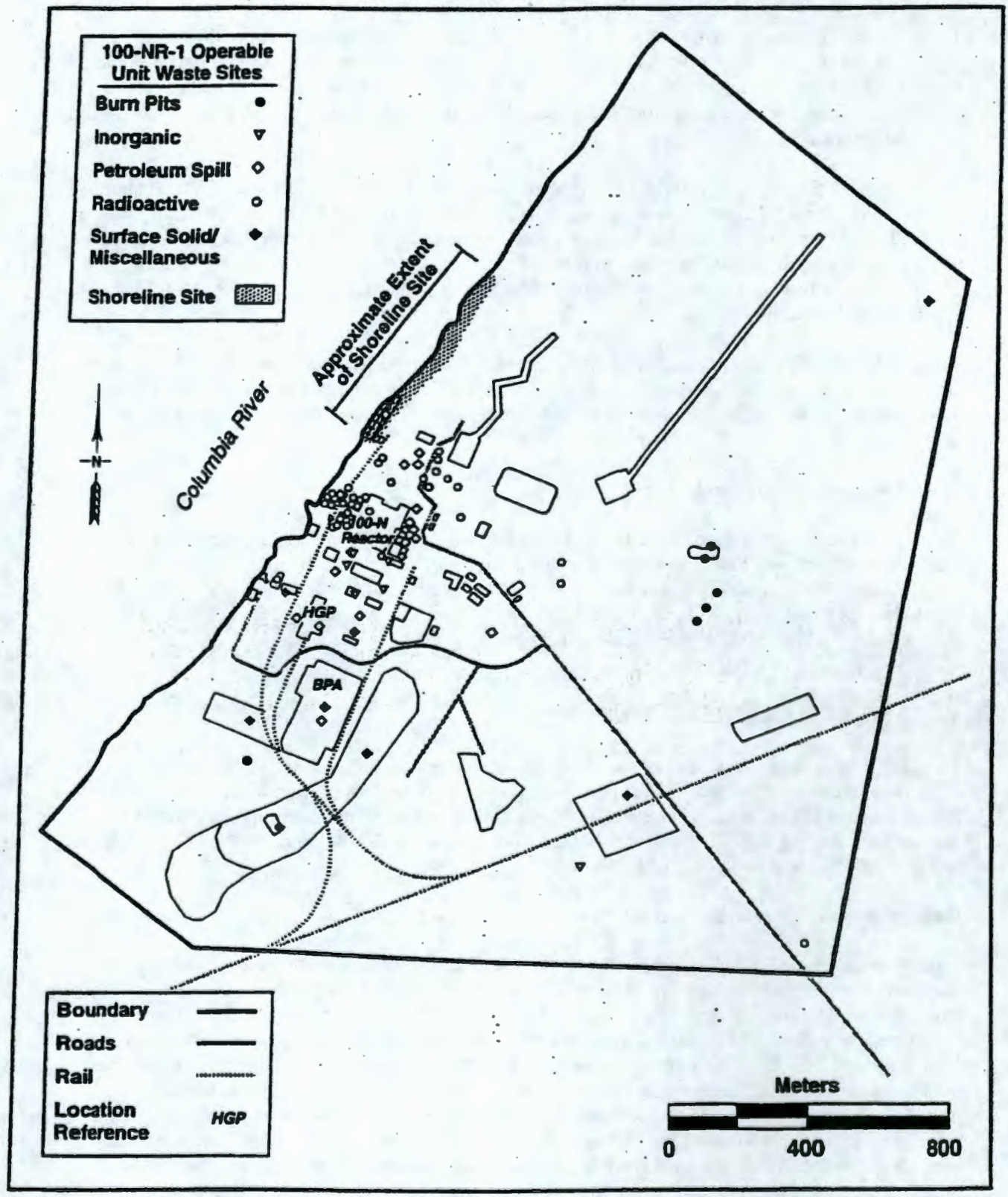


Figure 2 – 100-NR-1 Operable Unit

The purpose of the interim remedial actions is to identify and reduce potential future threats to human health and the environment from waste site contaminants. An additional ROD will be issued in the future to address the burial grounds in the 100 Area. It is anticipated that after all remedial actions are completed, a final risk assessment for the 100 Area NPL site will be completed. A final ROD will then be issued for the NPL site.

Consistent with the previous 100 Area soil cleanup decisions, and pending issuance of a final land use determination, the Tri-Parties have agreed to remediate the 100-NR-1 and 100-NR-2 OUs, to the extent practicable, so future use of the land is not precluded by contamination left from past Hanford Site operations. The objective of these interim remedial actions is to remediate the 100-NR-1 sites and the 100-NR-2 groundwater to minimize potential direct exposure effects, air and groundwater releases, and ecological and cultural impacts.

The 100 Area of the Hanford Site is complex and contains many individual waste sites. Based on the circumstances presented by the 100 Area, the use of an innovative approach to remediate individual waste sites will enhance the efficiency of the selected remedy. The approach is the "observational approach."

The Observational Approach

This approach relies on information from historical process operations including information on historical liquid effluent discharges and information from LFI's on the nature and extent of contamination, combined with a "characterize-and-remediate-in-one-step" methodology. Remediation of the sites specified in Appendix B proceeds until it can be demonstrated through a combination of field screening and confirmational sampling that cleanup goals have been achieved.

V. SITE CHARACTERISTICS

This section presents general facility and operation information about the Hanford Site and the 100-N Area. Also included are detailed descriptions and background discussions for the individual waste sites and the associated contaminants of concern. The information was compiled from many different sources including the 100-NR-1 and 100-NR-2 LFI reports, the 100-NR-1 and 100-NR-2 QRA reports, and the 100-NR-1 and 100-NR-2 CMS.

Hanford Facility Operations in the 100-N Area

Nine (9) water-cooled, graphite-moderated plutonium production reactors were constructed along the Columbia River at the Hanford Site between 1943 and 1963. The 100-N Reactor, the last to be built, is situated in the 100 Area in the northern part of the Hanford Site on a broad strip of land along the Columbia River about 48 km (30 mi) northwest of the city of Richland, Washington. The 100-N Reactor differs from the other reactors at Hanford, not only because of its closed-loop cooling system, but because it was designed as a dual-purpose reactor capable of producing both special nuclear material and steam generation for electrical power. Although called a "closed-loop cooling system," it actually operated as a bleed-and-feed system where a portion of the cooling waters were constantly bled off and replaced with fresh demineralized water. The cooling effluent removed from the loop eventually made its way to the 116-N-1 and 116-N-3 Liquid Waste Disposal Facilities (LWDFs).

The N Reactor operated between 1963 and 1987. It was designed for two modes of operation: (1) plutonium production; and (2) plutonium production with steam production as a byproduct. The byproduct steam was used to produce electricity in the adjacent Hanford Generating Plant (HGP), a Bonneville Power Administration (BPA) switching station. The 100-N Reactor went into production in

December 1963. The HGP was completed and started producing electrical power in April 1966. Both the reactor and the generating plant operated continuously, except during periodic shutdowns for maintenance and repairs, until January 7, 1987. The reactor was retired in October 1989, and orders were received to shut down the reactor in October 1991. Figure 3 shows the facilities in the 100-N Area, including some of the unplanned releases (UPRs) in the 100-N Area.

The 100-NR-1 OU encompasses an area of approximately 405 hectares (over 1,000 acres) and contains the N Reactor, the HGP, and adjacent support facilities. Reactor operations and former waste-handling practices have caused contamination in the soil around the N Reactor, the HGP, and the adjacent support facilities, and in the 100-NR-2 OU.

Site-Specific Geology and Hydrogeology

Stratigraphic divisions underlying the 100-N Area include the Hanford Formation, the Ringold Formation, and the Elephant Mountain Member of the Saddle Mountains Basalt. The Hanford Formation overlies the Ringold Formation and consists of two (2) gravel-dominated facies: an upper cobble-boulder unit and a lower pebble-cobble unit. The Ringold Formation overlies the Elephant Mountain Member and consists of seven (7) units. Thickness ranges for the Hanford Formation and the Ringold Formation are 5.8 to 24.5 m (19 to 77 ft) and 137.2 to 150.6 m (450 to 494 ft), respectively.

The upper portion of the Hanford Formation is composed of unconsolidated basaltic cobble and boulder-sized clasts. Cobbles as large as 15 cm (6 in.) were encountered during drilling in the vicinity of the units, although boulders as large as 0.9 m (3 ft) can be seen around 116-N-1 and 116-N-3. Below the cobble-boulder unit, clast size decreases to pebbles and cobbles with local dominant sand. The gravel and sand are predominantly basaltic in composition. Sometimes significant sand layers are intercepted during drilling. Sand layers from 3 to 4.9 m (10 to 16 ft) thick, consisting of very coarse to fine sand, have been encountered. In the vadose zone, sand layers may have promoted the localized lateral spread of contamination from 116-N-1 and 116-N-3 and other 100-NR-1 units during their operation. The sand zones are discontinuous and cannot, with certainty, be traced between wells.

Extensive grading, excavating, and backfilling of the surficial Hanford Formation have occurred within and around the 100-NR-1 OU. Consequently, it is difficult to distinguish undisturbed Hanford Formation from anthropogenically disturbed Hanford Formation because of similar bulk composition. The zone of disturbed material is up to 6.1 m (20 ft) thick and consists of unconsolidated basaltic cobble- to boulder-sized clasts with sand infilling. Clasts often exhibit white calcium carbonate coatings.

The underlying Ringold Formation is composed of fluvial pebble- to cobble-sized gravels with a silty sandy matrix. The sediments range from well-cemented, with carbonates and/or iron oxides, to uncemented. Cementation is discontinuous but laterally extensive. Basalt content of the gravels is typically less than 50% by volume. Some thin discontinuous sand lenses are found in the areas of 116-N-1 and 116-N-3. The contact between the Hanford Formation and the Ringold Formation is sometimes difficult to determine because a transition zone of reworked Ringold Formation is often present. The contact is a potential perching layer in the vadose zone because of the cemented nature of the Ringold Unit E. However, no perched water was observed during the 1995-1996 LFI activities.

Groundwater in the unconfined aquifer flows primarily in a west-northwesterly direction most of the year and discharges to the Columbia River. Fluctuations in river stage, because of dam operations and seasonal variations, can impact the flow direction, hydraulic gradients, and groundwater levels within the unconfined aquifer. The significant stratigraphic divisions at and above the water table at 116-N-1

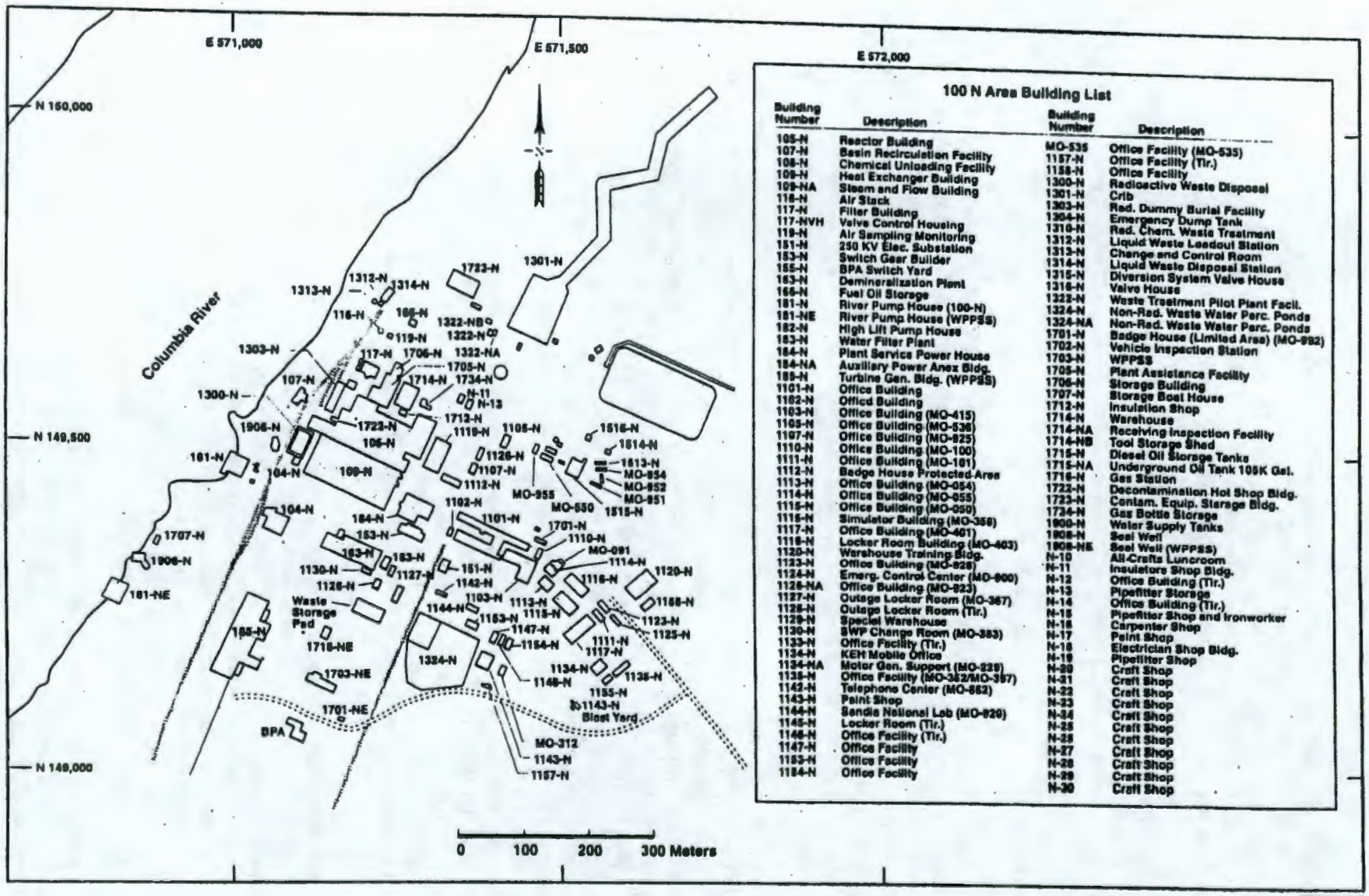


Figure 3 – 100-N Area Facility

and 116-N-3 are the Ringold Formation and the Hanford Formation. The unconfined aquifer is contained in the gravel-dominated Unit E lithofacies of the Ringold Formation. Detailed descriptions of the Hanford and Ringold Formations are found in *Hydrogeology of the 100-N Area, Hanford Site, Washington*, WHC-SD-EN-EV-027.

Fluctuations in river stage, caused by dam operations, and seasonal variations have the same general impact on flow direction, hydraulic gradients, and groundwater levels throughout the 100-N Area.

Contamination associated with 100-NR-1 waste sites ranges from surface contamination, such as at the 128-N-1 Burn Pit or the 100-N-47 Military Site, to very deep contamination, probably reaching groundwater (18 to 23 m [60 to 75 ft] for most of the 100-N Area), such as at 100-N-28 Resin Disposal Pit No. 2 and UPR-100-N-7 Return Line Leak. Approximate depth to groundwater near the 116-N-1 Crib is 19 m (60 ft) and near the 116-N-3 Crib it is 22 m (72 ft).

Ecological Analysis

Ecological surveys and sampling have been conducted in the 100 Areas and in and along the Columbia River adjacent to the 100 Areas. Sampling included plants with either a past history of documented contaminant uptake or an important position in the food web, such as river algae, reed canary grass, tree leaves, and asparagus. In addition, samples were collected of caddisfly larvae (next step in the food chain from algae), burrow soil excavated by mammals and ants at waste sites, and pellets cast by raptors and coyote scat to determine possible contamination of the upper end of the food chain. Bird, mammal, and plant surveys were conducted and reported in *Fiscal Year 1992 100 Area CERCLA Ecology Investigations*, WHC-EP-0448. Contamination data have been compiled from other sources, along with ecological pathways and lists of all wildlife and plants at the site, including threatened and endangered species. This information has been published in *A Synthesis of Ecological Data from the 100 Area of the Hanford Site*, WHC-EP-0601.

As indicated in various annual Hanford Site Environmental Reports[1], analysis of terrestrial and aquatic wildlife for radionuclides have indicated that some species have accumulated levels of radionuclides greater than background. Sr-90 has been detected in the offal of Columbia River whitefish and suckers at levels slightly exceeding levels found in a population of whitefish upstream in the Wenatchee River. Significant levels of Sr-90 have been found in skulpins. Elevated levels of Sr-90 have also been measured in goose bone and eggshells collected from Hanford Reach islands and a background island upstream of the Hanford Site. Collectively, the levels of radionuclides measured in Hanford fish and wildlife indicate accumulations of small amounts of specific radionuclides that possibly originated either from historic fallout or Hanford Site activities.

Cultural Resources Review

Thirty-one (31) archaeological sites have been recorded within 2 km (1.2 mi) of the 100-N Area perimeter. Four (4) of these sites are either listed, or are considered eligible for listing, on the National Register. Three (3) sites, two (2) housepit villages, and one (1) cemetery comprise the Ryegrass Archaeological District. The HGP site is already listed in the National Register. Three (3) areas near the 100-N Area are known to have been of some importance to the Wanapum. The knobs and kettles surrounding the area may have been called *Moolimooli*, which means "little stacked hills." Sites of religious importance may also exist near the 100-N compound.

The most common evidence of historic activities now found near the 100-N Area consists of historic archaeological sites where farmsteads once stood. Sixty-six (66) Cold War-era buildings and structures

[1] Prepared and published annually for DOE by the Pacific Northwest National Laboratory under Contract DE-AC06-76RLO 1830, the most recent of which is the *Hanford Site Environmental Report for Calendar Year 1997*, PNNL-11795, September 1998.

have been inventoried in the 100-N Area. Thirty (30) 100-N Area buildings/structures have been determined eligible for the National Register as contributing properties within the Hanford Site Manhattan Project and Cold War Era Historic District. These include the 105-N Reactor, 109-N Heat Exchanger Building, 1112-N Guard Station, 181-N River Water Pump House, 183-N Water Filter Plant, 184-N Plant Service Power House, and 185-N Export Powerhouse (Figure 3). The history of these eligible properties, up to and including demolition, have been documented in the *N Reactor Comprehensive Treatment Report, Hanford Site, Washington*, DOE/RL-96-91; the *Reactor Operations*, section of Chapter 2 of the Historic District Treatment Report (to be completed in fiscal year 2000); and individual Historic Property Inventory Forms. This documentation was authorized under the *Historic Building Programmatic Agreement*, DOE/RL-96-77, and was conducted through the ongoing Historic Buildings Mitigation Project. However, as required by Stipulation V (C) of the Programmatic Agreement, assessments of the contents of the contributing properties need to be performed prior to any deactivation, decontamination, or decommissioning activities. The purpose of an assessment will be to locate and identify any artifacts (e.g., control panels, signs, scale models, etc.) that may have interpretive or educational value as exhibits within local, state, or national museums.

Waste Disposal Practices

Figure 3 provides the location for various 100-N Area facilities. Liquid wastes were disposed of in the 100-N Area soil column and to the Columbia River in a variety of ways including outfalls, spillways, cribs, ponds, pits, french drains, and septic systems. Each of these systems is discussed below. There are two (2) Columbia River outfall structures in the 100-N Area: the 1908-N and 1908-NE Outfall Structures. The 1908-N Outfall was designed primarily for the discharge of raw river water that was used to remove heat from the secondary cooling system, using dump condensers located in the reactor facility. It also provided a disposal method, on an emergency basis, for primary cooling water and fuel storage basin water. The outfall structure includes a reinforced-concrete weir box that discharged to the bottom of the Columbia River via a 2.6 m (102 in.) diameter steel pipeline. The 1908-NE Outfall served the same purpose as the 1908-N Outfall, but serviced only the HGP facilities. Because the HGP is physically isolated from the reactor facilities, this outfall did not provide for emergency disposal of primary reactor coolant or fuel storage basin effluent. The 1908-N and 1908-NE Outfalls were permitted under the Hanford Site National Pollutant Discharge Elimination System (NPDES) permit and are still identified in the permit. However, all discharges via these outfalls have been discontinued.

Spillways were used for nonradioactive/nonhazardous wastewater disposal from both the 182-N Emergency Pumping Station and from water supply holding tanks located adjacent to the 182-N Building. These discharges consisted of cooling water from the pump bearings and overflow from the water supply holding tanks. All of the spillways discharge directly to the Columbia River and are permitted under the NPDES permit.

In order to maintain low dose rates and an efficient cooling system associated with the reactor core, the steam generator, and the fuel storage basin work areas, fresh demineralized water was added to these independent systems, and the wastewater (bleed off) was discharged to the 116-N-1 (1301-N) and 116-N-3 (1325-N) cribs and trenches. Portions of the primary coolant system were treated chemically with hydrazine, ammonium hydroxide, and morpholine for pH and corrosion control. These treated wastewaters were also discharged to the crib and trench disposal facilities. Wastewater, which was collected from sumps and from drains designed to manage radioactive wastes within the facility, was also discharged to the crib and trench facilities. These drains contained effluent from water quality laboratories, personnel decontamination stations, waste transfer stations, and from floor drains located in controlled, contaminated areas of the reactor building. The liquid waste stream discharged to the crib and trench facilities averaged 3,785 L/min (1,000 gal/min). In the early 1980s, the average was as high as 6,057 L/min (1,600 gal/min), primarily due to system drain valve leakage. However, the

leakage was corrected during normal maintenance outages, and the average discharge flows returned to approximately 3,785 L/min (1,000 gal/min).

Settling and percolation ponds were used in the 100-N Area to settle out solids from filter backwash, to treat corrosive regeneration effluent, and to dispose of backwash effluents. The ponds were generally unlined trenches with sloped sides. One exception is the 183-N (130-N-1) Filter Backwash Discharge Pond, which is a naturally low, marsh-like basin. This filter backwash discharge pond received filter backwash from the 183-N Facility.

The 183-N Water Treatment Facility included a chemical treatment facility, flocculation basins, and a filter system. Water was pumped directly from the Columbia River via the 181-N Pumphouse. During treatment, chemicals were added (flocculants and chlorine) to the water. The water was then filtered and separated into the various systems, such as the on-site potable water system, the fire protection system, and the demineralized water supply. The 163-N Demineralization Plant provided demineralized water for reactor primary coolant systems. The Plant demineralized, filtered, and treated the water; degassed it; and pumped it to a demineralized water storage tank. Large ion-exchange columns were located in the 163-N Demineralization Plant to remove minerals from the filtered water. This demineralized water was used in the primary, secondary, and fuel storage basin cooling water systems. Sodium hydroxide and sulfuric acid (H_2SO_4) were used to regenerate these ion-exchange columns. The NaOH and H_2SO_4, following regeneration, were discharged to the 163-N neutralization pit and a french drain.

Pits were also used in relation to the demineralization facilities. The resin disposal pit, located adjacent to the 183-N Clearwell, received flushed depleted ion-exchange resins. The flush water percolated to soils, and the remaining resin was collected and disposed of as solid waste. The pit was also used to dispose of overflow filtered water from the adjacent 183-N Clearwell. Neutralized wastes created by an unplanned release originating in the 108-N transfer system (acid leak) were also disposed in this pit. A second resin disposal pit, located near the 184-N Powerhouse, is better described as a french drain.

French drains and dry wells were generally used for the disposal of nonradioactive/nonhazardous liquid wastes. Dry wells and french drains are similar in construction. Dry wells usually have a large void space, while french drains are usually filled with coarse gravel.

In the 100-N Area, there are several french drains and dry wells for the disposal of steam condensate. A dry well (located north of the 1734-N Building) and a french drain (located north of the 13-N Building) are good examples of these types of waste sites. The dry well was used for the disposal of flush water from a fire protection header located within the 1734-N Building. The french drain, near the 13-N Building, was used as a steam condensate disposal point for steam trace lines to the 1310-N Facility and oil transfer piping systems.

There were three (3) types of septic systems at the 100-N Area: septic tank and drain field, septic tank and/or cesspool, and a pond-type treatment facility. Currently there are three (3) active septic systems located at the 100-N Area: a septic tank/cesspool system (124-N-1), one (1) septic tank and drain field system (124-N-1 and 124-N-9), and a pond treatment system (124-N-10). At the pond treatment system, three (3) ponds are arranged in a cascading overflow configuration. The third pond is unlined and allows percolation of the liquid effluent to soil. The first two (2) ponds are lined, and treatment is by air injection, biodegradation, and mixing.

The remaining septic systems have all been taken out of service and reportedly have been pumped out. Several are reported to have been backfilled with sand and have been abandoned in place. The abandoned and sand-filled systems include 124-N-5, 124-N-6, 124-N-7, and 124-N-8. Pumped and isolated systems include 124-N-2 and 124-N-4.

Disposal of radioactive solid waste generated at the 100-N Area was limited to the temporary storage of irradiated spacers in three large silos located northwest of the fuel storage basin. When the silos became full, the spacers were removed, packaged, and disposed of in radioactive burial grounds outside the 100-N Area. All remaining spacers were removed in late 1995 and early 1996. The silos remain in place, and soils adjacent to and under the silos may be contaminated. All other radioactive solid wastes, including those generated at the HGP facility, were packaged and disposed of in burial grounds outside the 100-N Area.

Other solid waste disposal in the 100-N Area was limited to nonradioactive construction debris and burning pits. Often, construction debris disposal sites were used as burning pits to dispose of combustible wastes. Most of the waste disposal occurred in a narrow strip east-southeast of the reactor. Many of these disposal sites include nonradioactive/nonhazardous wastes generated at the HGP and BPA facilities. Some isolated areas of construction-type debris can be found north of the reactor near the river shoreline.

Spill/Unplanned Release History

Throughout the operational history of the N Reactor, significant spills were documented in unplanned release reports. The unplanned release reports were used for reporting and tracking the activities associated with each spill. Spills in the 100-N Area consisted of three basic types: radioactive, corrosive, and petroleum.

Radioactive spills occurred with an unplanned release of radioactive wastewater or material. Releases occurred when valves, piping systems, or holding facilities were broken, corroded, or overfilled. Generally, these spills occurred below ground and were noted when contaminated water appeared at the surface, the ground subsided at the leak point, or elevated contamination levels were detected in nearby monitoring wells. A few of these spills resulted from overfilling or over-pressurizing the system.

Corrosive material spills consisted of either NaOH or H_2SO_4. These spills were likely buffered out by the soil to a nonhazardous state and, therefore, no remedial action is considered necessary. Spills or leaks occurred either through failure of the transport system (corrosion of the lines) or operator error during transfers from rail cars or trucks to storage facilities.

Petroleum spills occurred through corrosion failure of piping systems used to transport diesel fuel oils, or because of overfilling of a storage facility. Very small spills also occurred at transfer points from rail cars and tanker trucks.

Previous Response Actions

Response to unplanned releases or spills depended on the location of the spill, the constituents involved, and the potential impact to worker safety and the environment. Spills that were likely to have an impact on humans or the Columbia River were remediated, to the extent possible, at the time of the spill to mitigate potential impacts. For example, caustic or acid spills were neutralized, and the bulk of the contaminated soils was immediately removed to a disposal site.

Oil leaks were intercepted, where possible, to recover the oil near the location of the spill. For example, oil detected in monitoring wells was pumped out to the extent possible by the existing technology. In the case of one major oil spill, an interception trench was dug along the river shoreline, and the intercepted oil was burned. Oil-contaminated soils were removed for disposal elsewhere, when possible.

Radiologically contaminated spills were either stabilized by a cover of clean fill material or were removed and disposed of as radioactive solid waste. Generally, radiologically contaminated soils were removed until a level of approximately 10,000 disintegrations per minute (dpm) was obtained. Radiologically contaminated wastes were packaged and disposed of in radioactive burial grounds. Burial grounds that were routinely used were located in the 100-B, 100-D, 100-K, and the 200 Areas.

A groundwater pump and treat system has been in operation since September 1995 as part of an expedited response action at the 100-NR-2 OU. This system provides removal of Sr-90 from extracted groundwater, treatment of Sr-90 by ion exchange, and return of treated groundwater to the unconfined aquifer using upgradient injection wells. This system provides hydraulic control of groundwater to the river and has been shown to stop at least 90% of the mass of Sr-90 from reaching the Columbia River at the point of hydraulic control. Continuation of this pump and treat system is the interim action selected in this ROD for the 100-NR-2 OU.

Nature and Extent of Contamination and Investigative Approach

The LFIs were undertaken for the 100 Area OUs in a manner consistent with the *Hanford Past-Practice Strategy* for waste sites that were considered to be candidates for interim remedial actions. The LFI included data compilation, non-intrusive investigations, intrusive investigations, 100 Area aggregate studies, and data evaluation. The purpose of the LFI reports was to identify those sites that are candidates for interim remedial actions, provide a preliminary summary of site characterization studies, refine the conceptual model as needed, identify contaminant- and location-specific applicable or relevant and appropriate requirements (ARARs), and provide a qualitative assessment of the risks associated with the sites. The assessments included consideration of whether contaminant concentrations pose an unacceptable risk that warrants action through interim remedial actions. The preamble to EPA's *National Contingency Plan* (55 Federal Register 8666) states that interim actions are appropriate to remediate sites in phases in order to eliminate, reduce, or control the hazards associated with a site or to expedite the completion of a total site cleanup. According to this preamble, a balance must be achieved in the desire to definitively characterize site risks and analyze alternative remedial approaches for addressing site risks in detail with the desire to implement protective measures quickly. EPA's intent was expressed in the preamble as a bias for action in order to eliminate, reduce, or control hazards posed by a site as early as possible. Interim remedial actions are intended to achieve remedies that are expected to be consistent with final actions and a final ROD.

100-NR-1 Source Waste Sites. The 100-NR-1 OU includes sites contaminated as a result of intentional discharges of contaminated liquid effluents to operational facilities such as cribs, neutralization basins, and french drains; unplanned releases or leaks from piping systems and storage tanks; and the placement of (sometimes burning) construction debris, used equipment, and office/industrial waste at surface disposal areas. The 100-NR-1 waste sites, their former uses, waste types (contaminant types), and designated waste group are tabulated in Appendix B. The principal contaminants of concern for the 100-NR-1 OU are radionuclides, metals, and petroleum hydrocarbons.

One hundred and fourteen (114) sites in the 100-NR-1 OU were identified in the 100-NR-1/100-NR-2 CMS as potentially contaminated source waste sites (Appendix B). Thirty-three (33) of these 114 sites were not considered further in the CMS or the Proposed Plan because they met one or both of the following criteria: (1) sites that were never contaminated or are not currently contaminated; and (2) sites that will be remediated through a process other than this interim remedial action (Section 3.2 of the CMS). One waste site (100-N-20), for example, will be addressed as part of the 100 Area Remaining Sites remedial effort. Another (UPR-100-N-31) is addressed in conjunction with the RCRA closure of the 116-N-1 treatment, storage, and disposal (TSD) unit.

Each of the remaining potentially contaminated waste sites (and associated buried pipelines) was considered under this interim remedial action. To facilitate the determination of interim remedial actions, all but one (the shoreline site) of the waste sites were placed into one (1) of five (5) waste groups based on their suspected primary contaminants and unique characteristics: radioactive, petroleum (near-surface contamination and deep contamination), inorganic, burn pit, and surface solid.

100-NR-1 Shoreline Site. The remediation of the shoreline site is closely tied to final remediation of the 100-NR-2 Groundwater OU because of the complex, dynamic relationships among the Columbia River, the contaminated groundwater in the 100-N Area, and the contaminated soils at the shoreline site. Therefore, the shoreline site was not assigned to a waste group, but was addressed separately as a single, unique waste site in the 100-NR-1/100-NR-2 CMS.

Figure 4 shows the location and extent of the shoreline site. The shoreline site contains the N-Springs (riverbank seeps) along the eastern shore of the Columbia River as well as associated contaminated soil from groundwater discharge (mainly contaminated with Sr-90) and diesel fuel-contaminated soil from waste site 100-N-65(an interceptor trench built to collect diesel/fuel oil leaked to the groundwater). Although addressed separately due to differences with respect to source of contamination, contaminants of concern, and potential remedial action, these two (2) areas overlap and together constitute the shoreline site for the purpose of selecting interim remedial alternatives.

The shoreline site is approximately 840 m (2,772 ft) long and 22 m (73 ft) wide. The lateral boundaries are generally defined as the river's edge at the low-river stage (115 m [378 ft] above mean sea level), and the river's edge during a 300-year flood event (estimated at 123 m [402 ft] above mean sea level). The N-Springs are the result of groundwater discharge from the unconfined aquifer flowing under the 100-N Area, and from the release (at certain times of the year) of Columbia River water held in bank storage. The soil in the vicinity of the N-Springs became contaminated, primarily with Sr-90, as a result of the release of reactor cooling water and reactor decontamination solutions at the 116-N-1 and 116-N-3 Cribs and Trenches. Sr-90 concentrations in the soil aquifer sediments associated with the shoreline site are depicted in Figure 5. The cribs and trenches were designed to remove radionuclides from the reactor effluent water using the natural ion exchange and adsorptive capacities of the soil below these facilities. However, a percentage of the radionuclides were not fully captured in the soil column and migrated with groundwater to the shoreline area. Groundwater carrying these radionuclides, and possible other contaminants, enters the Columbia River via the riverbank seeps, or subsurface discharge to the river-bottom substrate, because of preferential flow paths of the groundwater in the area. The radioactive water discharged to the cribs and trenches contained activation and fission products, chemicals, from reactor cooling system decontamination processes, and other chemicals such as sodium dichromate.

100-NR-2 Groundwater Contamination. The 100-NR-2 OU encompasses the contaminated groundwater underlying the 100-N Area. During the years of reactor operations until shortly after reactor shutdown, large volumes of reactor coolant wastewater containing activation and fission products, as well as small quantities of corrosive liquids and laboratory chemicals generated by various N Reactor operations, were discharged to the soil through cribs and trenches. These wastewaters, as well as other smaller contributions disposed or spilled from facilities within the 100-N Area, infiltrated through the vadose zone soil and contaminated the groundwater. Because the large quantities of liquid effluents discharged to the soil during the operation of the N Reactor have been eliminated, the major driving force for migration of contaminants to the groundwater, and ultimately to the Columbia River, has been eliminated. Sr-90 is the contaminant of greatest concern in the groundwater because, without remediation, it renders the groundwater unusable for nearly 300 years and presents a potential human and environmental threat as it mixes with the Columbia River at the N-Springs area. A groundwater plume map depicting Sr-90 contamination under the 100-N Area is contained in Figure 6. This map depicts the hydraulic effects of the currently operating pump and treat system on the Sr-90 plume.

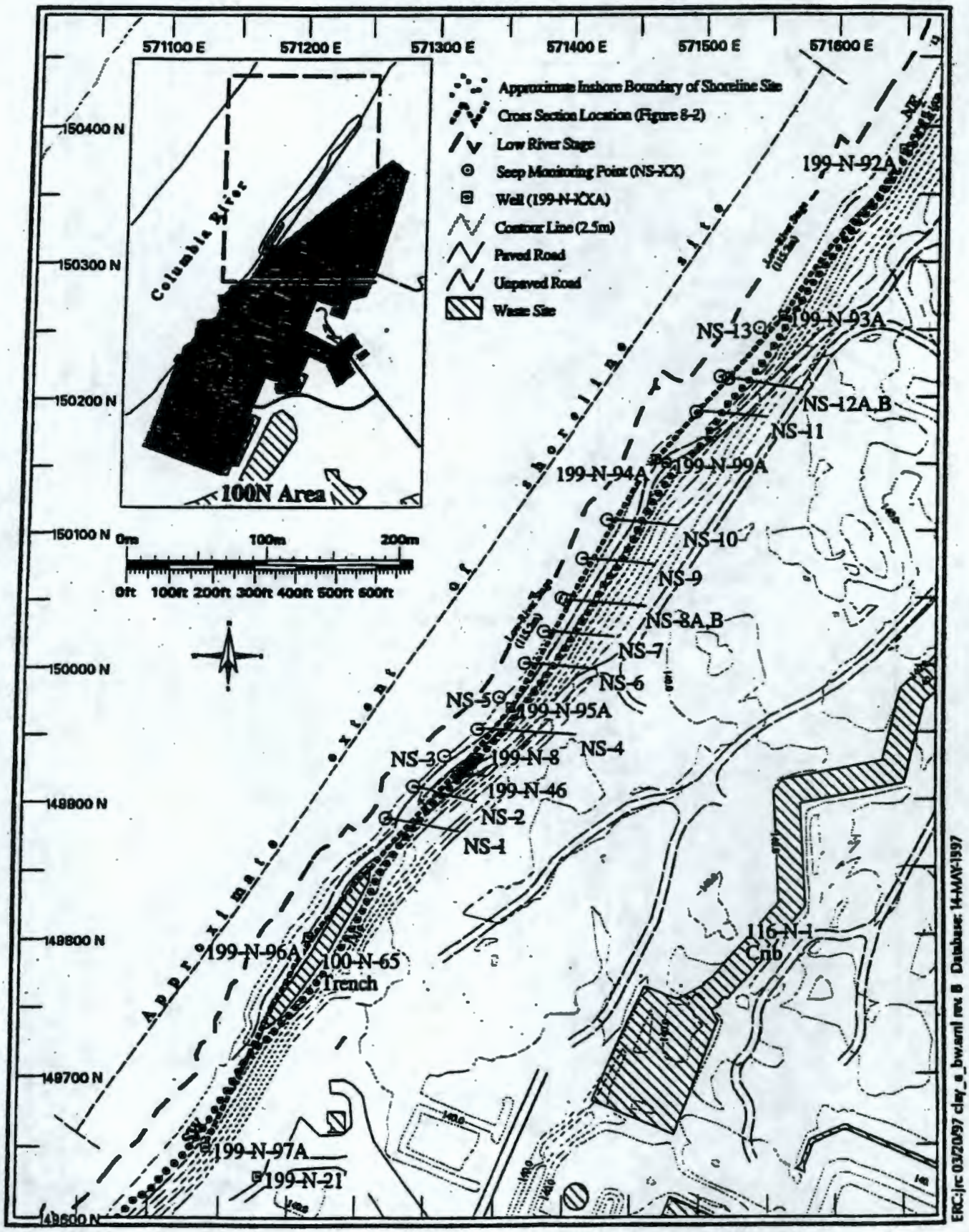
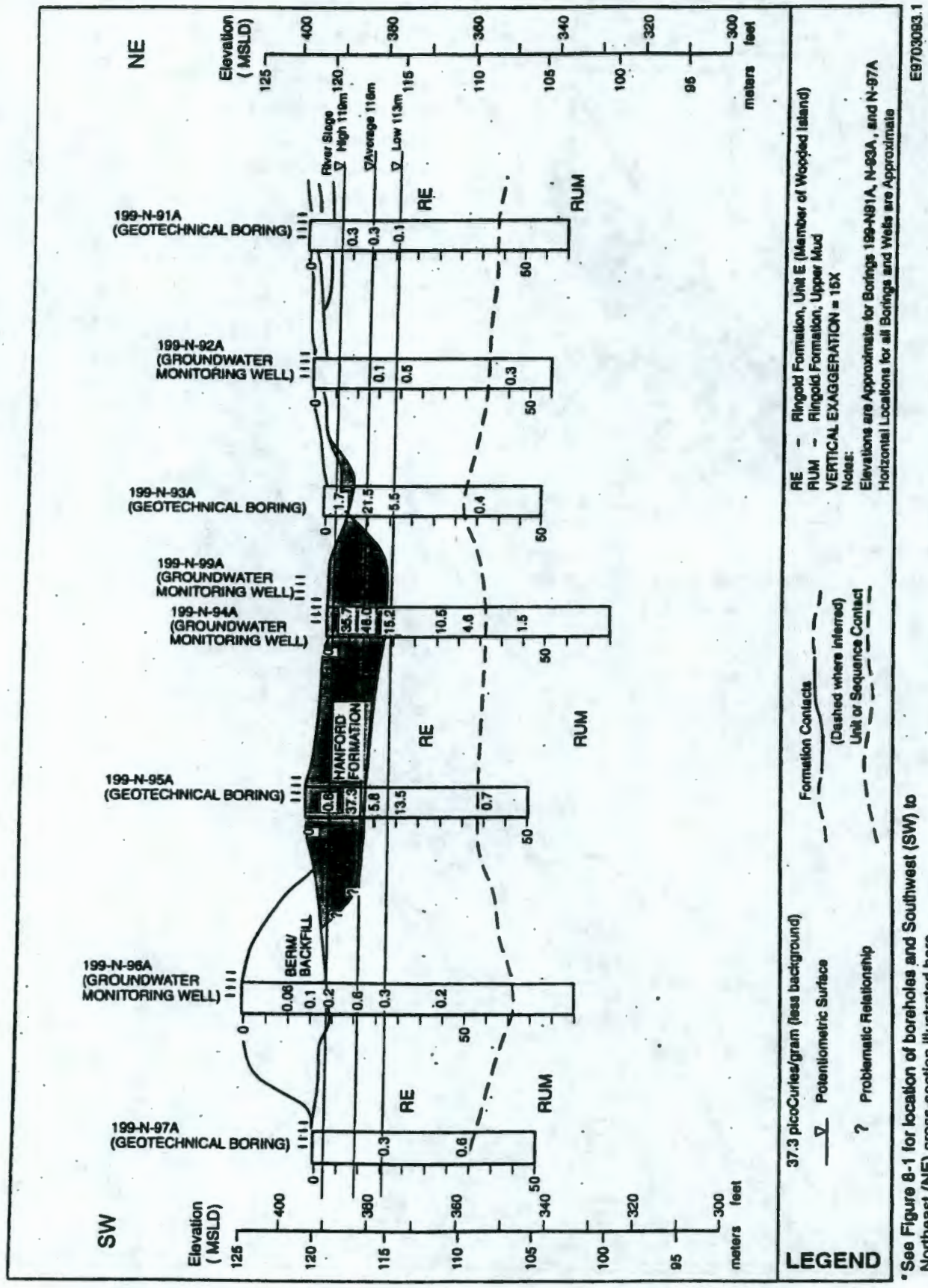


Figure 4 - Location and Extent of the Shoreline Site at the 100-N Area



*See Figure 8-1 for location of boreholes and Southwest (SW) to Northeast (NE) cross-section illustrated here.

Source: BHI, 1995

Figure 5 - Strontium-90 Concentrations in Soil Aquifer Sediments Within the Shoreline Site, 100-N Area (concentrations in pCi/g corrected for background)

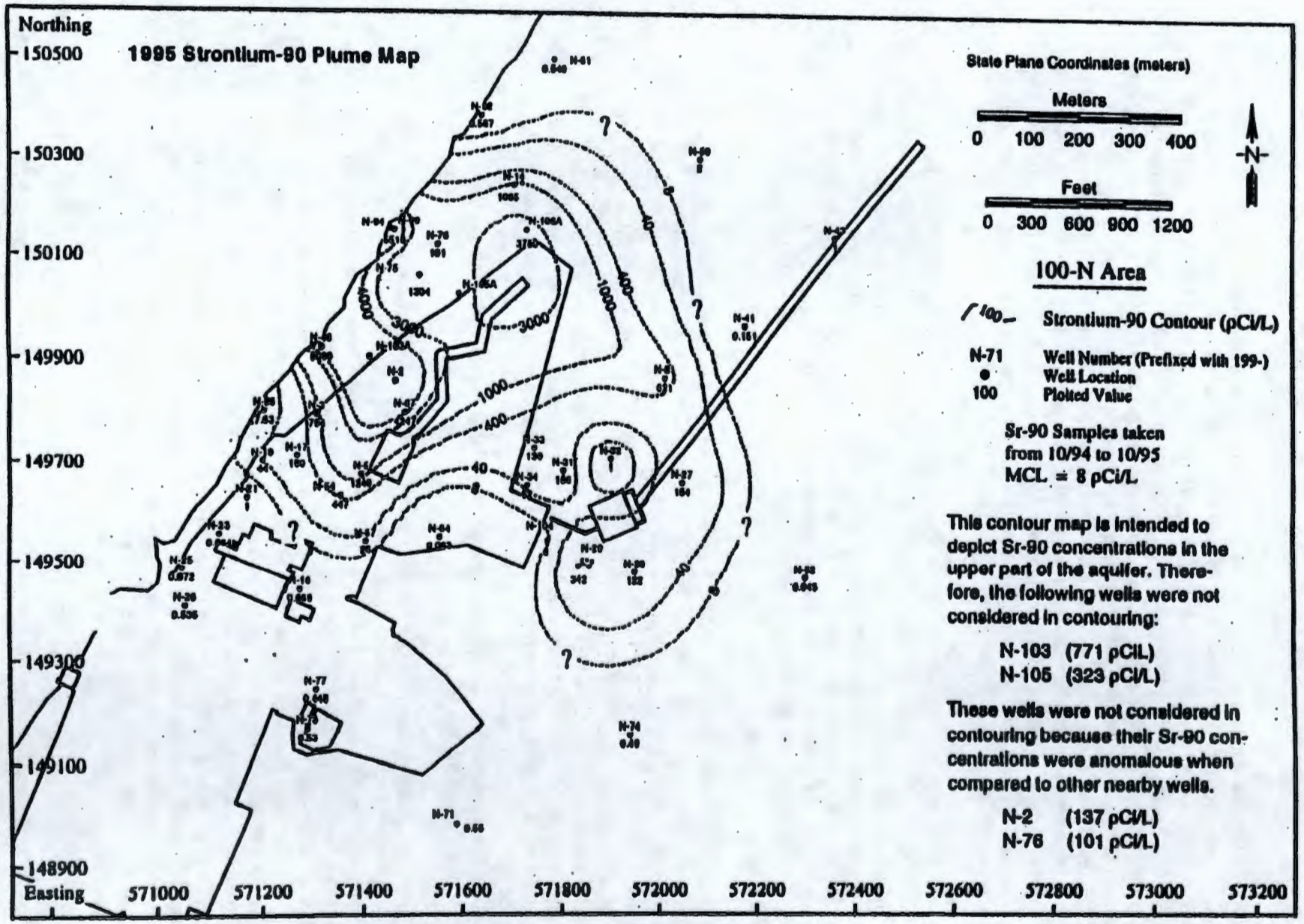


Figure 6 - Sr-90 Plume Map

The groundwater standard for Sr-90 is 8 pCi/L based on the drinking water standard. No ambient water quality standards for human and ecological protection have been published for Sr-90. Maximum Sr-90 concentrations in the groundwater over 5,000 pCi/L have been reported between 1993 and 1995 in wells near the river. Concentrations of Sr-90 in the groundwater at the point of discharge into the river have not been determined; however, given the known properties of Sr-90, it is expected that these concentrations would be similar to those found in the near-river wells. Intermittent high water in the Columbia River has caused, and will continue to cause, periods of higher Sr-90 concentrations in the groundwater and river interface as the influx of water into previously unsaturated sediments which causes the release of greater concentrations of Sr-90. Concentrations of Sr-90 in river water samples taken from sampling locations along the Columbia River have never been found to exceed drinking water standards.

The movement of Sr-90 within the wastewater discharged to the soil through cribs and trenches during reactor operations extended the contaminated soil zone to the Columbia River. This contaminated zone currently includes the aquifer and those portions of the vadose zone which were saturated during discharge operations. The equilibrium ratio of Sr-90 adsorbed onto sediments to Sr-90 mobile in groundwater is approximately 100:1, so most of the Sr-90 discharged to the cribs and trenches became bound to soil sediments. The adsorption characteristics of Sr-90 and drainage of the hydraulic mound after discharge to the cribs and trenches ceased left most of the Sr-90 bound to sediments above the water table.

The mass of Sr-90 bound in the vadose zone is estimated to be upwards of ten (10) times greater than the mass currently existing in the aquifer, but Sr-90 bound in the vadose zone is not expected to enter the aquifer. Changes in concentration measured in the monitoring wells are usually related to changes in the water table elevation and not Sr-90 mobility. When high flow or flood stage conditions in the Columbia River (such as those in 1997) resaturate the vadose zone, the Sr-90 bound to the soil desorbs. For example, groundwater samples collected during the 1997 flood stage reflected these elevated concentrations. Samples collected after the water table recovered from the flooding showed concentrations representative of the pre-flood values, indicating that the Sr-90 readsorbed to the soil once the water table recovered. Without the vertical driving force of the quantity of wastewater discharged during reactor operations, Sr-90 bound in the soil sediments above the water table is not expected to reach the aquifer.

The pump and treat system currently in use reduces the net flow of groundwater through the contaminated portion of the aquifer that would otherwise discharge into the river. The pump and treat system removes approximately 90% of the Sr-90 from the groundwater pumped through it; however, due to the equilibrium ratio of Sr-90, it is replaced by the Sr-90 from the sediments back into the groundwater. This replacement will continue for nearly 300 years, comparable to the time needed for radioactive decay to decrease Sr-90 to levels below 8 pCi/L, the drinking water standard. Little migration of the plume occurs now because of the elimination of discharge of the large volumes of wastewater and the adsorption characteristics of Sr-90. The other source of Sr-90 discharge into the river is bank storage. Bank storage refers to river water that enters the aquifer at the groundwater/river interface during high river stages, and then discharges back into the river during low river stages. Where the Sr-90 plume extends all the way to the groundwater/river interface, bank storage effects may result in additional Sr-90 discharge to the river. The pump and treat system is not capable of addressing the highly dynamic bank storage effects caused by the daily and seasonal cycles in the Columbia River.

Besides Sr-90 contamination, the groundwater currently contains tritium, nitrate, and sulfate, above the Maximum Contamination Level (MCL) or drinking water standard. Filtered chromium exceeded the MCL in only one (1) well. Filtered manganese exceeded the MCL in only two (2) wells. Total petroleum hydrocarbons (TPH) have been detected in only one (1) well at 18 mg/L. Groundwater

plume maps for tritium, nitrate, manganese, and sulfate are contained in Figures 7 through 10. Chromium and TPH contamination is not continuous, and therefore, cannot be defined in a plume map. As with the Sr-90 groundwater plume map, these maps depict the plumes during the operating pump and treat system. The effect of the pump and treat system on the co-contaminants is uncertain and has not been evaluated. Certain co-contaminant plumes are located outside the hydraulic capture and containment provided by the pump and treat system currently operating at the 100-N Area. Portions of other co-contaminant plumes are captured or contained by the pump and treat system, but the plumes in their entirety extend outside the impact of the pump and treat extraction wells. The flux of the co-contaminants to the river is reduced where the co-contaminant plumes occur within the hydraulic capture and containment of the pump and treat extraction wells. No estimates of the mass of the co-contaminants removed from the aquifer or the quantity prevented from entering the river are available at this time. The groundwater is migrating toward and has the potential of discharging into the Columbia River because of the natural water table gradient. Groundwater discharges through the riverbed and riverbank seeps at N-Springs.

VI. SUMMARY OF SITE RISKS

Potential risks to human health and ecological receptors have been evaluated in qualitative risk assessments QRAs for the 100-NR-1 and 100-NR-2 OUs. The primary objective of the results of the QRAs was to make a "yes" or "no" determination with respect to whether waste sites or the groundwater in these operable units should be considered as candidates for interim remedial measures.

The QRAs consisted of contaminant identification, exposure assessment, toxicity assessment, and human health, as well as ecological risk characterization. The contaminants of concern were identified based on historical sampling data and radionuclide inventories, as well as from the results of limited field investigation studies. The exposure assessment identified potential exposure pathways for future users of the sites. Current site risks to workers was not evaluated because no workers are located at the sites. The toxicity assessment evaluated the potential health effects to human or ecological receptors as a result of exposure to contaminants. Exposure scenarios evaluated potential use scenarios (frequent use and occasional use) in which the onset of exposures are delayed until the year 2018, based on the Tri-Party Agreement milestone for completion of remediation in the 100 Area.

Where remedial investigation results are not available, potential risks were evaluated by comparison to analogous sites with similar process history, similar environmental media, similar waste material, and similar contaminants. The waste sites contained in this ROD are considered analogous to the treatment, storage, and disposal (TSD) waste sites in the 100-NR-1 OU which are addressed through the Hanford Facility RCRA Permit.

Potential risks to human health and the environment were evaluated to determine if significant risks exist due to site contaminants. Two (2) types of potential human health effects due to contact with site contaminants were evaluated at other CERCLA sites. The first is the potential increase in cancer risks. This potential increase is expressed exponentially as 1×10^{-4}, 1×10^{-5}, and 1×10^{-6} (one in ten thousand, one in one hundred thousand, and one in a million, respectively). This means that for a 1×10^{-4} risk, if 10,000 people were exposed to a contaminant of concern for some period of time, one (1) additional person could be expected to be diagnosed with cancer in his/her lifetime. Based on current national cancer rates, approximately 2,500 people out of 10,000 are expected to be diagnosed with cancer. For the second type of potential human health effect, non-carcinogenic health impacts, a hazard index is calculated. A hazard index greater than or equal to 1.0 may pose a potential adverse human health risk.

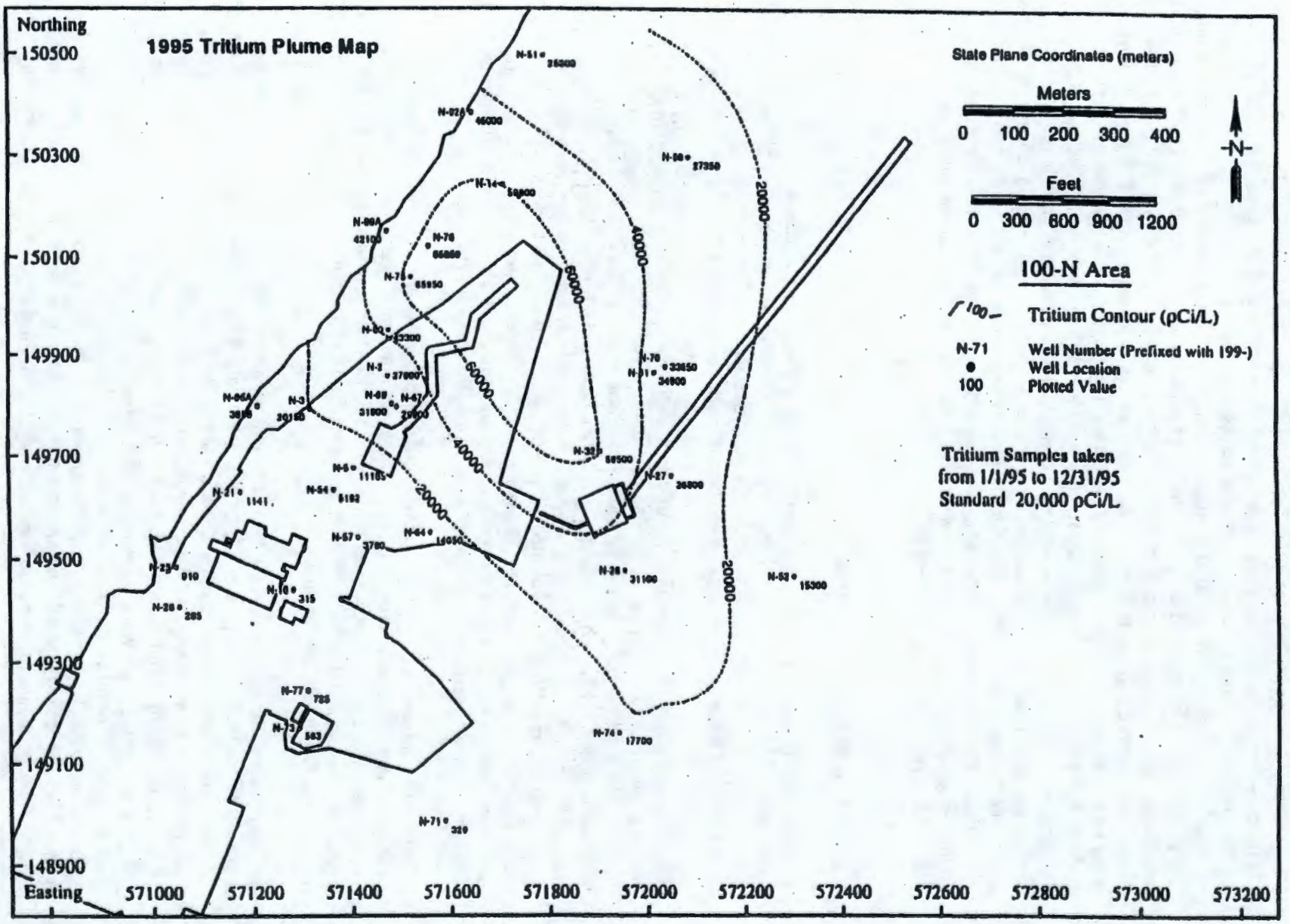


Figure 7 - Tritium Plume Map

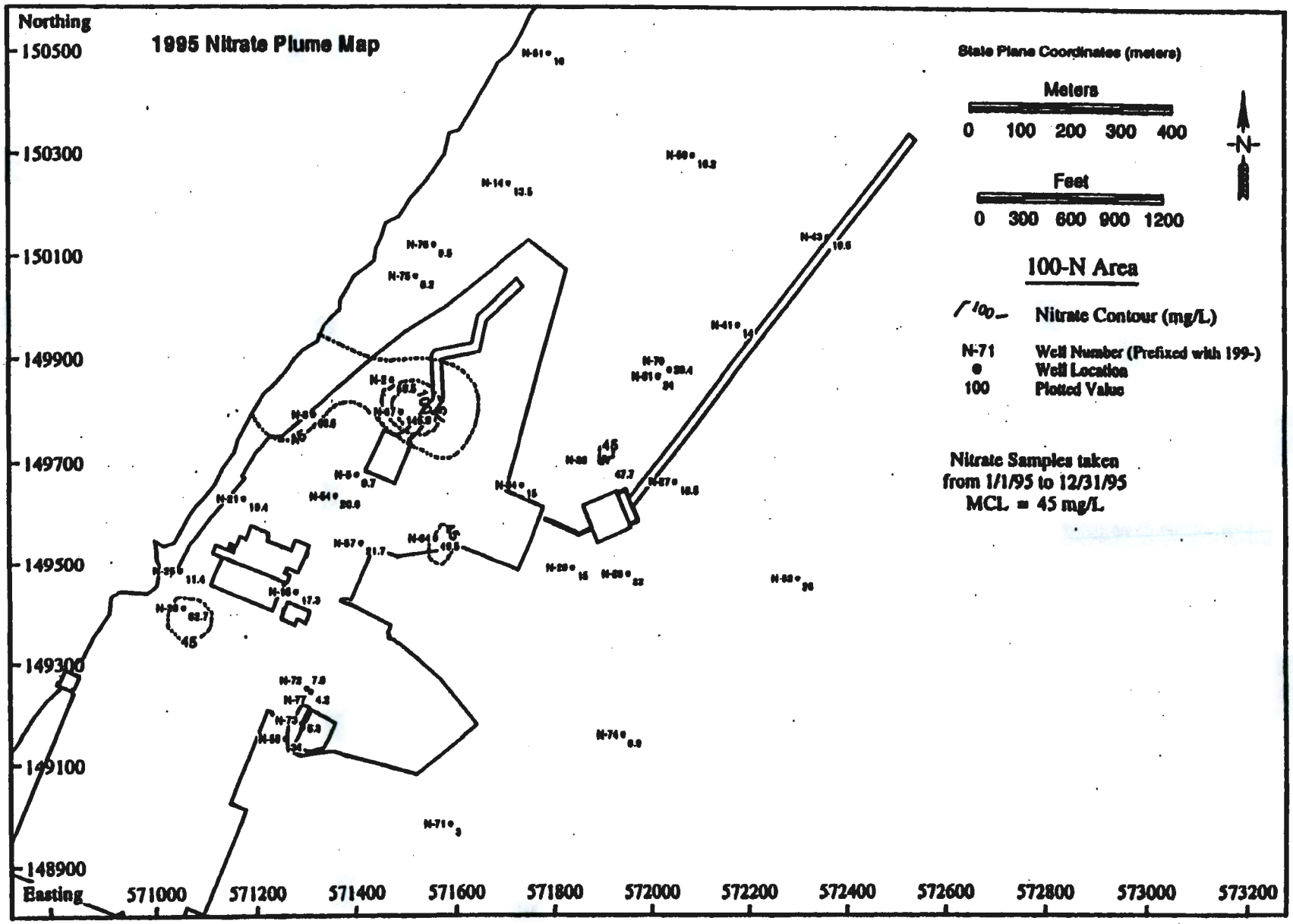


Figure 8 - Nitrate Plume Map

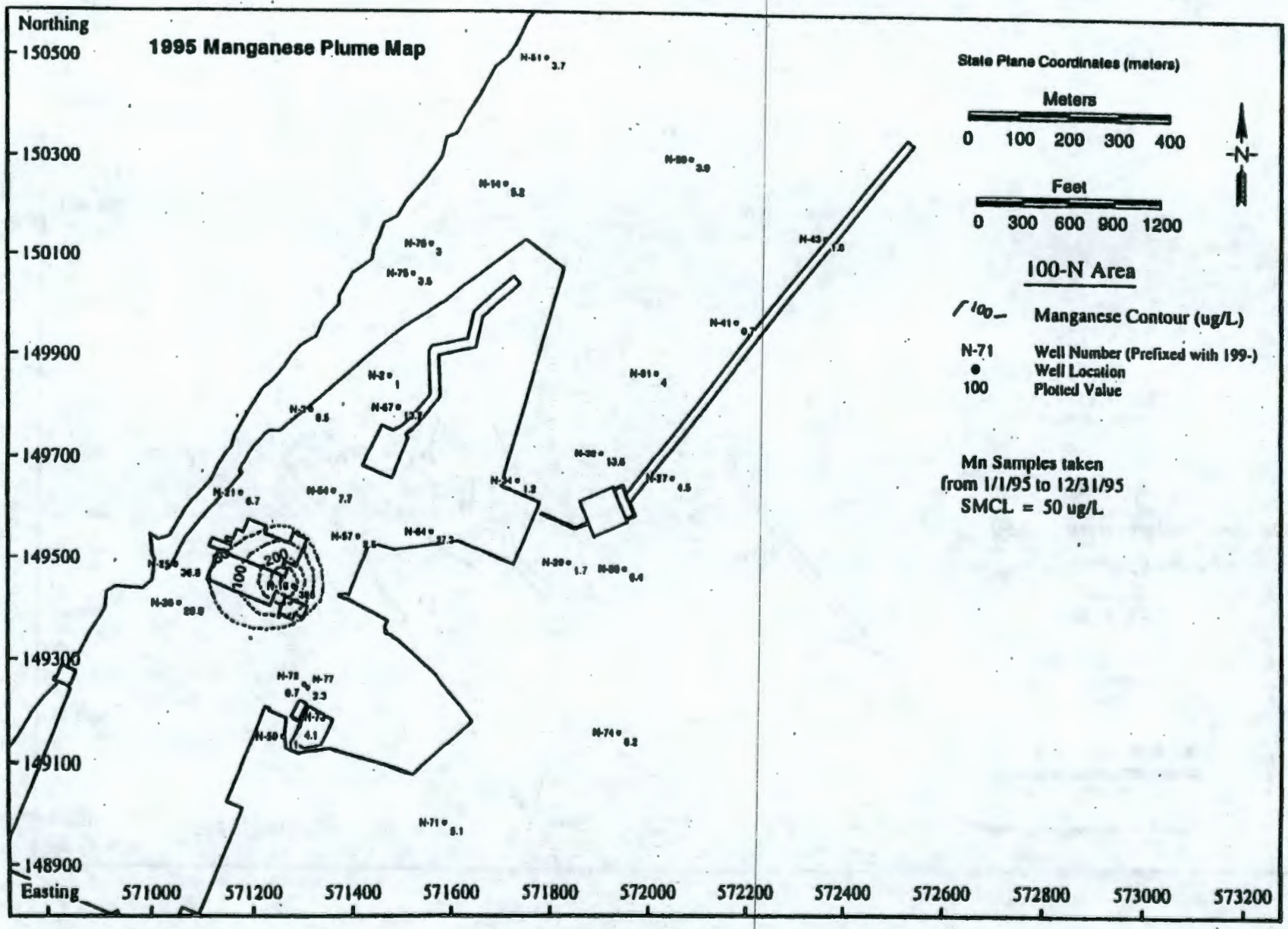


Figure 9 - Manganese Plume Map

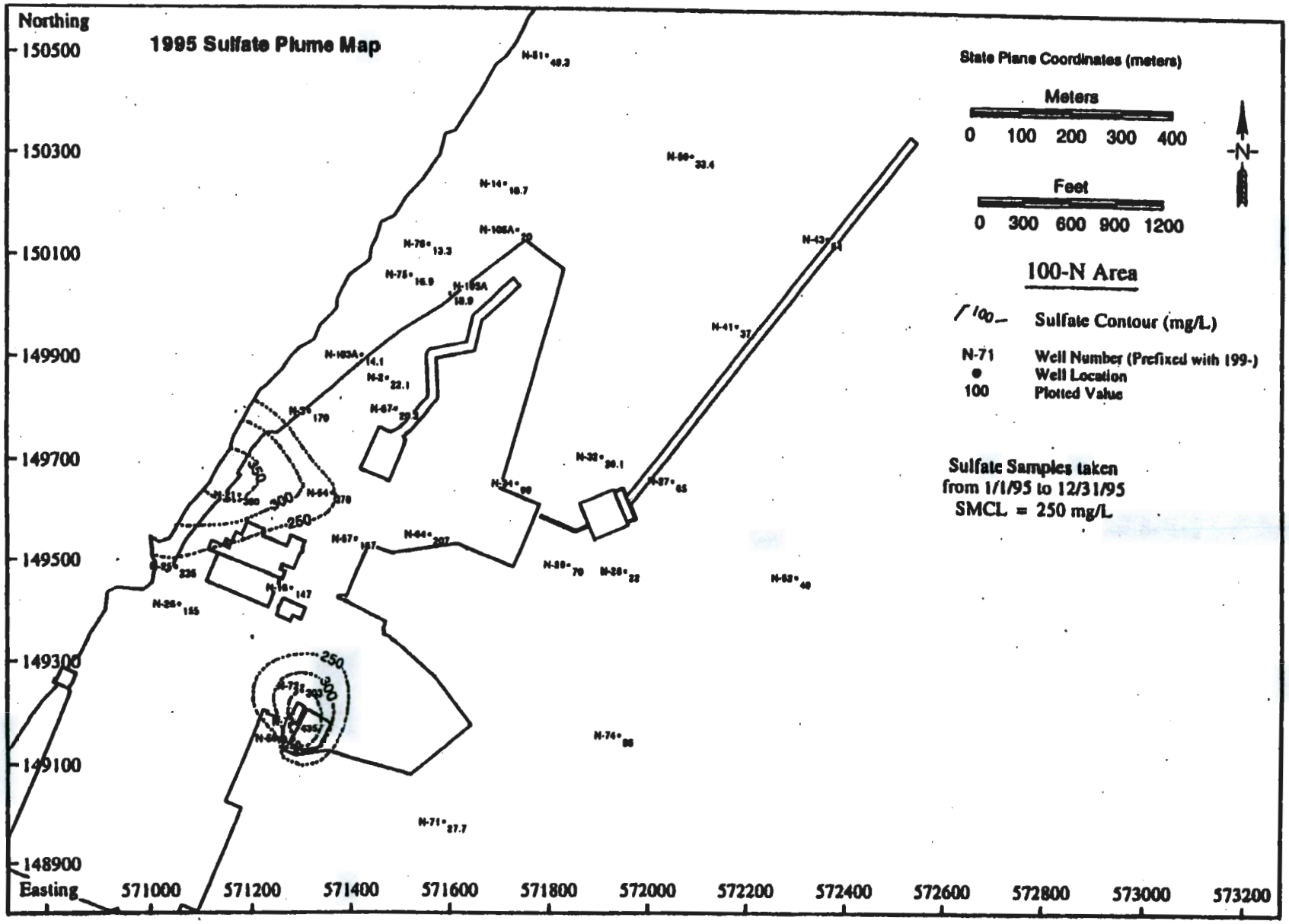


Figure 10 - Sulfate Plume Map

Qualitative Risk Assessment (QRA) Methodology. The QRA methodology consisted of an evaluation of risk for a defined set of human and environmental exposure pathways and scenarios. This methodology is not intended to be a replacement or substitute for a baseline risk assessment. For the 100-N Area OUs addressed in this ROD, the QRAs considered a frequent use human health exposure scenario with five (5) exposure pathways (i.e., soil ingestion, fugitive dust inhalation, inhalation of volatile organic compounds from soil, external radiation exposure, and drinking water ingestion) and a limited ecological assessment. The frequent-use scenario is generally similar to a residential scenario.

Adverse human health effects resulting from exposure to chemical contaminants are identified as either carcinogenic (i.e., causing development of cancer in one [1] or more tissues or organ systems) or non-carcinogenic (i.e., direct effects on organ systems, reproductive and developmental effects). Actions are proposed in this ROD to address unacceptable risk(s) posed to human health and the environment through one (1) or more pathways.

Assessment of ecological risk for source waste sites was provided by qualitative evaluation of the attainment of preliminary remediation goals for terrestrial animals. This evaluation concentrated on potential adverse effects to the Great Basin pocket mouse. The pocket mouse has a home range that is approximately the size of many of the waste sites and, if the mouse lived on these sites, would potentially receive a greater exposure to site contaminants than many other ecological receptors, thereby providing a conservative estimate of risk. Assessment of ecological risk for the groundwater OU was based upon a comparison of estimated doses to acceptable doses (ecological benchmarks) for aquatic receptors in the Columbia River.

Identification of Contaminants of Concern. Contaminants of concern were identified through an evaluation of both historical data and LFI data. Contaminants that were present in the top 4.6 m (15 ft) of soil and in the groundwater were included in the evaluation. The higher concentration from either the historical data set or the LFIs was selected for risk evaluation. The definition of potential site risk and subsequent development of remedial alternatives in the CMS were based on establishing preliminary remediation goals that comply with risk-based ARARs or to be considered (TBC) requirements. Radionuclide preliminary remediation standards protective of human health were calculated based on the EPA guidance level of 15 mrem/yr above natural background in soil for all pathways.

The RESidual RADioactivity (RESRAD) model was selected as the dose assessment model for generating preliminary remediation goals (PRGs) for radionuclide contaminants in soil. The model is used to determine individual radionuclide concentrations (pCi/g) in soil that correspond to a dose rate of 15 mrem/yr above background. The RESRAD model was also used to demonstrate that some residual soil contaminants, both radiological and nonradiological, will not reach the unconfined aquifer by migration through the soil column within one (1) thousand years. For drinking water, the radionuclide remediation standard is an annual dose equivalent to the total body or any internal organ of 4 mrem/yr based upon the average annual activity of beta particle and photon radioactivity from man-made radionuclides. The *Nationaly Primary Drinking Water Regulations* establish a gross alpha particle standard of 15 pCi/L for alpha emitting radionuclides (excluding radon and uranium). These remediation goals are consistent with other cleanup activities in the 100 Areas. Radionuclide preliminary remediation goals protective of ecological receptors were calculated based on a draft DOE standard of 0.1 rad/day for terrestrial animals and 1.0 rad/day for aquatic receptors. For nonradionuclides, preliminary remediation goals for soils were defined by risk-based ARARs in the Washington State *Model Toxics Control Act* (MTCA). Both human and ecological receptors were considered protected by MTCA Method B values for soils (Method A for TPH).

Remediation goals for nonradioactive contaminants in water, protective of groundwater, are based on MCLs and MTCA Method B levels (MTCA Method A for TPH). A listing of contaminants of concern that potentially may be found at 100-NR-1 waste sites along with their respective preliminary remediation goals is contained in Table 3. These cleanup levels will be reevaluated as part of the CERCLA five (5) year review and as part of final remedy selection for the site.

Toxicity Assessment. All radionuclides are classified by EPA as Group A human carcinogens due to their property of emitting ionizing radiation. For radium, this classification is based on direct human epidemiological evidence. For the remaining radionuclides, this classification is based on the knowledge that these elements are deposited in the body, delivering calculable doses of ionizing radiation to the tissues. Despite differences in radiation type, energy, or half-life, the health effects of ionizing radiation are identical but may occur in different target organs and at different activity levels. Cancer induction is the primary human health effect of concern resulting from exposure to radioactive environmental contamination since the concentrations of radionuclides associated with significant carcinogenic effects are typically orders of magnitude lower than those associated with systemic toxicity. The cancers produced by radiation cover the full range of carcinomas and sarcomas, many of which have been shown to be induced by radiation.

Human Health Qualitative Risk Assessment. Potential human health risks were qualitatively evaluated by comparing 100-N Area operations information, limited site-specific data, and analogous site information to preliminary remediation goals. Conceptual exposure models under a rural-residential exposure scenario that consider the potential contaminants, receptors, and exposure pathways through which the contact might occur aided the evaluation.

Under the rural-residential exposure scenario used, occupancy of the land surface was assumed to be continuous for 365 days/year for a period of thirty (30) years. It was assumed that human receptors could come into direct contact with contaminants in soil to a depth of 4.6 m (15 ft) because basements or other subsurface structures could be constructed within the site (excavation to 3.7 m [12 ft] with a 0.9 m [3 ft] buffer of clean soil). It was considered reasonable to assume that, beyond the 4.6 m depth, soils would remain undisturbed by human activities and that direct contact with deeper contaminants (greater than 4.6 m) would not occur. Under this rural-residential scenario, it was assumed that the unconfined aquifer underlying the 100-N Area would not be used as a potable water supply or for irrigation purposes for approximately 300 years (the estimated maximum time required for remediation of the unconfined aquifer). However, 0.76 m/yr (30 in/yr) of irrigation water from an off-site, uncontaminated source was assumed and included in the exposure evaluations.

The rural-residential exposure model assumes that direct human exposure to radionuclide contaminants within the top 4.6 m of soil occurs through ingestion of contaminated soil, inhalation of suspended dust, and external exposure to radiation. Indirect exposure pathways was by consumption of locally acquired vegetables, meat, fish, and milk. Exposure to nonradioactive contaminants in soil was based solely on the soil ingestion pathway per MTCA protocol. In some cases, there may be no contaminants in the top 4.6 m of soil at a site. In these instances, there would be no exposure through these pathways. For contaminants in soils deeper than 4.6 m, the concern was the potential migration of contaminants to groundwater and eventually to the Columbia River.

Based on this qualitative evaluation, contamination that exists at some of the 100-NR-1 waste sites pose a potential health risk to future users of the site outside the acceptable risk range of 1×10^{-4} to 1×10^{-6}. Calculations using the RESRAD dose assessment model and the maximum concentration levels in Table 4 demonstrate that the qualitative assessment of maximum total incremental cancer risk due to radionuclides is $> 1 \times 10^{-2}$, which indicates that remedial actions must be taken at the 100-NR-1 OU. Incremental cancer risk values calculated to be $> 1 \times 10^{-2}$ are not reported because the linearized

Table 3. Remedial Action Goals for Contaminants of Potential Concern at the 100-NR-1 Operable Unit

Contaminants of Potential Concern	First Remedial Action Objective – Protection from Direct Exposure		Second Remedial Action Objective – Protection of Groundwater/Columbia River	
	Remedial Action Goal for Nonradionuclides (mg/kg)	Remedial Action Goal for Radionuclides (pCi/g) [a]	Contaminant-Specific Concentration in Soil Protective of Groundwater (pCi/g or mg/kg)	Contaminant-Specific Concentration in Soil Protective of the Columbia River (pCi/g or mg/kg)
Americium-241	NA	31.1	[b]	[b]
Antimony-125	NA	10	29.3	29,300
Cesium-137	NA	6.2	[b]	[b]
Cobalt-60	NA	1.4	[b]	[b]
Europium-152	NA	3.3	[b]	[b]
Europium-154	NA	3.0	[b]	[b]
Plutonium-239/240	NA	33.9	[b]	[b]
Strontium-90	NA	4.5	[b]	[b]
Technetium-99	NA	15	176	176
Thorium-232	NA	1.3	[b]	[b]
Tritium (H-3)	NA	510	2,000	5,630
Uranium-233/234	NA	1.1	2	4
Uranium-235	NA	1.0	2.4	4.8
Uranium-238	NA	1.1	2.4	4.8
Antimony	32	NA	1.2	1.2
Arsenic	6.5 [c]	NA	0.0058	0.0036
Barium	5,600	NA	[b]	[b]
Cadmium	80	NA	[b]	[b]
Carbon Tetrachloride	7.7	NA	0.05	0.05
Chloroform	164	NA	0.72	0.16
Chromium (III)	80,000	NA	[b]	[b]
Chromium (VI)	400	NA	8	2
Hydrazine	0.33	NA	[b]	[b]
Lead	353	NA	[b]	[b]
Manganese	11,200	NA	[b]	[b]
Mercury	24	NA	[b]	[b]
Nickel	1,600	NA	[b]	[b]
PCBs	0.5	NA	[b]	[b]
Selenium	400	NA	[b]	[b]
Tetrachloroethylene	19.6	NA	0.16	0.16
TPH	100	NA	[b]	[b]
Vanadium	560	NA	[b]	[b]

Table 3. Remedial Action Goals for Contaminants of Potential Concern at the 100-NR-1 Operable Unit

Contaminants of Potential Concern	First Remedial Action Objective – Protection from Direct Exposure		Second Remedial Action Objective – Protection of Groundwater/Columbia River	
	Remedial Action Goal for Nonradionuclides (mg/kg)	Remedial Action Goal for Radionuclides (pCi/g) [a]	Contaminant-Specific Concentration in Soil Protective of Groundwater (pCi/g or mg/kg)	Contaminant-Specific Concentration in Soil Protective of the Columbia River (pCi/g or mg/kg)
Zinc	24,000	NA	[b]	[b]

[a] Single radionuclide soil concentrations corresponding to a 15 mrem/yr dose.

[b] The RESRAD and unit gradient models predict the contaminant will not reach groundwater within a 1,000-year time frame. It is anticipated that sampling will be required to verify that cleanup has been achieved, and that contaminants left in place are not migrating.

[c] The value presented is background and therefore this is the cleanup level.

NA = Not Applicable

equations using EPA cancer slope factors are only valid is estimating risk below 1×10^{-2}. Furthermore, a comparison of data also indicates contaminant levels exceed MTCA cleanup levels, indicating an unacceptable risk outside the MTCA range of 1×10^{-5} to 1×10^{-6}. Table 4 provides a comparison of maximum concentration levels in soil samples collected during the 100-NR-1 LFI with the preliminary remediation goals. Future site users could be exposed to contaminants in soil at concentrations above acceptable levels through ingestion of soil, inhalation of suspended dust, and external exposure to radiation. Actual or threatened releases of hazardous substances from the waste sites, and the potential for migration of these substances to the groundwater, if not addressed by implementing the response actions selected in this interim remedial action, may present a current or potential threat to public health, welfare, or the environment.

Table 4. Risk Due to Maximum Representative Concentration and Comparison to Preliminary Remediation Goals in Soil

Contaminant	Maximum Representative Concentration [a]	Soil Cleanup Standards [b]	Qualitative Maximum Incremental Cancer Risk
Cesium-137	15.5 pCi/g	6.1 pCi/g	4.482E-04
Cobalt-60	254 pCi/g	1.4 pCi/g	>1.0E-02
Strontium-90	431 pCi/g	3.7 pCi/g	1.341E-04
Thorium-232	3 pCi/g	0.97 pCi/g	3.720E-04
Lead	577 mg/kg	353mg/kg	N/A [c]
Maximum Total Incremental Cancer Risk Due to Radionuclides			>1.0E-02

[a] Maximum contaminant concentrations from soil samples collected during the 100-NR-1 Limited Field Investigation.

[b] Soil cleanup standards for radionuclides are the contaminant concentration that would equal 15 mrem/yr above natural background. Cleanup standard for lead is based on EPA's *Integrated Exposure Uptake Biokinetic Model for Lead in Children,* version D.99D, 1994.

[c] Lead does not provide a cancer risk.

The potential of direct human exposure to contaminants in soil at a depth greater than 4.6 m (15 ft) is unlikely. However, these deeper contaminants could migrate to groundwater. The potential for such migration was also considered in determining the need to remediate waste sites. Past disposal of liquid waste to the soil in the 100-N Area has impacted the underlying groundwater. The existing groundwater contamination that resulted from past operations in the 100-N Area is part of the 100-NR-

2 OU. Groundwater will continue to be monitored during the interim remedial action for the 100-NR-2 OU.

Contaminants that exceed drinking water standards at the groundwater/river interface are Sr-90 and tritium. No immediate risk to human health from these contaminants entering the river was identified in the 100-NR-1/100-NR-2 CMS due to river water concentrations being below drinking water standards and the lack of a human receptor at the groundwater seeps. DOE exercises control over access to this area of discharge immediately adjacent to the river (i.e., N-Springs) and will continue to do so during the interim action timeframe.

Summary of Key Uncertainties in the Human Health Risk Assessment. In general, the assessment of risk is based on a limited data set. Uncertainties are associated with both the contaminants identified for each waste site and from the groundwater and the concentrations of the contaminants. Collected samples may not be representative of conditions throughout the waste site or the aquifer and historical data may not accurately represent current conditions. Because the samples may not be completely representative of conditions at the 100-NR-1 and 100-NR-2 OUs, the qualitative evaluations of risks may be underestimated or overestimated.

Ecological Qualitative Risk Assessment. The purpose of the qualitative ecological risk assessment is to estimate the ecological risks from existing contaminant concentrations in the 100-NR-1 and 100-NR-2 OUs. The Great Basin pocket mouse was selected as the representative receptor for terrestrial waste sites in the *Hanford Site Risk Assessment Methodology* (DOE/RL-91-45, Rev. 3). This species was chosen as a representative for the larger number of possible animal receptors, such as rodents, hawks, and large mammals. The Great Basin pocket mouse would be more exposed to site contaminants than many other ecological receptors, thereby providing a conservative estimate of risk. Thus the assessment and measurement endpoint for the ecological QRA is the health and mortality of the Great Basin pocket mouse.

Contaminants found in the soil at waste sites in the 100-NR-1 OU include radioactive and nonradioactive elements. For nonradioactive elements, ecological effects were evaluated from uptake from the soil by plants and by accumulation of these elements through the foodweb. Radioactive elements have ecological effects resulting from their presence in the environment (external dose) and from ingestion (e.g., dose from contaminated food consumption), resulting in a total body burden. Total radiological dose to an organism can be estimated as the sum of doses (weighted by energy of radiation) received from all radioactive elements ingested, residing in the body, and available in the organism's environment.

The radiological dose an organism receives is usually expressed as rad/day. All exposure pathways are added in determining total organism dose. Internal exposure includes both body burden (contaminants that are taken into the body from all pathways) and dose from recent food consumption that is still in the gut. The dose to the Great Basin pocket mouse was used to screen the level of risk of an individual waste site. For radionuclides, dose to the pocket mouse is compared to 0.1 rad/day (DOE Order 5400.5, *Radiation Protection of the Public and the Environment, Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, International Atomic Energy Agency, Technical Report Series No. 332). For nonradiological contaminants, the dose was compared to toxicity values.

Potential ecological risks were qualitatively evaluated using the Great Basin pocket mouse as a representative receptor. Risks to the mouse were estimated assuming that the food pathway was the primary route of exposure to both radionuclides and chemical contaminants. The major portion of the risk to the Great Basin pocket mouse was attributable to Sr-90, while cobalt-60 and cesium-137

comprised the remainder of the risk. Based on this qualitative evaluation, contamination in soil thought to exist at some of the 100-NR-1 waste sites pose a potential unacceptable risk to ecological receptors. Nearly all of the radiological risk (EHQ > 1.0) to the Great Basin mouse at the 100 Area sites was attributable to Sr-90, although cobalt-60 also exceeded an EHQ of 1.0 at some sites. A comparison to analogous sites indicates that the risk estimates to the Great Basin pocket mouse due to exposure to heavy metals and various organic contaminants at selected sites would also exceed an EHQ of 1.0. This risk indicates that remedial action must be taken at the 100-NR-1 OU. Actual or threatened releases of hazardous substances from the waste sites, and the potential for migration of these substances to the groundwater, if not addressed by implementing the response actions selected in this interim remedial action, may present a current or potential threat to public health, welfare, or the environment.

The 100-NR-1/100-NR-2 CMS concluded that no groundwater contaminants of concern are above ecological remedial action goals based on EPA's and Ecology's ambient water quality criteria (AWQC) for protection of freshwater aquatic life. Although a drinking water standard of 8 pCi/L has been established for Sr-90, AWQC standards have not been established for Sr-90. The Sr-90 concentrations in groundwater and seeps are known to be elevated. Because of this, it is possible that concentrations of Sr-90 are also high in the pore water where aquatic receptors could be exposed. Further evaluation of potential impacts to aquatic and riparian resources is considered a vital part of the proposed interim action.

Summary of Key Uncertainties in the Ecological Evaluation. Significant sources of uncertainty in the exposure scenario are the assumptions that the receptors live on or in the waste site, that the waste site is uniformly contaminated, and, in the case of the Great Basin pocket mouse, that all food is contaminated. No provision is made for dilution of contaminated food by noncontaminated food. It was also assumed contaminants were not passed through the gut; but were completely retained (100 percent absorption efficiency). These assumptions result in a conservative estimate of risk.

VII. REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are site-specific goals that define the extent of cleanup necessary to achieve the specified level of remediation at the site. The RAOs are derived from ARARs, the points of compliance, and the restoration time frame for the remedial action. The RAOs were formulated to meet the overall goal of CERCLA, which is to provide protection to overall human health and the environment.

RAOs specific to the 100 Area for soils, solid wastes, groundwater, and riverbank sediments were initially developed in the *100 Area Feasibility Study, Phases 1 and 2*, DOE/RL-92-11. These objectives were developed further in the *100 Area Source OU Focused Feasibility Study* (FFS), DOE/RL-94-61, and used in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, to determine remedial action goals for soils and solid wastes. The objectives were refined for the 100-N Area in the CMS based on the following: (1) the 100-N Area conceptual fate and transport models, (2) the conceptual exposure models, and (3) additional information that became available since the feasibility studies were completed. The RAOs for the 100-NR-2 OU are based on the interim nature of actions that need to be taken until future decisions are made with regard to groundwater/river protection technologies and receptors.

The cleanup levels for radionuclides in soil that present a direct exposure concern is based on the EPA guidance level of 15 mrem/yr above background (*Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, EPA, OSWER No. 9200.4-18). The cleanup levels for radionuclides in water supplies is based on MCLs that correspond to 4 mrem/yr (40 CFR 141). The cleanup levels

for radionuclides are based on agreements made among EPA, Ecology, and DOE that were established during the development of the interim action ROD and the RDR/RAWP for the 100-BC-1, 100-DR-1, and 100-HR-1 OUs.

The cleanup levels for nonradioactive chemical contaminants are based primarily on ARARs including:

- The Washington State "Model Toxics Control Act Cleanup Regulation" (MTCA) (WAC 173-340);
- MCLs promulgated under the federal *Safe Drinking Water Act* (SDWA) (40 CFR) and/or the State of Washington's Drinking Water Standards (WAC 246-290); and
- AWQC developed under the federal *Clean Water Act* (CWA) (40 CFR 131) and/or state standards promulgated by the State of Washington (WAC 173-201).

It is anticipated that cleanup actions may generate wastes that are regulated as dangerous wastes under WAC 173-303. Compliance with RCRA ARARs, including the substantive requirements for storage and RCRA land disposal restrictions, will be verified and/or achieved should dangerous waste be generated. It is not anticipated that wastes will be generated during selected interim actions that are significantly different from a dangerous waste perspective than wastes generated at other 100 Area remedial actions with one exception. Based on previous characterization of contaminated wastes generated during 100-NR-1 and 100-NR-2 OU remedial actions that originated from or have come in contact with contaminated soil or debris from the 116-N-1 and 116-N-3 Cribs and Trenches is defined as state-only listed waste (F003 due to methanol – based on previous characterization) in accordance with the Part A Permit Application for these units. It is anticipated that these F003 wastes will meet ERDF waste acceptance criteria without the need for treatment due to very low or nondetectable concentrations of methanol. Other hazardous constituents may be identified during remedial action.

The RAOs for the 100-NR-1 OU and for the 100-NR-2 OU are presented below.

100-NR-1 Source Waste Sites: The RAOs for soils are:

- Protect potential human and ecological receptors under the rural-residential scenario from exposure by ingestion, external exposure, and inhalation to radioactive contaminants present in the upper 4.6 m (15 ft) of soils, structures, and debris. The levels of reduction will be such that the total dose does not exceed EPA radionuclide soil cleanup guidance of 15 mrem/yr above Hanford Site background for 1000 years following remediation.

- Protect potential human and ecological receptors under the rural-residential exposure scenario from exposure by ingestion of nonradioactive contaminants present in surface and shallow subsurface soils and debris in the upper 4.6 m (15 ft) of soil having concentrations exceeding the MTCA Method B levels (Method A for TPH).

- Protect the unconfined aquifer from adverse impacts by: (1) reducing concentrations of radioactive and nonradioactive contaminants present in all portions of the soil column that could migrate to the unconfined aquifer, or (2) reducing contaminant transport within the soil column. Contaminant levels will be reduced so concentrations reaching the unconfined aquifer do not exceed MCLs promulgated under the SDWA or the State of Washington's Drinking Water Standards, or MTCA Method B levels (Method A for TPH), whichever is lower. The location and measurement of the point of compliance will be defined in the Remedial Design/Remedial Action Workplan. Monitoring for compliance will be performed at the defined point.

- Protection of the Columbia River from adverse impacts so contaminants remaining in the soil after remediation do not result in an impact to groundwater and, therefore, the Columbia River that could exceed the ambient water quality criteria (AWQC) under the *Clean Water Act* for protection of fish. Since there are no AWQC for radionuclides, MCLs will be used. Measurement of compliance will be at a near-shore well, in the downgradient plume. The location and measurement will be defined by EPA and Ecology.

- Prevent destruction of significant cultural resources and sensitive wildlife habitat. Minimize the disruption of cultural resources and wildlife habitat in general and prevent adverse impacts to cultural resources and threatened or endangered species.

100-NR-2 Groundwater: The RAOs for the groundwater are:

- Protect the Columbia River from adverse impacts from the 100-NR-2 groundwater so that designated beneficial uses of the Columbia River are maintained. Protect associated potential human and ecological receptors using the river from exposure to radioactive and nonradioactive contaminants present in the unconfined aquifer. Protection will be achieved by limiting exposure pathways, reducing or removing contaminant sources, controlling groundwater movement, or reducing concentrations of contaminants in the unconfined aquifer.

- Protect the unconfined aquifer by implementing remedial actions that reduce concentrations of radioactive and nonradioactive contaminants present in the unconfined aquifer.

- Obtain information to evaluate technologies for Sr-90 removal and evaluate ecological receptor impacts from contaminated groundwater (by October 2004).

- Prevent destruction of sensitive wildlife habitat. Minimize the disruption of cultural resources and wildlife habitat in general and prevent adverse impacts to cultural resources and threatened or endangered species.

Residual Risks Post-Achievement of RAOs. Residual risks after meeting RAOs (except the shoreline site) were estimated based on a residential land use scenario for soils. Site risks from contaminated soils, structures, and debris (with respect to metals and organics) are reduced from greater than 1×10^{-3} to approximately 1×10^{-5}. Site risks from contaminated soils, structures, and debris with respect to radionuclides are reduced from greater than 1×10^{-2} to approximately 3×10^{-4}. The current groundwater pump and treat system would have to be operational for nearly 300 years to achieve the drinking water standard for Sr-90.

Remediation Time Frame. Completion of these actions shall be consistent with the overall goal of completing 100 Area remedial actions by the year 2018. For groundwater and river protection, remedial actions will likely exceed 2018, based on the current technology.

VIII. DESCRIPTION OF ALTERNATIVES

100-NR-1 Source Waste Site Alternatives (including the Shoreline Site)

To evaluate remedial alternatives, information related to future land use, groundwater use, and cleanup standards is necessary. However, this information may not be fully developed before the timely

consideration of interim remedial actions. For example, future land use decisions for the Hanford Site, including the 100-N Area, continue to be discussed by the responsible government agency (DOE), the local government agencies, and many other Hanford Site stakeholders and interested parties. In lieu of a land use decision, the objectives of the interim remedial actions authorized in this ROD are to reduce potential threats to human health and the environment from these waste sites and not preclude any future land use in the 100 Area.

The *100 Area Source Operable Unit Focused Feasibility Study,* DOE/RL-94-61, identified five (5) general response actions that could be applied to waste sites in the 100 Area under the rural-residential scenario. The alternatives analyzed were no action, institutional controls, remove/dispose, remove/ex-situ bioremediation/dispose, and in-situ bioremediation. To facilitate the development of remedial alternatives and the subsequent detailed and comparative analyses of their suitability, all but one (the shoreline site) of the waste sites were placed (based on suspected primary contaminants and unique characteristics) into one (1) of five (5) waste groups: radioactive, petroleum (near-surface contamination and deep contamination), inorganic, burn pit, and surface solid.

The shoreline site presents unique remedial challenges because of its location at the groundwater/Columbia River interface. Furthermore, the remediation of the shoreline site is closely tied to final remediation of the 100-NR-2 Groundwater OU because of the complex, dynamic relationships among the Columbia River, the contaminated groundwater in the 100-N Area, and the contaminated soils at the shoreline site. Therefore, the shoreline site was not assigned to a waste group, but was addressed separately as a single, unique waste site in the CMS.

Four (4) remedial alternatives were considered for the 100-NR-1 waste sites (excluding the shoreline site) under the rural-residential scenario:

- No Action
- Remove/Dispose
- Remove/Ex-Situ Bioremediation/Dispose
- In-Situ Bioremediation

Four (4) remedial alternatives were considered for the shoreline site:

- No Action
- Institutional Controls
- Remove/Dispose
- Cover (Containment)

The shoreline site contains two (2) distinct areas: (1) the riverbank seeps in the 100-N Area (the N-Springs) and associated contaminated soils in their vicinity, and (2) the contaminated soil associated with waste site 100-N-65 (an interceptor trench built to collect diesel/fuel oil leaked to the groundwater). Although addressed separately due to differences with respect to source of contamination, contaminants of concern, and potential remedial action, these two (2) areas overlap and together constitute the shoreline site for the purpose of developing and comparing remedial alternatives. The shoreline site, the remedial alternatives associated with it, and the applicable analysis of the remedial alternatives are discussed separately from the remainder of the 100-NR-1 waste sites.

Applicable RAOs used to evaluate the remedial alternatives include MTCA Method B for nonradioactive chemical contaminants in soil, MTCA Method A for petroleum contaminants (TPH), and 15 mrem/yr above natural background for radionuclides. If remedial alternatives involve excavation of contaminants (e.g., removal action) to achieve these cleanup standards, the applicable

depth for the rural-residential scenario is 4.6 m (15 ft) below surrounding grade. A summary of all remedial alternatives considered follows.

No Action (applicable to both the 100-NR-1 sites and the shoreline site): The no action alternative was evaluated to provide a baseline to compare to the other alternatives. It represents a hypothetical scenario where no restrictions, controls, or active remedial actions are applied to a site. The no action alternative would limit future use of the 100-N Area and is not protective of human health and the environment.

Institutional Controls (specifically applicable to the shoreline site but also an integral element of all four alternatives for the 100-NR-1 waste sites): This alternative includes the following elements:

- DOE will continue to use a badging program to control access to the associated sites for the duration of the interim action. Visitors (i.e., persons not employed on the Hanford Site who are granted access for discussions on project related matters, employment interviews, or tours) entering any of the sites associated with this ROD are required to be escorted at all times.
- DOE will utilize the on-site excavation permit process to control land use (e.g., well drilling or excavation of soil) within the 100-NR-1 or 100-NR-2 OUs.
- DOE will maintain existing signs prohibiting public access to the shoreline site.
- DOE will provide notification to Ecology upon discovery of any trespass incidents.
- Trespass incidents will be reported to the Benton County Sheriff's Office for investigation and evaluation for possible prosecution.
- DOE will add access restriction language to any land transfer, sale, or lease of property that the U.S. Government considers appropriate while institutional controls are compulsory, and Ecology will have to approve any access restrictions prior to transfer, sale, or lease.
- Until final remedy selection, DOE shall not delete or terminate any institutional control requirement established in this ROD unless Ecology have provided written concurrence on the deletion or termination.
- DOE will evaluate the implementation and effectiveness of institutional controls for the 100-NR-1 and 100-NR-2 OUs on an annual basis. DOE shall submit a report to Ecology by July 31 of each year summarizing the results of the evaluation for the preceding calendar year. At a minimum, the report shall contain an evaluation of whether or not the OU IC requirements continue to be met and a description of any deficiencies discovered and what measures have been taken to correct problems.

Land use restrictions would be used to limit certain types of land use (e.g., restricting drilling or excavation) through the use of the on-site excavation permit process. Access controls would consist of signs. Groundwater monitoring would be used to evaluate the effectiveness of the proposed remedial action and to support decisions to continue the action or implement other actions. Institutional controls would be required to prevent human exposure to and use of contaminated land and groundwater. DOE would be responsible for establishing and maintaining land use and access restrictions until maximum contaminant levels and risk-based criteria are met or the final remedy is selected.

Remove/Dispose (applicable to both the 100-NR-1 sites and the shoreline site): This alternative includes the following elements:

- Remove contaminated soil, structures, debris, and pipelines to a depth of 4.6 m [15 ft] below surrounding grade or to the bottom of the engineering structure, whichever is deeper. Dispose of soil, structures, debris, and pipelines at ERDF.
- Treat these wastes as required to meet ERDF acceptance criteria.
- Backfill excavated areas with clean material, grade, and re-vegetate the areas.
- Maintain ICs as described above until remediation is complete.

Under this alternative, contaminated media would be excavated, transported to, and disposed of at the ERDF in accordance with ERDFs waste acceptance criteria. Any material that exceeds the disposal facility's waste acceptance criteria, which would include compliance with RCRA land disposal restrictions, would be stored on the Hanford Site in a manner consistent with ARARs until treated to meet waste acceptance criteria. If such waste material exists, the procedure for dealing with it will be agreed to by DOE, EPA, and Ecology before final disposition. As the contaminated material is excavated, it would be characterized and segregated before transportation. Excavation would continue until all contaminated material exceeding the remedial action goals and cleanup standards is removed. The site would then be backfilled and re-vegetated.

Remove/Ex-Situ Bioremediation/Dispose (applicable to the 100-NR-1 waste sites): This alternative includes the following elements:

- Remove contaminated material (soil/debris) down to a depth of 4.6 m [15 ft] below surrounding grade or to the bottom of the engineering structure, whichever is deeper. The depth of removal (15 ft) may be adjusted if field conditions warrant and with Ecology approval.
- Remove contaminated material (soil/debris) below 4.6 m [15 ft] as necessary if field conditions warrant and Ecology approves.
- Ex-Situ bioremediate petroleum contaminated material within the 100-N OU boundary.
- Dispose of residual contaminated media to an Ecology approved facility.
- Collect and dispose of leachate to the Effluent Treatment Facility (ETF) or as approved by Ecology.
- Backfill excavated areas with clean material, grade, and re-vegetate the areas.
- Maintain ICs as described above until remediation is complete.

This alternative is the same as the previous alternative except that petroleum-contaminated soil would be placed on a nearby remediation pad and treated using bioremediation. Bioremediation helps to achieve a reduction in waste volume requiring disposal. Following remediation, previously contaminated soil that meets the cleanup standards could be used as clean backfill. Soil not meeting the treatment goal would be transported to the ERDF for disposal. Leachate and runoff produced during this process would be collected and monitored to determine if they comply with the associated ARARs. If treatment would be required, treatment and disposal would include trucking the leachate and runoff to the ETF within the Hanford Site, provided it meets the waste acceptance criteria.

In-Situ Bioremediation (applicable to the 100-NR-1 waste sites): This alternative includes the following elements:

- In-Situ bioremediate petroleum contaminated material below 4.6 m [15 ft] of surrounding grade, bottom of engineering structure, or where excavation for ex-situ bioremediation is terminated, whichever is greater.
- Install necessary injection wells and infrastructure.
- Maintain groundwater monitoring wells to monitor bioremediation and impacts to groundwater.
- Grade and re-vegetate the areas.
- Maintain ICs as described above until remediation is complete.

Under this alternative, a system of injection wells would supply oxygen, bacteria, and nutrients to the petroleum-contaminated soils at depth where remediation would take place. Monitoring wells would be used to monitor the bioremediation and any impacts to groundwater. No excavation or removal would be required.

Cover (Containment) (applicable to the 100-NR-1 waste sites): This alternative is specific to the shoreline site and includes the following elements:

- Maintain ICs as described above until remediation is complete.
- Groundwater monitoring.
- Surface water controls.
- Installation of a surface barrier.
- Grade and re-vegetate the areas.

The surface barrier would be designed to eliminate direct exposure pathways for human and ecological receptors. Details of proposed cover design can be found in the 100-NR-1/100-NR-2 CMS.

100-NR-2 Groundwater Site Alternatives

Seven (7) groundwater remedial alternatives for the 100-NR-2 OU were analyzed in the CMS. Of the seven alternatives, none of the alternatives that include long-term physical barriers were considered appropriate for an interim action. The construction costs for the barriers were high and the soil flush system alternative was considered too speculative at this time to be considered for interim use. Also, the physical barriers could potentially preclude the implementation of final remedies that do not incorporate the chosen barrier in the final action, or conversely, would require removal costs to implement a different final remedy. Therefore, the following four (4) alternatives were selected for further consideration for purposes of an interim action:

- No Action
- Institutional Controls
- Hydraulic Controls
- Pump and Treat

The pump and treat alternative differs from the hydraulic control alternative by incorporating treatment of pumped groundwater into the design. Both alternatives include the creation of a hydraulic "barrier" that decreases the flux of groundwater going to the river.

Insufficient information exists to make a final remedy decision for Sr-90; therefore, Ecology, EPA, and DOE propose to control movement of Sr-90 to the Columbia River as an interim remedial action for river protection. This interim control would be accomplished through operation of the existing pump and treat system while further information is gathered for a final remedy. The selected interim remedial action will provide some control over movement of Sr-90 to the Columbia River and will not preclude possible final remedies at this OU or the source sites OU.

Characteristics of Sr-90 in 100-N Area soils result in significant problems with the remediation of groundwater at the 100-NR-2 OU. With its twenty-nine (29)-year half-life, current concentrations in groundwater, concentrations adsorbed onto the saturated soil, and rate of migration, it would take 300 years for the Sr-90 concentrations to meet drinking water standards (8 pCi/L) through natural attenuation, mostly as the result of radioactive decay. Sr-90 is adsorbed to soil in the saturated zone and exists in equilibrium with the Sr-90 in the groundwater at a ratio of approximately 100 parts in soil to 1 part in groundwater. These adsorption and equilibrium properties are the reasons for the difficulties in Sr-90 remediation of the 100-NR-2 OU. These difficulties are summarized below.

Operational Information on the Existing Groundwater Pump and Treat System: As Sr-90-contaminated groundwater is removed by a groundwater remedial technology, such as pump and treat,

the clean water that replaces it becomes recontaminated by contact with the contaminated soil, and the 100 to 1 equilibrium ratio is re-established. Because of the substantial quantity of Sr-90 adsorbed to soil, this results in virtually no short-term decrease in Sr-90 concentrations in the groundwater. No remedial alternatives were identified in the 100-NR-1/100-NR-2 CMS that are known to be safely implementable and able to substantially shorten the 300-year remediation time associated with natural attenuation by radioactive decay. The expedited response action pump and treat system at N-Springs is currently removing approximately 0.1 Ci/yr. There are approximately 85 Ci of Sr-90 in the saturated soils within the 100-N Area. The time frame necessary to meet drinking water standards (8 pCi/L) with this removal rate is not significantly different from that of natural attenuation by radioactive decay (270 years with pump and treat versus 300 years for natural attenuation by radioactive decay). Although the pump and treat system would not significantly alter the remediation timeframe, it is removing approximately 90% of the Sr-90 from retrieved groundwater. This reduces the flux of Sr-90 to the river which is attributable to groundwater contamination. This system does not, however, reduce Sr-90 concentrations that are not influenced by the pump and treat system, specifically the contaminated sediments at the shoreline site. Innovative applications of technologies, such as soil flushing, that may be able to disrupt the soil-groundwater equilibrium and remove significant quantities of Sr-90 are considered experimental. More information would be needed to define the implementability of this or other innovative technologies that could shorten the time necessary to achieve groundwater remedial goals.

The movement of Sr-90-contaminated groundwater from the waste sites to the Columbia River has extended the contaminated soil zone to the river's edge (the shoreline site in the 100-NR-1 OU). Remediation for the purpose of river protection is complicated at the shoreline site. Technologies to prevent the flow of Sr-90 to the Columbia River include various forms of barriers, including hydraulic barriers and physical barriers. These technologies must be physically located slightly inland of the Columbia River to operate properly. The shoreline site, located between the river and a barrier, contains approximately 2 to 5 Ci of Sr-90 that may remain unaffected by implementing these technologies. However, the effect of hydraulic or physical barriers on the shoreline site is not known at this time. Because of the loading of Sr-90 in the shoreline site and because of the 100 to 1 equilibrium phenomenon of Sr-90 in 100-N Area soils, contaminated sediments would continue to release Sr-90 into the groundwater near the river at concentrations above drinking water standards with any of these technologies. This is due to the flushing action as the river level rises and falls. The amount of time that it would take to remediate the shoreline site and thereby reduce the concentrations migrating to the river may or may not be shorter than would occur solely through natural decay and attenuation. Not enough information is known about the relationship between the barrier technologies and the flushing capability of the river with barrier placement to determine this time frame.

Groundwater entering the river could reach an aquatic and riparian ecological receptor through direct uptake of Sr-90 in contaminated food and water. Ecological receptors may contact contaminants in groundwater through overland discharges and upwelling that may be present when the Columbia River is at low stage and in sediment pore water at the groundwater/river bottom interface. While the Sr-90 concentration in pore water and its potential impact to an ecological receptor is not entirely known, no significant adverse impacts have been identified at this time. Part of the interim actions for the 100-NR-2 OU must include gathering more information to determine whether Sr-90 concentrations are causing short- or long-term impacts to these receptors. This information is required in order to evaluate further remedial actions.

IX. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The selected remedial actions are believed to provide the best balance of tradeoffs among the alternatives with respect to the nine (9) CERCLA evaluation criteria used to evaluate remedies. The

nine (9) CERCLA evaluation criteria are divided into three (3) categories: threshold, balancing, and modifying criteria. The first two (2) criteria (Overall Protection of Human Health and the Environment and Compliance with ARARs) are threshold criteria; only those remedial alternatives that provide adequate protection of human health and the environment and comply with ARARs (or justify a waiver) are eligible for consideration. The five (5) balancing criteria help describe relative technical and cost differences among the remedial alternatives. The modifying criteria may prompt modification of the remedial alternatives based on the community's comments and concerns.

A comparative analysis of the remedial alternatives relative to the evaluation criteria is required by CERCLA. The detailed and comparative analyses were presented in the CMS. These analyses for the 100-NR-1 waste sites, the shoreline site, and the groundwater are summarized below for the threshold and balancing criteria. A statement on the modifying criteria, and state and community acceptance, which applies to all the selected remedies, appears at the end of the summary of the CERCLA analyses. Analysis of the remedial alternatives against RCRA performance standards and *National Environmental and Policy Act of 1969* (NEPA) values follows the CERCLA analyses.

Evaluation of the Alternatives for the 100-NR-1 Waste Sites (Excluding the Shoreline Site)

Four (4) remedial alternatives were considered for the 100-NR-1 waste sites (excluding the shoreline site) under the rural-residential scenario:

- No Action
- Remove/Dispose
- Remove/Ex-Situ Bioremediation/Dispose
- In-Situ Bioremediation

The following is a comparative analysis of these remedial alternatives against the CERCLA criteria.

Overall Protection: Overall protection of human health and the environment is the primary objective of the remedial action and addresses whether or not a remedial action provides adequate overall protection of human health and the environment. Alternatives that do not meet this threshold criterion are not valid alternatives.

The no action alternative provides no control of exposure to the contaminants at the waste sites. The remove/dispose, remove/ex-situ bioremediation/dispose, and in-situ bioremediation alternatives would provide protection of human health and the environment by removing and/or treating contaminants to attain protective concentrations.

Compliance with Applicable or Relevant and Appropriate Requirements: Compliance with ARARs addresses whether a remedial action will meet all of the ARARs and other federal and state environmental statutes or provides ground for invoking a waiver. This is also a threshold criterion.

The no action alternative would not meet the principal ARARs identified for all of the sites. The remove/dispose, remove/ex-situ bioremediation/dispose, and in-situ bioremediation alternatives would meet the ARARs (e.g., cleanup standard required under MTCA such as direct soil exposure levels, groundwater and river protection standards [*Clean Water Act*, primary and secondary drinking water standards], river protection standards [AWQC], *Migratory Bird Treaty Act*, and *Endangered Species Act of 1973*). If wastes subject to land disposal restrictions under RCRA are encountered, the wastes would be treated before disposal or a treatability variance could be requested.

Long-Term Effectiveness and Permanence: This criterion refers to the magnitude of residual risk and the ability of a remedial action to maintain reliable protection of human health and the environment after remedial goals have been met.

The no action alternative would not meet remedial action goals and, therefore, would not provide for long-term effectiveness. The remove/dispose, remove/ex-situ bioremediation/dispose, and in-situ bioremediation alternatives provide long-term effectiveness and permanence because no source of risk above cleanup levels would remain at the site in the first fifteen (15) feet below ground surface. All removed soils would be treated, if needed and as appropriate, before being placed in the ERDF.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This criterion refers to an evaluation of the anticipated performance of the treatment technologies that may be employed in the remedy.

The no action alternative would not reduce the mobility, toxicity, or volume of the contaminants through treatment. The remove/dispose alternative would utilize a small amount of treatment to reduce the toxicity, mobility, and/or volume by employing solidification/stabilization or other treatment as appropriate to meet ERDF waste acceptance criteria. The remove/ex-situ bioremediation/dispose and in-situ bioremediation alternatives provide the most significant level of treatment specific to petroleum, and would reduce volume, toxicity, and mobility.

Short-Term Effectiveness: Short-term effectiveness refers to an evaluation of the timeframe with which the remedy achieves protection. It also refers to any potential adverse effects on human health and the environment during the construction and implementation phases of a remedial action.

The no action alternative would pose no additional risks to the community, the workers, or the environment, if implemented. All alternatives, except the no action alternative, would achieve remedial action objectives relatively quickly. The remove/dispose alternative would pose a risk of release of contaminants and worker exposure during excavation, transport, and disposal of contaminated media that is not present with the other alternatives; remediation activities would need to be carefully planned to minimize the associated risk. The in-situ bioremediation and remove/ex-situ bioremediation/dispose alternatives would be used only for remediation of petroleum, which poses a relatively low risk of release or worker exposure. Any additional contaminated materials will be excavated and disposed at ERDF provided they meet the waste acceptance criteria.

Implementability: Implementability refers to the technical and administrative feasibility of a remedial action, including the availability of materials and services needed to implement the selection solution.

The no action alternative would be easy to implement both technically and administratively. The remove/dispose and in-situ bioremediation alternatives would be easier to implement than the remove/ex-situ bioremediation/dispose alternative.

Cost: Table 5 contains estimated costs for the remove/dispose, in-situ bioremediation, and remove/ex-situ bioremediation/dispose alternatives. These costs use a 7% discount rate and have an accuracy range between +50 and –30%. The total estimated cost to remove/dispose piping is significant, about $34,400,000. This piping remove/dispose cost represents approximately 70% of the cost to implement the selected remedy for all 100-NR-1 waste sites. This high cost is due to the extensive excavation that will be required to remove all underground piping associated with 100-NR-1 waste sites.

Table 5. Cost Estimates for Source Site Remedial Action Alternatives

Site	Rural-Residential Scenario			Site	Rural-Residential Scenario		
	Remove/ Dispose	In-Situ Bio[a]	Remove/ Ex-Situ Bio[a]/ Dispose		Remove/ Dispose	In-Situ Bio[a]	Remove/ Ex-Situ Bio[a]/ Dispose
UPR-100-N-1	$176,709			100-N-13	$98,242		
UPR-100-N-2	$163,508			100-N-14	$98,242		
UPR-100-N-3	$253,288			100-N-16	$94,446		
UPR-100-N-4	$97,464			100-N-17	$94,224		
UPR-100-N-5	$335,922			100-N-18	$93,965		
UPR-100-N-6	$104,056			100-N-19	$94,502		
UPR-100-N-7	$375,378			100-N-22	$125,274		
UPR-100-N-8	$95,409			100-N-23	$93,891		
UPR-100-N-9	$104,037			100-N-24	$114,943		
UPR-100-N-10	$95,409			100-N-25	$108,555		
UPR-100-N-11	$95,853			100-N-26	$101,593		
UPR-100-N-12	$459,863			100-N-28	[b]		
UPR-100-N-13	$88,873			100-N-29	$130,884		
UPR-100-N-14	$95,409			100-N-30	$130,884		
UPR-100-N-17	$2,409,203	$903,509		100-N-31	$130,884		
UPR-100-N-18	$105,000		$107,994	100-N-32	$130,884		
UPR-100-N-19	$105,944		$112,486	100-N-33	$106,777		
UPR-100-N-20	$102,056		$105,660	100-N-34	$93,817		
UPR-100-N-21	$97,168		$100,162	100-N-35	$98,242		$99,369
UPR-100-N-22	$105,092		$108,696	100-N-36	$94,724		$98,254
UPR-100-N-23	$103,593		$104,720	100-N-37	$197,021		
UPR-100-N-24	$107,499		$121,304	100-N-38	$130,884		
UPR-100-N-25	$97,779			100-N-39	$97,483		
UPR-100-N-26	$99,908			100-N-45	$149,807		
UPR-100-N-29	$101,704			100-N-46	$75,261		
UPR-100-N-30	$117,313			100-N-47	$197,021		
UPR-100-N-32	$105,092			100-N-50	[c]		
UPR-100-N-35	[b]			100-N-51a	[c]		
UPR-100-N-36	$96,816		$97,408	100-N-51b	[c]		
UPR-100-N-37	$93,983			100-N-65	[c]		
UPR-100-N-39	$99,297			116-N-4	[b]		
UPR-100-N-40	$143,993			118-N-1	[b]		
UPR-100-N-41	$94,761			120-N-3	$117,146		
UPR-100-N-42	$2,842,571	$910,025		124-N-2	$212,349		
UPR-100-N-43	$106,574		$116,719	124-N-3	$149,807		$212,349
100-N-1	$320,925			124-N-4	$766,864		
100-N-3	$254,529		$329,895	128-N-1	$140,531		
100-N-4	$386,783			600-32	$2,046,397		
100-N-5	$349,327			600-35	$161,268		
100-N-6	$94,113			Piping	$34,440,348		
100-N-12	$93,743		$94,334				

[a] The costs for In-Situ Bioremediation and Ex-Situ Bioremediation are the same in the Rural-Residential exposure scenario.

[b] Available information indicates there may be no contaminants within the upper 4.6 m (15 ft) of the soil column. Further information will be acquired during design.

[c] Costs and/or additional costs for these sites will be established during design.

Ex-Situ = Ex-Situ Bioremediation
In-Situ= In-Situ Bioremediation
UPR = Unplanned Release

Costs do not include a 3% design cost and a 3% design data collection cost.

State Acceptance: State acceptance indicates whether, based on its review of the CMS, Proposed Plan, and Administrative Record, the state concurs with, opposes, or has no comment on the selected interim remedial action. The State of Washington concurs with the selection of the interim remedial actions described in this ROD.

Community Acceptance: Community acceptance refers to support by the public for the preferred remedial action alternative and is assessed following a review of the public comments received on the CMS and Proposed Plan. On April 2, 1998, a meeting was held to discuss the Proposed Plans for the 100-NR-1 and 100-NR-2 OUs. The results of the public meeting and the public comment period indicate overall general acceptance and support of the preferred remedial alternatives. Community response to the remedial alternatives is presented in the Responsiveness Summary in Appendix A, which summarizes questions and comments received during public comment.

Evaluation of the Alternatives for the Shoreline Site

Four (4) remedial alternatives were considered for the shoreline site:

- No Action
- Institutional Controls
- Remove/Dispose
- Cover (Containment)

The following is a comparative analysis of these remedial alternatives against the CERCLA criteria.

Overall Protection: The draft Columbia River Comprehensive Impact Assessment Screening Assessment indicates that contaminant levels in the 100-N Area may pose a potential risk to human and ecological receptors under some scenarios, and further investigations may be warranted. The no action alternative provides no control of exposure to the contaminants at the shoreline site and thus provides no protection from potential risks. The institutional controls alternative would provide protection of human health by preventing exposure to contaminants for an interim period, during which time potential ecological impacts and human health risks could be further evaluated. The remove/dispose alternative would be protective of human health and the environment upon completion of the action. However, the remove/dispose alternative would only provide protection for an interim period as the clean fill would be subject to recontamination. Recontamination could occur as groundwater moves through the area and/or from fluctuating river levels. Although both the cover and remove/dispose alternatives would provide some protection to human health and the environment from risk due to contamination, they would cause severe environmental impacts at the shoreline site during implementation.

Compliance with Applicable or Relevant and Appropriate Requirements: ARARs do not apply to the no action alternative since no action will be taken. The cover and the remove/dispose alternatives would meet the ARARs for the actions (e.g., cleanup standards required under MTCA, such as direct soil exposure levels, *Clean Water Act*, primary and secondary drinking water standards, AWQC, *Migratory Bird Treaty Act*, and *Endangered Species Act of 1973*) identified for the site. The institutional controls alternative, which Ecology, EPA, and DOE view as an interim action pending selection of a final remedy for the 100-NR-2 OU, would attain ARARs for that limited action, but would not attain cleanup standards during the interim action time frame. For the shoreline site, for the institutional controls alternative, the only ARARs that apply are MTCA, "Minimum Standards for Construction and Maintenance of Wells" (WAC 173-160), and all the Location-Specific ARARs listed in Section XI, Statutory Determinations, of this document. The cover alternative would comply with the ARARs. The remove/dispose alternative would meet the ARARs. If wastes subject to land

disposal restrictions under RCRA are encountered, the wastes would be treated before disposal, or a treatability variance or waiver could be requested.

Long-Term Effectiveness and Permanence: At the shoreline site, the ability of a remedial action to provide long-term effectiveness and permanence is dependent upon final remedial action for the contaminated groundwater in the 100-NR-2 OU. The no action alternative would not meet remedial action goals and, therefore, would not provide for long-term effectiveness. The institutional controls alternative, if selected, would require long-term maintenance to remain protective of human health, and would not be effective in protecting ecological receptors from potential risks. The cover alternative would provide a greater degree of long-term effectiveness by stabilizing and isolating the contaminants in place; however, the requirement for long-term maintenance would be significant. The remove/dispose alternative would provide the greatest long-term effectiveness and permanence. However, depending upon the final remedial action for groundwater and the timing of remedial action at the shoreline site, the remove/dispose action may have to be repeated on a periodic basis due to recontamination of the soil by contaminated groundwater.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This criterion refers to an evaluation of the anticipated performance of the treatment technologies that may be employed in the remedy.

Neither the no action alternative, the institutional controls alternative, nor the cover alternative would reduce the mobility, toxicity, or volume of the contaminants in soil through treatment. The remove/dispose alternative would utilize a small amount of treatment to reduce the toxicity, mobility, and/or volume by employing solidification/stabilization or other treatment as appropriate to meet ERDF waste acceptance criteria.

Short-Term Effectiveness: The no action and institutional controls alternatives would pose no additional risks to the community, the workers, or the environment, if implemented. The cover alternative could be implemented relatively quickly with minimal risks to the community or workers but would affect the environment and ecological receptors at the shoreline site during implementation. The remove/dispose alternative would achieve protection relatively quickly. During implementation of this alternative, contaminated soil would be uncovered, representing the potential for a release of contaminants and worker exposure. Remediation activities would be carefully planned to minimize the associated risk. The environmental and ecological receptors at the shoreline site would be affected during implementation of the remove/dispose alternative. Both the cover and remove/dispose alternatives would impact the shoreline environment during implementation.

Implementability: The no action alternative would be easy to implement both technically and administratively. Because access restrictions are already in place at the shoreline site, the institutional controls alternative is easily implemented. The cover alternative is implementable with existing technologies, but not without significant impacts to the shoreline environment. The remove/dispose alternative is possible with existing technologies. However, the cover and remove/dispose alternatives would be difficult to implement because of technical and administrative problems posed by the proximity of the Columbia River.

State Acceptance: State acceptance indicates whether, based on its review of the CMS, Proposed Plan, and Administrative Record, the state concurs with, opposes, or has no comment on the selected interim remedial action. The State of Washington concurs with the selection of the interim remedial actions described in this ROD.

Cost: The cost estimates for the shoreline alternatives are presented in Table 6.

Table 6. Comparative Cost Summary of the Shoreline Site Remedial Alternatives

Alternative	Cost ($)
No Action	Negligible
Remove/Dispose	$10,896,000
Institutional Controls	$63,400
Cover	$6,456,000

Note: These are initial costs; however, costs comparable to the initial costs may be incurred for repeating the remove/dispose action on a periodic basis should recontamination occur from the influx of contaminated groundwater.

Community Acceptance: Community acceptance refers to support by the public for the preferred remedial action alternative and is assessed following a review of the public comments received on the CMS and Proposed Plan. On April 2, 1998, a meeting was held to discuss the Proposed Plans for the 100-NR-1 and 100-NR-2 OUs. The results of the public meeting and the public comment period indicate overall general acceptance and support of the preferred remedial alternative. Community response to the remedial alternatives is presented in the Responsiveness Summary in Appendix A, which summarizes questions and comments received during public comment.

Evaluation of Alternatives for the 100-NR-2 Groundwater OU

Overall Protection: All of the alternatives, except for the no action alternative, would provide protection of human health by preventing exposure to contaminants. The hydraulic controls (does not include treatment) and pump and treat alternatives would control the flux of Sr-90 discharges to the river while potential adverse impacts are evaluated.

Compliance with Applicable or Relevant and Appropriate Requirements: The Sr-90 pump and treat system is an interim groundwater remedial action that is currently operational under an expedited response action/action memorandum for Sr-90 at N-Springs. This system is providing benefit to the environment by the removal of Sr-90 and controlling the flux to the river. As part of this action, other contaminants are present for which the design of the pump and treat system is not capable of removing. Therefore, discharge limits will exceed the drinking water standards or MCL for two (2) other contaminants, which are nitrate and tritium. For the alternative, interim hydraulic controls and pump and treat, re-injection of groundwater will occur within a portion of the groundwater plume that is already contaminated with Sr-90 as well as nitrate and tritium. The re-injection of groundwater may not meet drinking water standards or MCLs for Sr-90, tritium, and nitrate and will not be full compliance with the *Safe Drinking Water Act of 1974* (SDWA) (40 U.S.C. 300, et seq.), "National Primary Drinking Water Regulations" (40 CFR 141) and "Underground Injection Regulation" (WAC 173-218). Tritium and nitrate are not the focus of this interim action, but are co-located with the Sr-90, which is the principal threat to human health and the environment. A final remedy will follow this interim action ROD at a later date that will address all ARARs.

Waste management ARARs will be complied with for all alternatives generating waste. Air and radiation protection standards will also be complied with for all alternatives other than the no action alternative.

Long-Term Effectiveness and Permanence: The no action and institutional controls alternatives provide no long-term effectiveness and permanence. Hydraulic controls would provide some temporary control for migration of contaminants but no long-term effectiveness and permanence. The pump and treat alternative will remove and treat contaminants in a manner that will provide some permanent reduction of contaminant levels in the groundwater but is not intended to be a permanent or final solution.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Only the pump and treat alternative would reduce the toxicity of the extracted groundwater by removing Sr-90 through ion exchange. However, the concentration of Sr-90 remaining in the contaminated groundwater plume would not be measurably reduced by use of the treatment system. None of the other interim action alternatives use a treatment element.

Short-Term Effectiveness: The no action and institutional controls alternatives would present no increased risk to workers, the community, or the environment. Neither of these alternatives would achieve the interim action objective of controlling the flux of Sr-90 discharges to the river.

Implementation of the pump and treat and hydraulic controls alternatives would be accomplished by use of the existing pump and treat system (without the treatment element under the hydraulic controls alternative) and, therefore, would immediately obtain the objective of controlling flux of Sr-90 discharges to the river. Due to use of the existing system, there would be no construction associated with these alternatives. Short-term impacts associated with worker risk from operation of either of these alternatives are small, however, because the pump and treat alternative contains a treatment element to maintain (the ion-exchange system), it would have a slightly higher potential for short-term worker risk than hydraulic controls.

Implementability: All of the interim alternatives are technically and administratively feasible, and implementability is not expected to be significantly different for any of the four (4) alternatives. The no action alternative would be the easiest alternative to implement. Access controls are already in place as part of DOE's operation of the Hanford Site; continued maintenance of these controls would be anticipated during the five (5)-year interim action period in any event, and these controls would be institutionalized. The hydraulic controls and pump and treat alternatives would require routine maintenance and operation and, therefore, may be slightly more difficult to implement than the no action and institutional controls alternatives.

Cost: Negligible costs are associated with the no action alternative. No additional costs are associated with the institutional controls alternative because existing controls will be maintained during the interim. The annual operating costs for hydraulic controls and pump and treat system already in place are $261,900 and $329,100, respectively. No capital costs are associated with any of the four (4) alternatives. A comparative cost analysis (Table 7) for a five (5)-year period shows that Hydraulic Controls, at a present worth cost of $1,153,109 is the third lowest cost alternative, after No Action and Institutional Controls. The Pump and Treat Alternative is the most expensive alternative, at a present worth cost of $1,448,981.

State Acceptance: State acceptance indicates whether, based on its review of the CMS, Proposed Plan, and Administrative Record, the state concurs with, opposes, or has no comment on the selected interim remedial action. The State of Washington concurs with the selection of the interim remedial actions described in this ROD.

Community Acceptance: Community acceptance refers to support by the public for the preferred remedial action alternative and is assessed following a review of the public comments received on the CMS and Proposed Plan. On April 2, 1998, a meeting was held to discuss the Proposed Plans for the

Table 7. Comparative Cost Summary of 100-NR-2 Operable Unit Alternatives

Alternative	Capital Cost ($)	One-Year Operating Cost ($)	Total Present Worth Cost ($)
No Action	Negligible	Negligible	Negligible
Institutional Controls[a]	Negligible	Negligible	Negligible
Hydraulic Controls[b]	Negligible	$261,900	$1,153,000
Pump and Treat[b]	Negligible	$329,100	$1,449,000

[a] No additional costs, over and above the costs of existing controls, are expected.
[b] Present worth costs are for 5 years. Calculation of net present worth of a cash flow annually escalated at 3.2% and annually discounted at 10.2% (7% plus 3.2%) per year for 5 years. The 3.2% annual escalation is published by DOE (Environmental Restoration Contractor rates 12/20/96) and is assumed constant for 5 years. The 7% discount rate was obtained from the EPA Hotline [(800) 424-9346]. The first year is not escalated or discounted.

100-NR-1 and 100-NR-2 OUs. The results of the public meeting and the public comment period indicate overall general acceptance and support of the preferred remedial alternative. Community response to the remedial alternatives is presented in the Responsiveness Summary in Appendix A, which summarizes questions and comments received during public comment.

X. SELECTED REMEDY

Based upon consideration of CERCLA remedial action and RCRA corrective action requirements, the analysis of alternatives, and public comments, the Tri-Parties have selected interim remedial actions for the 100-NR-1 and 100-NR-2 OUs. The selected interim remedy for these OUs is defined below.

The components of the selected remedy achieve the best balance of the nine (9) evaluation criteria described above.

100-NR-1 Waste Sites Selected Remedy (excluding the shoreline and Petroleum Waste Sites)

The selected remedy for the 100-NR-1 OU source waste sites as listed in Appendix B is to remove/dispose contamination in waste sites within the radioactive, inorganic, burn pit, and surface solid groups.

The future land use for the 100 Area has not been determined. The selected remedy for these waste sites will not preclude any future land use. The RAOs and cleanup standards will be re-evaluated as part of the final remedy for this operable unit and as part of the CERCLA five (5)-year review, and if future land use and groundwater use determinations are inconsistent with the selected remedy.

The selected remedy for the 100-NR-1 source waste sites will include the following activities:

1. Per the Tri-Party Agreement, DOE is required to submit the remedial design report, remedial action work plan, and sampling and analysis plan as primary documents. These documents and associated documents concerning the planning and implementation of remedial design and remedial action shall be submitted to Ecology for approval prior to the initiation of remediation. The 100 Area remedial design report and remedial action work plan may be revised as an alternative to submitting new documents. All work required under this approved remedial action must be done in accordance with approved plans and ARARs.

2. Prior to beginning remedial action or excavation, a cultural and natural resources review will be conducted.

3. Remove and stockpile any uncontaminated overburden that needs to be moved to gain access to contaminated soils and, to the extent practicable, use this overburden for backfilling excavated areas.

4. The extent of remediation of the waste sites will be as follows:

   a) For remediation of the top 4.6 m (15 ft) below surrounding grade or the bottom of the engineering structure, whichever is deeper, remove until contaminant levels are: (1) demonstrated to be at or below MTCA Method B levels for nonradioactive chemicals, and achieve 15 mrem/year above background for radionuclides for rural residential exposure, and (2) demonstrated to provide protection of the groundwater and the Columbia River. Contaminant levels will be reduced so concentrations reaching the groundwater or the Columbia River do not exceed MTCA Method B levels, federal and state MCLs, or federal and state AWQC, whichever is most restrictive.

   b) For sites where the engineered structure and/or contaminated soil and debris begins above 4.6 m (15 ft) and extends to below 4.6 m (15 ft), the engineered structure (at a minimum) will be remediated so the contaminant levels are demonstrated to be at or below MTCA Method B levels for nonradioactive chemicals and the 15 mrem/yr residential dose level and are at levels that provide protection of groundwater and the Columbia River. Any residual contamination present below the engineered structure and at a depth greater than 4.6 m (15 ft) shall be subject to several factors in determining the extent of remediation, including reduction in risk by decay of short-lived radionuclides (half-life less than 30.2 years), protection of human health and the environment, remediation costs, sizing of the ERDF, worker safety, presence of ecological and cultural resources, the use of institutional controls, and long-term monitoring costs. The extent of remediation must ensure that contaminant levels remaining in the soil are protective of groundwater and the Columbia River. For nonradioactive contaminants, MTCA specifies that concentrations of residual contaminants in soil are considered protective of groundwater if levels do not exceed 100 x the groundwater cleanup levels established in accordance with WAC 173-340-720. If residual concentrations exceed cleanup levels calculated using the 100 times rule, site specific modeling will be preformed to provide refinement on contaminants found to simulate actual conditions at the waste site. For radionuclides, groundwater and river protection may be demonstrated through a technical evaluation using the computer model RESRAD. The decision of whether to proceed with the remove/dispose alternative below 4.6 m (15 ft) or the bottom of the engineering structure, whichever is deeper, will be made by Ecology on a site-by-site basis. A public comment period of no less than thirty (30) days will be required prior to making any determination on the balancing factors.

4. The measurement of contaminant levels during remediation will rely on field screening methods. Appropriate confirmational sampling of field screen measurements will be taken to correlate and validate the field screening. After field screening activities have indicated that cleanup levels have been achieved, a more extensive confirmational sampling program will be undertaken that routinely achieves higher levels of quality assurance and quality control that will support the issuance of an interim remedy CERCLA closeout report for the waste site.

5. After a site has been demonstrated to achieve cleanup levels and RAOs, it will be backfilled and re-vegetated. To the extent practicable, removed and stockpiled uncontaminated overburden will be used for backfilling of excavated areas. Re-vegetation plans will be developed as part of remedial design activities. Efforts will be made to avoid or minimize impacts to natural resources during

remedial activities, and the Natural Resources Trustees and Native American Tribes will be consulted during mitigation and restoration activities.

6. Pipelines associated with the units will be removed and disposed or sampled to determine if they meet remedial action objectives and can be left in place.

7. Treatment of excavated soils will be conducted before disposal, as required, to meet RCRA land disposal restrictions and the ERDF waste acceptance criteria.

8. Excavated contaminated soils, structures, and pipelines will be transported to the ERDF for disposal. Excavation activities will follow all appropriate construction practices for excavation and transportation of hazardous materials and will follow as low as reasonably achievable (ALARA) practices for remediation workers. Dust suppression during excavation, transportation, and disposal will be implemented as necessary.

9. Post-remediation monitoring of the vadose zone and groundwater will be performed to confirm the effectiveness of remediation efforts and accuracy of modeling predictions associated with the selected remedy.

10. Institutional controls and long-term monitoring will be required for sites where wastes are left in place and preclude an unrestricted land use. Institutional controls selected as part of this remedy are designed to be consistent with the interim action nature of this ROD. Additional measures may be necessary to ensure long-term viability of institutional controls if the final remedial actions selected for the 100 Area does not allow for unrestricted land use. Any additional controls will be specified as part of the final remedy. The following institutional controls are required as part of this interim action:

    (a) DOE will continue to use a badging program and control access to the sites associated with this ROD for the duration of the interim action. Visitors entering any of the sites associated with this Interim Action ROD are required to be escorted at all times.

    (b) DOE will utilize the on-site excavation permit process to control land use well drilling and excavation of soil within the 100 Area OUs to prohibit any drilling or excavation except as approved by Ecology.

    (c) DOE will maintain existing signs prohibiting public access.

    (d) DOE will provide notification to Ecology upon discovery of any trespass incidents.

    (e) Trespass incidents will be reported to the Benton County Sheriff's Office for investigation and evaluation for possible prosecution.

    (f) DOE will take the necessary precautions to add access restriction language to any land transfer, sale, or lease of property that the U.S. Government considers appropriate while institutional controls are compulsory, and Ecology will have to approve any access restrictions prior to transfer, sale, or lease.

    (g) Until final remedy selection, DOE shall not delete or terminate any institutional control requirement established in this Interim Action ROD unless Ecology have provided written concurrence on the deletion or termination and appropriate documentation has been placed in the Administrative Record.

(h) DOE will evaluate the implementation and effectiveness of institutional controls for the 100-NR-1and 100-NR-2 OUs on an annual basis. The DOE shall submit a report to Ecology by July 31 of each year summarizing the results of the evaluation for the preceding calendar year. At a minimum, the report shall contain an evaluation of whether or not the institutional control requirements continue to be met and a description of any deficiencies discovered and measures taken to correct problems.

11. Because this is an interim action and wastes will continue to be present in the 100 Area until such time as a final ROD is issued and final remediation objectives are achieved, a five (5)-year review will be required.

100-NR-1 Shoreline Selected Remedy

The selected remedy for the 100-NR-1 shoreline site is institutional controls. Institutional controls shall be implemented for the shoreline site due to Sr-90 concentrations existing in the sediments above cleanup levels. Additional measures may be necessary to ensure long-term viability of institutional controls if the final remedial actions selected for the 100-NR-1 and 100-NR-2 OUs do not allow for unrestricted use. Any additional controls will be specified as part of the final remedy. The institutional controls as stated above for the 100-NR-1 waste sites (see #10) are applicable to the shoreline site.

100-NR-1 Petroleum Waste Sites Selected Remedy

Petroleum sites, as identified in Appendix B, will be remediated pursuant to Ecology's cleanup standards established under WAC 173-340, MTCA. The selected remedy is to remove and ex-situ bioremediate contaminated soil and debris within the top 15 feet. This may be adjusted based on field conditions and with Ecology approval. For contamination and debris below 15 feet or the termination point of the ex-site bioremediation point, the remedy is in-situ bioremediation. The specifics of the remedy are stated below.

1. Per the Tri-Party Agreement, DOE is required to submit the remedial design report, remedial action work plan, and sampling and analysis plan as primary documents. These documents and associated documents concerning the planning and implementation of remedial design and remedial action shall be submitted to Ecology for approval prior to the initiation of remediation. The 100 Area remedial design report and remedial action work plan may be revised as an alternative to submitting new documents.

2. Remove and stockpile any uncontaminated overburden that needs to be moved to gain access to contaminated soils and, to the extent practicable, use this overburden for backfilling excavated areas.

3. The extent of remediation of the waste sites will take into account certain site-specific factors. The extent of remediation will be established based on the following criteria:

   - For remediation of the top 4.6 m (15 ft) below surrounding grade or the bottom of the engineering structure, whichever is deeper, contaminated soil and debris will be removed and ex-situ bioremediated within the 100-N OU boundary. Bioremediation will continue until contaminant levels are demonstrated to be at or below MTCA Method A for TPH diesel. The

depth of removal for ex-situ bioremediation can be adjusted (shallower or deeper than 15 feet) based on field conditions and requires Ecology approval. The RA/RD workplan will provide the specifics of the bioremediation.

- For remediation of contaminated soil and debris below 15 feet or at the termination point of the ex-situ bioremediation, in-situ bioremediation will be performed until contaminant levels are demonstrated to be at or below MTCA Method A for TPH diesel and are at levels that provide protection of groundwater and the Columbia River. The RA/RD workplan will provide the specifics of the bioremediation.

4. The measurement of contaminant levels during remediation will rely on field screening methods. Appropriate confirmational sampling of field screen measurements will be taken to correlate and validate the field screening. After field screening activities have indicated that cleanup levels have been achieved, a more extensive confirmational sampling program will be undertaken that routinely achieves higher levels of quality assurance and quality control that will support the issuance of an interim remedy CERCLA closeout report for the waste site.

5. After a site has been demonstrated to achieve cleanup levels, it will be backfilled and re-vegetated in accordance with approved plans. To the extent practicable, removed and stockpiled uncontaminated overburden will be used for backfilling of excavated areas. Re-vegetation plans will be developed as part of remedial design activities. Efforts will be made to avoid or minimize impacts to natural resources during remedial activities, and the Natural Resources Trustees and Native American Tribes will be consulted during mitigation and restoration activities.

6. Treatment of excavated soils will be conducted on-site. If treatment is not successful, the disposal location will be an Ecology approved disposal facility.

7. Collect and treat, if necessary, any leachate generated. Dispose of leachate to the ETF or other facility approved Ecology.

8. Maintain ICs for the petroleum sites (listed in Appendix B) as stated above in the selected remedy for the 100-NR-1 waste sites.

100-NR-2 Groundwater OU Selected Remedy

The selected remedy for the 100-NR-2 Groundwater OU is as follows:

- Remove Sr-90 contaminated groundwater through extraction and treatment with ion exchange and discharge treated groundwater upgradient into the aquifer.
- Maintain groundwater monitoring well networks with Ecology approval to monitor pump and treat operations and impacts to groundwater.
- Evaluate technologies for Sr-90 removal and submit information to Ecology.
- Evaluate aquatic and riparian receptor impacts from contaminated groundwater and submit information to Ecology.
- Remove Petroleum Hydrocarbons (free-floating product) from any monitoring well and purge into an on-site tank for disposal to an approved off-site or on-site facility.
- Remove Petroleum contaminated solid waste, treat if necessary, and dispose to ERDF.
- Dispose of non-hazardous wash/rinse waters to the Hanford Effluent Treatment Facility or other facilities approved by EPA and Ecology.

The selected remedy for the 100-NR-2 groundwater OU will include the following activities:

1. DOE is required to submit the remedial design information and sampling and analysis plan as part of the 100-NR-1 RD/RA workplan . The RD/RA workplan will require Ecology approval.

2. Operate the existing pump and treat system per the design configuration described in the *N-Springs Pump and Treat System Optimization Study* (DOE/RL-97-34). This includes up to three (3) pumping wells and up to two (2) injection wells. The minimum requirement for the pump and treat system is to achieve a 90% reduction in Sr-90 concentration in the extracted groundwater. Spent ion exchange resin will be disposed to ERDF and treated as necessary to meet ERDF waste acceptance criteria. . The system shall operate continuously, excluding approved maintenance operations and system modifications, and other approved shutdowns. Any shutdown period greater than one (1) week shall require notification to Ecology.

3. Petroleum hydrocarbons have been observed as floating product sporadically in two (2) wells (199-N-17 and 199-N-18) in the 100-N Area. Should floating product be observed during future monitoring activities, a discriminating intake system may be required to remove it; however, this system has not been proven to be technically feasible. Use of this system will be based on a determination of feasibility during the RDR/RAWP phase. Should the system prove feasible, it would be installed directly in the well. Recovered product would be purged into an on-site tank for separation from water and disposed or reclaimed in accordance with the RDR/RAWP.

4. During this interim action, DOE will investigate groundwater remediation and river protection technologies for Sr-90 contamination and submit information to Ecology within 5 years of this ROD. The Tri-Parties will determine which technologies warrant further investigation, such as through the Innovative Treatment Remediation Demonstration. Investigations will include literature review studies and, if appropriate, bench-scale and field testing. Pump and treat may be considered as an integral part of other alternatives; however, groundwater remediation technologies to be evaluated will focus on innovative technologies to remove Sr-90 from contaminated sediments and groundwater. River protection technologies to be evaluated may include hydraulic control or physical barrier systems to assess their impact on Sr-90 concentrations at the shoreline site.

5. DOE will conduct an evaluation of aquatic and riparian receptor impacts from contaminant discharges at the groundwater/river interface and will coordinate with ongoing efforts . DOE shall submit information to Ecology within 5 years of this ROD. The evaluation will include a literature search and an evaluation of existing data. Laboratory testing and studies of ecological receptors (e.g., through bioassays or injury assessments) and their habitat (e.g., pore water sampling) may be required.

6. DOE will continue to monitor the network of wells within the 100-N Area groundwater system of interest (the uppermost, unconfined shallow system that has been contaminated by the source waste sites) for all contaminants of concern. The continued monitoring will: (1) assess the performance of the chosen interim action; (2) assess the performance of technologies including, if appropriate, field testing; (3) further define the extent and nature of the Sr-90 groundwater plume; and (4) further define the extent and nature of contaminant plumes for the other contaminants of concern; tritium, chromium (VI), manganese, nitrate, sulfate, and TPH. This last monitoring objective will provide information that can be used to help determine a final groundwater remedial action, or the need for other interim actions, for these contaminants of concern. Details of the monitoring program will be defined as part of the operations and maintenance plan and will be submitted to Ecology for approval. The monitoring plan shall include monitoring methods, schedules, documentation and tracking, and methods of analysis.

7. Because this is an interim action and contaminants will continue to be present in the groundwater until such time as a final ROD is issued and final remediation objectives are achieved, a five (5)-year review will be required.

8. Maintain ICs for the groundwater as stated above in the selected remedy for the 100-NR-1 waste sites.

XI. STATUTORY DETERMINATIONS

Under CERCLA Section 121, selected remedies must be protective of human health and the environment, comply with ARARs, be cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practical. In addition, CERCLA includes a preference for remedies that employ treatment that significantly and permanently reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. This section discusses how the selected remedies meet these statutory requirements.

Protection of Human Health and the Environment. The results of the QRA for the 100-NR-1 OU were based on limited site-specific soil data, 100-N Area historical operations information, and/or process knowledge at analogous sites in the 100 Area. The QRA concluded that several waste sites posed unacceptable risks to human health and the environment. Remediation of waste sites at 100-NR-1 will principally occur to remove contaminated soils, structures, and debris. The selected remedies for 100-NR-1 protect human health and the environment through removal, treatment, and disposal of contaminated soils, structures, and debris, including pipelines as well as through land use restrictions to prevent exposure to contaminants that pose a risk to human health and the environment under assumed future land use scenarios. Implementation of these interim remedial actions will not pose unacceptable short-term risks toward site workers that cannot be mitigated through standard remediation practices.

The results of the QRA for 100-NR-2 OU concluded that some contaminant concentrations in groundwater exceed human health-based risk levels established for drinking water. The QRA concluded that no groundwater contaminants were above ecological remedial action goals based on the AWQC for protection of freshwater aquatic life. However, because the main risk at 100-NR-2 is due to the Sr-90 concentrations in groundwater and at the groundwater/river interface, and because this constituent does not have water quality criteria established for it, further evaluation of potential impacts to aquatic and riparian resources is required as a vital part of the interim remedial action for the 100-NR-2 OU. The selected remedy for the 100-NR-2 OU protects human health and the environment through Sr-90 removal and reducing the movement of Sr-90 discharges to the river. Continued access controls to groundwater and the groundwater/river interface at N-Springs will also provide protection while potential future actions and ecological impacts are evaluated.

Compliance with ARARs. The 100-NR-1 selected remedies comply with the federal and state ARARs identified below. No waiver of any ARAR is being sought for the 100-NR-1 interim remedial action.

The 100-NR-2 selected remedy will comply with all ARARS identified below except it will not be in full compliance with the *Safe Drinking Water Act of 1974* (SDWA) (40 U.S.C. 300, et seq.), "National Primary Drinking Water Regulations" (40 CFR 141) and "Underground Injection Regulation" (WAC 173-218). For the interim hydraulic controls and pump and treat alternatives, reinjection of groundwater will occur within a portion of the groundwater plume that is already contaminated with Sr-90. The remedy utilizes treatment to the extent practical and reasonable, but the reinjection of groundwater may not meet drinking water standards or MCLs for Sr-90. As a consequence, an interim action waiver of these ARARs is being granted as part of the selected interim remedial action for the

100-NR-2 OU pursuant to CERCLA Section 121(d)(4)(A) and the NCP, 40 CFR 300.430 (f)(1)(ii)(E)(1). The interim remedial action for the 100-NR-2 OU will be followed by a final remedial action that will address all ARARs.

The basis for the interim action waiver is that this is an interim action which will be followed by a final action that will meet ARARs. In addition, because the pump and treat system has been operational for nearly 4 years and based on the engineering and design of the system, the discharge can not normally meet the MCLs or drinking water standards for Sr-90 along with other contaminants present such as tritium and nitrate. The system is currently operating at greater than 95% efficiency. No additional environmental benefit would be gained by increasing the number of resin columns used to treat the groundwater based on the additional secondary waste generated compared to the reduction of Sr-90 in the groundwater. This waiver is supported based on the operational history of the system as well as field experience of maintaining the system during the last four years.

The ARARs identified for the 100-NR-1 and 100-NR-2 OUs are the following:

Chemical-Specific ARARs

- *Model Toxics Control Act* (MTCA) (70.105D, RCW), "MTCA Cleanup Regulation" (WAC 173-340). Establishes risk-based cleanup levels that are applicable, or relevant and appropriate for this action, for establishing cleanup levels for metal and organic contaminants in soil, structures, debris, groundwater, and surface water.

- *Safe Drinking Water Act of 1974* (SDWA) (40 U.S.C. 300, et seq.), "National Primary Drinking Water Regulations" (40 CFR 141) and "National Secondary Drinking Water Regulations" (40 CFR 143). Establish MCLs and secondary MCLs for public drinking water supplies that are relevant and appropriate for establishing groundwater and river protection standards.

- *Federal Water Pollution Control Act of 1977* (33 U.S.C. 1251, et seq.), "Water Quality Standards" (40 CFR 131). Establishes AWQC that are relevant and appropriate for establishing groundwater and soil cleanup values that are protective of the Columbia River.

- "Water Quality Standards for Surface Waters of the State of Washington" (WAC 173-201A). Establishes surface water quality criteria that are relevant and appropriate for establishing soil cleanup values that are protective of the Columbia River.

Action-Specific ARARs

- MTCA Cleanup Regulation (WAC 173-340). Risk-based cleanup levels are applicable for establishing cleanup levels for soil, structures, and debris.

- *Hazardous Waste Management Act of 1976* (70.105 RCW), "Dangerous Waste Regulations" (WAC 173-303). This RCRA-authorized state program is applicable to the identification and generation of dangerous waste (which includes all federally-regulated hazardous waste under RCRA) and storage, transportation, treatment, and disposal of those wastes generated during the interim remedial action that designate as dangerous waste.

- "RCRA Land Disposal Restrictions" (40 CFR 268). Applicable for treatment and disposal of wastes designated as dangerous wastes.

- "RCRA Standards for Miscellaneous Treatment Units" (40 CFR Part 264, Subpart X). Applicable to the construction, operation, maintenance, and closure of any miscellaneous treatment unit constructed in the 100 Area for treatment of dangerous wastes.

- *Solid Waste Management Act* (70.95 RCW), "Minimum Functional Standards for Solid Waste Handling" (WAC 173-304). Applicable for management of solid wastes generated during the interim remedial action.

- *Toxic Substances Control Act* (15 U.S.C. Section 2601, et seq.) implemented via 40 CFR 761. Applicable to the management and disposal of remediation waste containing regulated concentrations of polychlorinated biphenyls (PCBs), including specific requirements for PCB remediation waste.

- "Requirements for Land Disposal of Radioactive Wastes" (10 CFR 61). Establishes requirements for management and disposal of radioactive waste at Nuclear Regulatory Commission-licensed facilities that are relevant and appropriate for wastes generated by the interim remedial action.

- *Clean Air Act* (42 U.S.C. Section 7401, et seq.) and "National Emissions Standards for Hazardous Air Pollutants" (40 CFR 61). Applicable to remedial activities that will result in airborne emissions of hazardous air pollutants, including prohibitions on radionuclide emissions that would result in an effective off-site dose equivalent of 10 mrem/yr and visible emissions from asbestos-handling activities.

- *Washington Clean Air Act* (70.94 RCW), "Air Pollution Regulations" (WAC 173-400). Applicable to remedial activities that will result in the emissions of air pollutants, including requirements for best available control technology for fugitive emissions.

- "Emission Limits for Radionuclides" (WAC 173-480). Applicable to remedial activities that will result in air emissions of radionuclides from specific sources, including requirement for best available radionuclide control technology (BARCT).

- *Nuclear Energy and Radiation Act* (70.98 RCW) and "Radiation Protection – Air Emissions" (WAC 246-247). Applicable to remedial activities that will result in airborne emissions of radionuclides, including prohibition on radionuclide emissions that would result in an effective off-site dose equivalent of 10 mrem/yr and requirements for monitoring as appropriate.

- "State Waste Discharge Regulation" (WAC 173-216). Substantive (non-permitting) requirements applicable to remedial activities that result in any liquid discharges to the ground, including requirements for all known available and reasonable methods of prevention, control, and treatment and discharge limits.

- "Underground Injection Regulation" (WAC 173-218). Substantive (non-permitting) requirements applicable to remedial alternatives that discharge liquid through wells that may endanger groundwater of the state. The current pump and treat system discharges may not meet drinking water standards for Sr-90, tritium, and nitrate. The selected interim action will be followed by a final remedy that will address all ARARs.

- "Minimum Standards for Construction and Maintenance of Wells" (WAC 173-160). Applicable for the location, design, construction, and abandonment of water supply and resource protection (including monitoring) wells.

Location-Specific ARARs

- *National Archeological and Historical Preservation Act of 1974* (26 U.S.C. 469) implemented via 36 CFR 65. Applicable when remedial activities may cause irreparable harm, loss, or destruction of significant artifacts in the 100-N Area.

- *Archeological Resources Protection Act of 1979* (16 U.S.C. 417) implemented via 43 CFR 7. Applicable when remedial activities may cause possible harm or destruction of sites in the 100-N Area having religious or cultural significance.

- *National Historic Preservation Act of 1966* (16 U.S.C. Section 470, et. seq.) implemented via 36 CFR 800. Applicable to remedial activities that could impact historic or potentially historic properties.

- *Endangered Species Act of 1973* (16 U.S.C. Section 1531, et. seq.) implemented via 50 CFR 17, 22, 200, 225, 226, 227, 402, and 424. Applicable to remedial activities that could impact threatened or endangered species or critical habitat upon which endangered or threatened species depend.

- "Habitat Buffer Zone for Bald Eagle Rules" (77.12.655 RCW) implemented via WAC 232-12-292. Applicable if the areas of remedial activities include bald eagle habitat.

- *Hanford Reach Study Act* (Public Law 100-605). Applicable to remedial activities that could result in any direct and adverse impacts to the Columbia River.

Other Criteria, Advisories, or Guidance to be Considered for this Interim Remedial Action (TBCs)

- *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, BHI-00317, Rev 2. Delineates primary requirements including regulatory requirements, specific isotopic constituents and contamination levels, the dangerous/hazardous constituents and concentrations, and the physical/chemical waste characteristics that are acceptable for disposal of wastes at ERDF.

- *The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group*, December 1992. Provides stakeholder input on potential future uses of the 100 Area.

The scope of the remedy for the 100-NR-1 shoreline site is limited to institutional controls. Therefore, the only ARARs identified for the shoreline site are the following:

Chemical-Specific ARARs

- *Model Toxics Control Act* (MTCA) (70.105D, RCW), "MTCA Cleanup Regulation" (WAC 173-340). Establishes risk-based cleanup levels that are relevant and appropriate for this action.

Action-Specific ARARs

- "Minimum Standards for Construction and Maintenance of Wells" (WAC 173-160). Applicable for the location, design, construction, and abandonment of water supply and resource protection (including monitoring) wells.

Location-Specific ARARs

- *National Archeological and Historical Preservation Act of 1974* (26 U.S.C. 469) implemented via 36 CFR 65. Applicable when remedial activities may cause irreparable harm, loss, or destruction of significant artifacts in the 100-N Area.

- *Archeological Resources Protection Act of 1979* (16 U.S.C. 417) implemented via 43 CFR 7. Applicable when remedial activities may cause possible harm or destruction of sites in the 100-N Area having religious or cultural significance.

- *National Historic Preservation Act of 1966* (16 U.S.C. Section 470, et. seq.) implemented via 36 CFR 800. Applicable to remedial activities that could impact historic or potentially historic properties.

- *Endangered Species Act of 1973* (16 U.S.C. Section 1531, et. seq.) implemented via 50 CFR 17, 22, 200, 225, 226, 227, 402, and 424. Applicable to remedial activities that could impact threatened or endangered species or critical habitat upon which endangered or threatened species depend. See Table 2.

- "Habitat Buffer Zone for Bald Eagle Rules" (77.12.655 RCW) implemented via WAC 232-12-292. Applicable if the areas of remedial activities include bald eagle habitat.

- *Hanford Reach Study Act* (Public Law 100-605). Applicable to remedial activities that could result in any direct and adverse impacts to the Columbia River.

Cost Effectiveness. The selected remedies for the 100-NR-1 OU provides overall effectiveness proportional to its cost. The use of limited field investigation and observations/monitoring to direct clean-up activities will ensure that a protective remedy is implemented while saving both time and money by reducing the level of characterization required before remediation can be implemented. Costs for the petroleum site selected remedy of remove/ex-situ bioremediation/dispose and in-situ bioremediation are less expensive or comparable, respectively, to the remove/dispose alternative. Interim institutional controls at the shoreline site are less expensive than the other alternatives analyzed. For the 100-NR-2 OU, it has been determined that the higher cost of the pump and treat system is justified in order to maintain environmental benefit by reducing the concentration of Sr-90 in the treated discharge.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable. The Tri-Parties have determined that the selected remedies represent the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable, cost-effective manner. Of the alternatives that are protective of human health and the environment and comply with ARARs, the selected remedies provide the best balance of tradeoffs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, cost, also considering the statutory preference for treatment as a principal element and considering state and community acceptance.

The 100-NR-1 selected remedies (for all waste sites other than the shoreline site) provide protection of human health and the environment by removing or treating contaminants to attain protective concentrations and by complying with ARARs. It utilizes treatment to reduce the toxicity, mobility, and/or volume by employing solidification/stabilization or other treatment as appropriate to meet ERDF waste acceptance criteria as well as employing bioremediation to naturally reduce TPH contaminated soil. The remove/treat/dispose alternative would pose a risk of release of contaminants and worker exposure during excavation, transport, and disposal of contaminated media and will need to be carefully planned to minimize the associated risk. The alternative is considered to be readily implementable but will be costly, particularly due to the large cost required to remediate pipelines associated with the waste sites.

Remediation of the shoreline site of the 100-NR-1 OU is closely tied to the determination of a final remedy for the 100-NR-2 OU. Permanent solutions for this site will be defined at the time the final remedy for the 100-NR-2 OU is determined. Further evaluation is required before a permanent solution is selected for the 100-NR-2 OU.

Preference for Treatment as a Principal Element. The selected remedies for the 100-NR-1 OU utilize treatment to reduce the toxicity, mobility, and/or volume by employing solidification/ stabilization/bioremediation as appropriate to meet ERDF waste acceptance criteria and cleanup standards. The selected remedy for the 100-NR-2 OU utilizes treatment of Sr-90 through continued use of the existing pump and treat system with ion exchange resin. The selected remedy for the 100-NR-2 OU will be reevaluated as part of the CERCLA five (5) year review and as part of final remedy selection for the site.

On-Site Determination. The preamble to the National Contingency Plan states that when non-contiguous facilities are reasonably close to one another and wastes at these facilities are compatible for a selected treatment or disposal approach, CERCLA Section 104(d)(4) allows the lead agency to treat these related facilities as one site for response purposes and, therefore, allows the lead agency to manage waste transferred between such non-contiguous facilities without having to obtain a permit. The 100 Area NPL sites addressed by this ROD and ERDF are reasonably close and are compatible for disposal at ERDF, therefore, these sites and ERDF are considered to be a single site for the response purposes under this ROD.

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

DOE, EPA, and Ecology reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments, it was determined that no significant changes to the remedies, as originally identified in the Proposed Plan, were necessary.

APPENDIX A

RESPONSIVENESS SUMMARY

PUBLIC COMMENT RESPONSES
100-N AREA DECISION DOCUMENTS

I. Responsiveness Summary Overview

The Hanford Site was established in 1943 to produce plutonium for nuclear weapons. It is situated north and west of the cities of Richland, Kennewick, and Pasco, Washington. Land use in the areas surrounding the Hanford Site includes urban and industrial development, irrigated and dry-land farming, grazing, and designated wildlife refuges. Operations at the Hanford Site are currently focused on environmental cleanup and waste management.

The 100 Area, which encompasses approximately 68 km^2 (26 mi^2) bordering the south shore of the Columbia River, is the site of nine retired plutonium production reactors. The waste sites being considered for remediation in this ROD are all within the 100-N Area. The 100-N Area is being remediated under the authority of two RODs. A 100-NR-1 TSD ROD addresses the four (4) TSD units in the 100-N Area. This ROD, the 100-NR-1/100NR-2 ROD, addresses RCRA past-practice waste sites, unplanned releases, spills, and associated piping in the 100-NR-1 OU, and the underlying groundwater, designated as the 100-NR-2 OU.

The 100-NR-1 OU encompasses an area of approximately 405 hectares (1,000 acres). Reactor operations and former waste-handling practices caused contamination in the soil around the N reactor, the HGP, and the adjacent support facilities. The 100-NR-1 OU encompasses all the soil waste sites including the associated structures and pipelines in the 100-N Area.

One hundred fourteen (114) sites in the 100-NR-1 OU were identified as potentially contaminated source waste sites. Thirty-three (33) of the 114 sites were not considered for further action because they were never contaminated or are not currently contaminated, or they will be remediated through another action. Eighty-one (81) sites remain to be remediated under the 100-NR-1/100-NR-2 ROD.

The source waste sites covered under this ROD were organized into 5 waste groups based on their suspected primary contaminants and characteristics. The 5 waste groups and the number of sites in each are as follows: radioactive (37 sites), petroleum [near-surface (20 sites) and deep contamination(2 sites)], inorganic (6 sites), burn pit (6 sites), and surface solids (9).

II. Background on Community Involvement and Concerns

The public has been involved in the cleanup of the Hanford Site since the *Hanford Facility Agreement and Consent Order* was signed in 1989. Since 1989, a number of stakeholder working groups and task forces have been used to enhance decision making at the Hanford Site. In January 1994, the Hanford Advisory Board was formed to provide informed advice to DOE, EPA, and Ecology. To date, the board has issued over ninety pieces of advice, several of which directly relate to 100 Area cleanup.

A consistent message from interested citizens and affected Indian Nations is to get on with cleanup and protect the Columbia River.

III. Summary of Major Questions and Comments Received During the Public Comment Period and the Agency Response to Those Comments

Comments received during the public comment period are presented in this section. Responses to the comments follow each comment. Copies of all comment letters and Ecology's response are located in the Administrative Record.

HANFORD GENERATING PLANT, ENERGY NORTHWEST GENERAL COMMENTS

1. **Comment:** Based on the HGP site's location, Energy Northwest believes that the selection of a rural residential cleanup level is not warranted.

   Response: The selection of the rural residential cleanup level reflects precedence set in the remediation of the 100-BC-1, 100-DR-1, and 100-HR-1 liquid effluent waste sites. The Record of Decision for these remediation actions states 'for the purposes of this interim action, the remedial action objectives are for "unrestricted use".

2. **Comment: Energy Northwest**, as a fiscally responsible municipal corporation of the State of Washington, wants to minimize any undue burden on our customers. Therefore, it is in our best interest to immediately proceed with D&D as necessary to restore the HGP site. The resources are available and we intend to proceed at a quicker rate than proposed by 100 Area remediation schedule.

   Response: The proposed schedule identified in the *Engineering Evaluation/Cost Analysis for the 100-N Area Ancillary Facilities and Integration Plan* is a duration-only schedule, which does not include specific start or end dates, and is intended to indicate the relative priority and critical path of cleanup activities. Specifically, the schedule was established taking into consideration the priority of remediation activities, while ensuring that interference between facility decontamination and demolition and waste site remediation is minimized. Another consideration was to develop a schedule with a relatively even distribution of funding. However, as funding availability fluctuates, the schedule can be delayed or accelerated accordingly within the ten-year time frame.

3. **Comment:** The proposed schedule should provide the flexibility to permit immediate completion of the restoration work at HGP.

   Response: See response to General Comment 2 under Hanford Generating Plant, Energy Northwest General Comments.

HANFORD GENERATING PLANT, ENERGY NORTHWEST SPECIFIC COMMENTS

A. *Engineering Evaluation Cost Analysis for the 100-N Area Ancillary Facilities and Integration Plan*, DOE/RL-97-22, Rev. 1.

1. **Comment**: Page 1-2, Line 11: Energy Northwest would like to follow its own schedule to complete work earlier than scheduled. This EE/CA should allow Energy Northwest to fund and contract for cleanup, decontamination, and demolition to a selected contractor of our own

selection in accordance with our procedures as long as the cleanup, etc. meets the technical requirements of this EE/CA.

Response: See response to General Comment 2 under Hanford Generating Plant, Energy Northwest General Comments.

2. **Comment:** Page 2-9: In the first bullet, it is on the northwest wall.

Response: Comment noted. The word *wall* was omitted from the description.

3. **Comment:** Page 2-15: The physical description for 181-NE is incorrect. The facility houses four circulating pumps and their respective lubricating water pumps in addition to the three fire protection pumps.

Response: Comment noted. The physical description for 181-NE should state that it houses four circulating pumps and their respective lubricating water pumps in addition to the three fire protection pumps.

4. **Comment:** Page 2-16: There is no 1605-NE Observation Post at HGP. Also see Figure 2-1.

Response: At the time the EE/CA was prepared, available information indicated the existence of a 1605-NE observation post. The NE designation references facilities associated with the Hanford Generating Plant, which is managed by Energy Northwest. A subsequent investigation has indicated that the facility is located in the 100-N Area, not within the boundaries of the Hanford Generating Plant, and is managed and controlled by the Project Hanford Management Contractor.

5. **Comment:** Page 3-1: In third paragraph, it should be clarified that areas inside the HGP fence do not interfere with any other cleanup operations.

Response: Comment noted. The areas inside the HGP fence do not interfere with any other cleanup operations.

6. **Comment:** Pages A-6, 7: The availability of basic utilities is essential to keep demolition costs under control. However, we are already addressing the loss of power to HGP and there is no potable water or sewer system. In addition, the rail lines should be maintained for demolition. The large transformers are normally moved by rail.

Response: Comment noted. As stated in the EE/CA, if there is no justification for keeping services functional, they should be removed. Therefore, the proposed actions provides flexibility to keep rail lines in operation as long as justified.

7. **Comment:** Appendix C: The cost estimates were based on a model that Energy Northwest has already shown to be unreliable for our work.

Response: An EE/CA is a document that assesses the various remediation alternatives of a collection of facilities or remediation units. In order to effectively compare one alternative to another, it is most helpful if the alternative estimates are developed using the same estimating methodology. This allows for an equitable comparison of alternative actions without concern over the use of differing estimating tools. Because the MCACES models have been approved by the DOE for out year baseline estimates, MCACES was applied to the 100-N Area EE/CA facilities as the estimating tool. MCACES meets the U.S. Environmental Protection Agency's

guidance for accuracy of cost estimates, which states that typically "study estimate" costs are expected to provide an accuracy of +50 percent to -30 percent and are prepared using available data. During the remedial design, and when additional information becomes available, the cost estimates will be refined.

B. *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units, DOE/RL-95-111, Rev. 0*

1. **Comment:** Page 1-2, line 15: Please note that the BPA Substation and transmission lines are still in service with no intent to demolish.

   Response: Comment noted. As stated on page 2-4, facilities to remain active are not addressed in this EE/CA. Appendix B Table B-2 identifies the BPA Substation as an active facility. Therefore, the BPA Substation is not addressed for removal in this EE/CA.

2. **Comment:** Page 3-75: We believe item 37 is a transformer oil spill and not a dump site. See also Table 3-7.

   Response: A review of the Waste Identification Data System (WIDS) listing report for the site in question (100-N-39) has indicated the site was a dumping area. The WIDS report references a Bonneville Power Administration memorandum (1981) that states that the site was used as a dump for construction debris. There is another site identified in WIDS, UPR-100-N-37, which was an unplanned release of transformer oil. The CMS addresses both 100-N-39 and UPR-100-N-37.

3. **Comment:** Page 3-83: In item 10 the facility in the third column should be 1701-NE.

   Response: Comment noted. The building listed (1710-NE) should be 1701-NE.

4. **Comment:** Page 3-93: The concrete and soil below the steam line trestle drains should also be listed.

   Response: Waste sites listed in the CMS were obtained from the Waste Identification Data System (WIDS). WIDS is the official database recognized by the Tri-Parties containing information on all identified waste sites at Hanford. The concrete and soil below the stream line trestle were not included in the WIDS system during preparation of the CMS. However, an evaluation of the site will be made to determine appropriateness for inclusion in WIDS. If the site is added to WIDS, it will be addressed in accordance with the applicable action memorandum or record of decision.

5. **Comment:** Page 9-6, 9.2.4: The schedule should be flexible for Energy Northwest HGP activities.

   Response: See response to General Comment 2 under Hanford Generating Plant, Energy Northwest General Comments.

6. **Comment:** Page 9-6: Energy Northwest will meet the training requirements with our own program.

   Response: All DOE-RL and DOE-RL contractor personnel working at the Hanford Site, including at sites associated with the 100-NR-1 Operable Unit, will be provided with and will successfully complete general site training as specified in Condition II.C.2 of the Hanford

Facility Dangerous Waste Permit. Personnel working at the Hanford Generating Plant, which is operated by Energy Northwest, will be trained in accordance with Energy Northwest training programs.

Geosafe Comments

A. *100-NR-1 Treatment, Storage and Disposal Units Corrective Measures Study/Closure Plan,* DOE/RL-96-39

1. **Comment:** The in situ vitrification (ISV) discussion should include a brief discussion of past ISV work performed at Hanford. Performance information regarding ISV's treatment effectiveness for plutonium, strontium and cesium should also be discussed.

   Response: In situ vitrification was included as a component in four of the alternatives that were evaluated in the screening process described in Section 5.2. The purpose of the assessment in Section 5.1 is to make a qualitative evaluation of effectiveness, implementability, and cost of potentially useful technologies. The qualitative evaluation against these factors relied on a variety of information, including the performance of in situ vitrification methodologies employed at Hanford. The in situ vitrification technology was carried forward for further evaluation, implying that the technology was considered potentially beneficial for remediating the sites under consideration, which could include treatment for plutonium, strontium, and cesium.

2. **Comment:** The discussion on the presence of excessive moisture effecting ISV treatment cost is irrelevant and should be removed. This is true only if there is a substantial amount of groundwater moving into the treatment zone. Note in Figure 2-2 and 2-3, the groundwater elevation is approximately 60 and 70-ft below grade and would not be an issue.

   Response: The discussion regarding the effect of moisture on the technology (Section 5.1.4.4) is provided in the context of discussing some of the advantages and disadvantages of the technology. The fact that the technology was carried forward for further evaluation implies that excessive moisture was not considered a factor in selecting remediation alternatives at these sites.

3. **Comment:** The discussion should include some mention of the added benefits resulting from vitrification such as: the product will exhibit no hazardous characteristic and should easily pass TCLP testing, the vitrified product has an extremely low leaching rate-even if ground to a fine powder and inundated in water and the vitrified product is expected to have a geologic life expectancy substantially greater than 10,000 years.

   Response: Chapter 6 discusses the implementation of the in situ vitrification technology and how it would be implemented under four different alternatives. In two of the cases, in situ vitrification was rejected because of the potential for intrusion into the vitrified monolith, and the third case it was rejected because of depth limitations of the technology. In the fourth case, in situ vitrification was retained for detailed evaluation. During the detailed evaluation of alternatives, in situ vitrification was rejected because it had a higher cost of implementation than that of the preferred option (remove/dispose). The durability of the vitrified product was never called into question.

B. *Proposed Plan for Interim Remedial Action and Dangerous Waste Modified Closure of the TSD Units Associated Sites in 100-NR-1 Operable Unit,* DOE/RL-97-30, Rev. 0

1. **Comment:** Given the high concentration of radionuclies in the 116-N-1 and N-3 Cribs and Trenches, a discussion should be provided on how this material will meet the ERDF waste acceptance criteria (WAC). I assume the waste is not being diluted to meet the WAC requirements. A table showing the WAC criteria versus available characterization information from the subject units should be included.

   Response: Clean or slightly contaminated soil would be added to the high contamination soil fraction for the purpose of controlling radiation exposure to workers and to meet some operational limitations at ERDF concerning ambient air quality. The need to blend the soil is not related to the ERDF WAC.

2. **Comment:** Given that plutonium concentrations greater than 100 nCi/g are considered to be a TRU regulated waste, some discussion should be provided on the TRU components of the waste being shipped to ERDF.

   Response: There are a few samples that showed localized plutonium concentrations in excess of 100 nCi/g, but the contaminated soil in the cribs and trenches, taken in aggregate and without addition of any other soil, is expected to be significantly below the 100 nCi/g threshold. The radionuclide content will be verified by sampling that will be done during the remedial design phase.

3. **Comment:** Given that the proposed plan is selected for implantation the 116-N-1 and 116-N-3 units will still require institutional controls for the radionuclide plume that will be left in place; thus elimination of purely in situ treatment options for similar reasoning does not seem to be justified or logical. Additional discussion on why in situ treatment alternatives have not been evaluated should be provided.

   Response: Under the preferred option (remove/dispose), radionuclide contamination will be removed to a depth of at least 15 ft, thereby reducing the potential for exposure from near-surface intrusion. In contrast, the vitrification alternative would result in radionuclide contaminants remaining in relatively close proximity to the ground surface (and to potential intruders).

Comments by an Individual

1. **Comment:** In evaluating a number of Hanford Annual environmental reports it appears for 1996 the dose from Strontium-90 was .-18 mrem per year. Which equated to 126 person mrems for the Tri-Cities. The government is spending $1,374,000,000,000.00 per mrem reduction (i.e., .062 Ci/yr flux reduction) or about 20 million dollars per person mrem reduction. Are these costs per mrem or person mrem reduction justified? In my review of cost benefit ALARA Analysis – number of ten thousand dollars per mrem reduction is what I remember being justified. Please provide references to dose reductions that justify this level of spending for such a small dose reduction.

   Response: There are no specific references to dose reductions to justify this level of expenditure. The concentrations of Strontium-90 in the groundwater reaching the Columbia River (which is a point of compliance) are 1000 to 2000 times the Maximum Concentration Level (8 picoCuries/L) allowed by law. Upon reaching the Columbia River, the incoming Strontium-90 is diluted by the Columbia River to levels which are below the MCL. However, because the groundwater at the river's edge is above the MCL, the DOE is required by law to address this problem. The DOE can achieve this requirement by either a remedial action that will clean-up the site to below the MCL's or by setting an alternative concentration limit

(ACL). The ACL can only be set after demonstrating that it is impracticable to remediate the site. The present pump-and-treat is scheduled to last five years, and is part of a process to determine the practicability of remediating the site.

2. **Comment:** Page 2-3, 120-N-1 and 120-N-2 TSDs: Respectfully request Ecology delete TSDs 120-N-1 and 120-N-2 from this continued monitoring as a modified RCRA/CERCLA closure plan and provide a plan that is reflective of the current conditions of clean closure of TSD sites 120-N-1 and 120-N-2. Ecology and DOE provide only an inventory of acid or caustic liquids that were deposited at these sites. The documentation says nothing was detected in the soil samples – therefore the site is clean. No elevated sulfate observed in the groundwater are probably the result of discharging Sulfuric Acid and is not of major concern or major health problem for the concentration observed. The water will still meet general house hold and irrigation uses (Davis and DeWiest, Hydrogeology). The elevated Sulfate will only provide odor or taste that is not harmful. I respectfully requested that the money currently being spent on RCRA groundwater monitoring of 120-N-1 and 2 be refocused to something more constructive like removing 1500 drums of uranium and oil in the 300 Area.

Response: While the 120-N-1 and 120-N-2 TSD units are subject to RCRA closure requirements, the groundwater underlying these units is currently being monitored as part of the on-going CERCLA program. The current groundwater monitoring regimen will be followed until a final action for groundwater remediation is determined. The proposed plan for continued groundwater monitoring does not call for the expenditure of any additional resources than are currently being expended to meet CERCLA monitoring requirements.

3. **Comment:** Page 2-3, 116-N-1, 116-N-3, and UPR-100-N-31. As is provided in DOE/RL-96-39 the modeling performed indicates that Strontium-90 will not significantly reach the Columbia River. And as was provided in earlier analysis more remediation of Strontium-90 occurs through natural attenuation than through pump and treat systems (i.e., .1 Ci remove from pump and treat and 2.2 Ci from natural attenuation- decay). The natural attenuation provides 96% of the Strontium-90 remediation in the 100-N Area – Ecology and DOE need to explain why such efforts are being taken to expend such monetary resources for such little return of 5% of the Strontium-90 – it will still take 270-300 years potentially to remediate this site with either of these two technologies? Respectfully request the cessation of the 100 N Area expenditure on pump and treat of $1,000,000 per year and refocus the money on solving the 200 Area Carbon tetrachloride plume which is of real concern as demonstrated in BHI's model predictions of contaminant plumes (BHI-00608 and BHI-00469) and is observed by the rate of spending in the Annual groundwater reports (i.e., 1997, 1996, 1995, 1994). With the current pump and treat and further analysis there appears to b a 2.55 Ci per year contribution to the Columbia River as calculated from the 1996 average Strontium-90 in the Columbia River and average flow of 4500 cubic meters per second (Table Annual average Sr-90 Dose) and not the claimed .063 Ci/yr flux. Request Ecology reconcile these differences in Flux.

Response: It is unclear what the commentor's calculation of 2.55 Ci/yr represents. However, this number appears to be the average number of curies/year in the Columbia River. The 0.063 Ci/year is calculated by taking the concentrations of groundwater at the river shore and multiplying the concentration by the total flux of water discharging through the contaminated zone into the river for each year. It is agreed that the current pump-and-treat system will not significantly reduce the clean-up time over natural attenuation. The purpose of the current pump-and-treat system is to accomplish the following:

- remove Sr-90 from the groundwater,
- reduce the flow of water through the aquifer (by reducing the flow of water, it also reduces the amount of Sr-90 being released to the river),

- and collect data for either additional remedial alternatives and/or help set an alternative concentration limit for this site.

4. **Comment:** Provide the cost estimate for the Barrier Wall – Passive Remedial action. The earlier analyses are missing from these current document. Ecology's earlier estimate demonstrate pump and treat cost approximately $300,000,000 more than the Barrier Wall which makes pump and treat less effective.

   Response: The estimated cost of a permeable reactive barrier is $28,000,000 (DOE/RL-96-11). However, a constructibility test for installation of an impermeable barrier showed that the required sheet pile could not be installed using drive techniques.

5. **Comment:** The current approach of putting out these four documents (DOE/RL-96-102, DOE/RL-97-30, DOE-RL-96-30, and DOE/RL-95-111) is very confusing. Request Ecology and DOE provide one single document that provide a clear plan for Remedial Actions for 100 N Area. It is very unclear what was evaluate and against what to determine what is the right approach to remediate groundwater at 100 N Area. In reviewing these documents it appears previous analysis are not now considered. Please provide the detail written analysis that has lead Ecology to recommended alternative on continued pump and treat.

   Response: With regard to the approach for publishing documents for the 100-N Area remedial actions, it should be noted that both the RCRA and CERCLA regulatory processes require a detailed evaluation of alternatives in the form of a corrective measures study (RCRA) or a feasibility study (CERCLA). The alternatives recommended as a result of these studies are presented to the public in a proposed permit modification (RCRA) or a proposed plan (CERCLA). In order to provide the public with convenient access to the greatest amount of information and to minimize the expense of producing both RCRA and CERCLA documents for proposed actions in the 100-N Area, the RCRA and CERCLA procedural requirements were integrated. The proposed plans, along with the appropriate corrective measures studies, were issued to meet the RCRA and CERCLA requirements. Each of the proposed plan documents is accompanied by a summary that describes the integration of RCRA and CERCLA requirements and discusses other actions that are underway or planned in the 100-N Area. In addition, the issuance of these documents meets two milestones established by the Tri-Party Agreement: M-15-12B required documentation to cover the TSD units and M-15-12C required coverage of the 100-NR-1 and 100-NR-2 source units.

   With regard to the analysis associated with continuing the pump-and-treat operations, the current pump-and-treat system is part of Emergency Remedial Action installed in 1995. It is not the final remedy. Data collected during the operation of the pump-and-treat will be used to select the final remedy. That final remedy will also solicit public comments. At present, it is very difficult to remove Strontium-90 adsorbed onto the sediments. As long as Sr-90 adsorbed onto the sediments is in contact with the groundwater, the concentrations in the groundwater will exceed the maximum concentration limit by three orders of magnitude. This is due to the chemical equilibrium between the Strontium-90 on the sediments and in the groundwater.

Comments by an Individual

1. **Comment:** As a taxpayer I am concerned that excessive amount of money would be proposed to be spent cleaning up a single site along the river to pristine conditions when I cannot foresee the future need of the public to utilize this specific small area for agricultural or residential use. Even if the 100 N Area is "cleaned UP", these is no sampling protocol which can guarantee the public that it is clean and safe to habitate with no risk. The same applies to the entire Hanford Site. Which I am not knowledgeable about the treaty rights of the tribes, nor the specifics of the MTCA, I feel recreational/industrial use is a reasonable alternative, which adequately reduces the dose to the public, removes the bulk of the source term from near the river, and doesn't cost an exorbitant amount of money.

   Response: See response to General Comment 1 under the HGP comments.

XIII. NEZ PERCE COMMENTS

1. **Comment:** It is difficult to ascertain the impact of these actions upon our people as none of the Native American Scenarios outlined in the Columbia River Comprehensive Impact Assessment (CRCIA) were assessed.

   Response: The future land use for the Hanford Site has not yet been determined under this interim action. To provide a basis for evaluating the various remediation technologies, two land-use scenarios were used. One reflects a conservative approach in which the land would be used extensively (i.e., rural residential) and the other reflects a less conservative approach in which the land would be used in a less intensive way (i.e., ranger/industrial). Once the land use for the entire Hanford site has been determined, past and future actions throughout the site will be assessed to ensure consistency with the intended use.

2. **Comment:** Chromium contamination of the 100-N Area is not being addressed. During Fiscal Year 1968, N reactor operations consumed more than 15,000 lb. of Sodium Dichromate (**Chemical Discharged to the Columbia River from DUN Facilities, Fiscal Year 1968** DUN_4668). Chromium concentrations in groundwater samples from Well 199-N-80 are consistently above drinking water standards of 50 ug/L, but remediation of chromium in groundwater is postponed until the final remedial action.

   Response: Well 199-N-80 was drilled and completed in 1992 to RCRA well standards and is completed in a confined sand unit. This confined sand unit is about 15 ft below the upper unconfined aquifer and is separated from it by a clay layer (Hartman and Lindsey 1993). The chromium values at 199-N-80 are above the drinking water standard (50 1g/L) and above the values determined for the upper unconfined aquifer. The upper unconfined aquifer contains the groundwater that can be directly influenced by discharge from the 100-N Facilities (1324N/NA, 1301-N and 1325-N) and other surface activities. The only other well that may be screened in the same unit as 199-N-80 is well 199-N-8P. This is a piezometer located within 50 to 75 ft of the river. Samples are collected from this piezometer on an irregular basis. Chromium was not detected in a sample from 199-N-8P collected in April 1992. It is also important to note that wells screened in the uppermost unconfined aquifer (199-N-75), in the bottom of the unconfined aquifer (199-N-69) and adjacent to the river (199-N-8T, 199-N-8S), all within the general Arial location of well 199-N-80 do not have chromium values above the drinking water standard. The chromium values at well 199-N-80 appear to be well-specific and not related to overall aquifer water quality. Hartman and Lindsey (1993) comment that high chromium values may be a result of the stainless steel used for the well casing and screen. The potential for deep contamination will be further evaluated as part of the interim action.

Reference: Hartman, M.J., and K.A. Lindsey, 1993, *Hydrogeology of the 100-N Area, Hanford Site, Washington*, WHC-SD-EN-EV-027, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Washington Department of Fish and Wildlife (WDFW) general comment

1. **Comment:** The 100-N Area has multiple contaminants of concern that must be addressed by the proposed remedial actions of the 100-NR-1/100-NR-2 Operable Units. The 100-NR-2 groundwater operable unit affects the shoreline site of the 100-NR-1 operable unit. Proposed interim actions should not foreclose final remedial actions, which address all contaminants of concern above maximum concentration levels.

   Response: The Tri Parties agree with the comment. The proposed interim action is to continue the existing pump and treat system, which will not preclude a final remedial action.

Washington Department of Fish and Wildlife (WDFW) Specific Comments

1. **Comment:** WDFW concurs with the interim remedial actions for the 100 NR-1 sites.

   Response: Comment accepted.

2. **Comment:** WDFW concurs with the interim remedial action of the Sr-90 pump and treat while an evaluation of the effects of tritium, Sr-90, and hexavalent chromium on aquatic receptors is performed. The pump and treat establishes a hydraulic gradient preventing the other contaminants of concern from reaching the river. Furthermore, the effectiveness of the interim remedial action should be evaluated.

   Response: Comment accepted. The interim remedial action will be evaluated formally at the end of the first five years of operation under the interim record of decision. Informal evaluation of the system will occur throughout its operation and at each yearly budget review cycle.

3. **Comment:** WDFW strongly agrees with the tri-party agencies that "more information must be obtained to determine whether Sr-90 concentrations are causing short- or long-term impacts to these [aquatic] receptors" and that "further evaluation of potential impacts to aquatic and riparian resources is considered a vital part of the proposed interim action". The contaminated groundwater is an exposure pathway to aquatic receptors, and aquatic receptors are currently exposed to contaminants of concern. WDFW requests studies be initiated to evaluate the impacts to aquatic receptors. We are dismayed that studies have not already been initiated.

   Response: Comment accepted. Discussions being held by the Tri-Parties and interested stakeholders under the Innovative Technology Remediation Demonstration project have included the proposal to further evaluate the impacts of the N Area groundwater on the ecological receptors in the area. It is expected that these discussions will lead to field sampling and subsequent impact analysis.

4. **Comment:** Terrestrial cleanup is occurring in the 100 Area. As part of the cleanup effort in the 100-N area, WDFW urges USDOE to initiate a moderate level biological evaluation of contaminants to terrestrial and avian species, and cooperatively work with WDFW, U.S. Fish and Wildlife Service and the Hanford Natural Resource Trustee Council in developing the

biological studies. WDFW also would encourage the evaluation be expanded to include the entire 100 Area National Priority List site.

Response: Ecology, EPA, and USDOE are also members of the Hanford Natural Resource Trustee Council and expect to work cooperatively with WDFW and others in developing a plan to access impacts of the remedial actions on terrestrial receptors in the 100 Area.

5. **Comment:** WDFW has not been provided adequate information to enable us to make any recommendations toward a final remedy for the 100 NR-2 operable unit and the shoreline site of the 100-NR-1 operable unit.

   Response: This is an interim action aimed at making substantial progress in an area of substantial contamination. The Tri-Parties are not currently in a position to issue a recommendation on a final action.

6. **Comment:** WDFW would like to point out to USDOE project staff that USDOE is a trustee and has responsibilities to the public concerning natural resources. The documents include I&I language identifying commitment of resources for each alternative response action. We believe such commitments are appropriate only after full mitigation, including compensatory mitigation, has been provided. It should be clearly stated that the intent of the I&I statements are being included as important public information, not as an attempt to circumvent natural resource damage liability.

   Response: The language included in the documents speaks to the commitment of resources such as diesel fuel, backfill, and expendable equipment. The intent was to provide relevant information, as it became available.

7. **Comment:** The Corrective Measures Study is deficient due to a lack of environmental analysis, and as such, it is premature to consider final remedial alternative(s) and/or corrective action(s). Studies need to be initiated to evaluate impacts from tritium, Sr-90, and hexavalent chromium to aquatic receptors.

   Response: The Corrective Measures Study is sufficient to support the interim actions proposed.

General Comment by an Individual

1. **Comment:** Of the two alternatives I prefer alternative support, not remedial.

   Response: It is assumed that the commentor misunderstood the range of alternatives evaluated and the alternative recommended for implementation. Alternative support was not evaluated as part of this study, nor was a specific alternative called out as remedial.

Washington State Department of Health (DOH) General Comments

1. **Comment:** We are pleased that work is starting on this unit because we believe that 100-N is currently the main area of the Hanford Site where the public can receive radiation exposure from Hanford pollutants. The evaluation of the cleanup levels based on various land uses and controls coincides with the approach that DOH has recommended in it's Hanford Guidance for Radiological Cleanup. DOH hopes that remediation of this area can proceed on schedule and using a sound technical basis that will give priority to those areas that have a current measurable dose impact on the public.

Response: Comment accepted. The Tri-Parties have agreed to proceed with the remediation of the N Area using the schedule included with the corrective measures study.

DOH Specific Comments

1. **Comment:** The rural residential scenario used to evaluate future potential risks is sometimes referred as an unrestricted use scenario (for example, DOE/RL-97-30, page 13). This scenario also is implied to not preclude any future land use (for example, DOE/RL-96-102, page 4). Since this scenario restricts the use of 100-N Area groundwater, terms other than 'unrestricted use' or 'not precluding any future land use' would be more appropriate when referring to this scenario.

   Response: The term rural residential scenario is defined in DOE/RL-97-30, page 3, paragraph 4 and in DOE/RL-96-102, page 3, paragraph 8 as a scenario which includes restrictions on groundwater use, including a follow-on statement that drinking and irrigation water would need to be supplied from an offsite source (additional details of the scenarios are provided in Appendix F of the CMS.)

2. **Comment:** Reference is made to a 15 mrem/y dose standard for cleanup of sites contaminated with radioactivity. This cleanup level is sometimes referred to as an EPA standard, other times as an EPA draft standard, and other times as EPA guidance. For members of the public not familiar with radiation regulations, use of the term 'EPA standard' implies an EPA regulation with legally binding requirements. Since this EPA cleanup level has not been promulgated and has been withdrawn from consideration for promulgation, it would be more appropriate to consistently refer to it as EPA guidance.

   Response: Comment accepted. Consistently referring to the 15mrem/y dose standard for cleanup as an EPA guidance would be appropriate. This guidance is included under the category of 'to be considered' in the regulatory applicability section of the corrective measures studies and proposed plans and will be used to define the interim cleanup standards applicable to the proposed actions.

3. **Comment:** DOE/RL-96-102, page 19, Receptor Pathway Descriptions
   The text states that 'access control by the DOE currently prevents potential exposure to contaminated groundwater emanating at 100-N-Springs'. This is not the case at times of very low river stage, where ample dry land is exposed above the water line but below the marked radiation zones. This land is below the river's high water mark and is accessible to humans.

   Response: Warning signs at the N-Springs, which face the river, are intended to inform the potential trespasser of the dangers in the area. In addition, the Hanford Patrol and remediation personnel are in the area and are keenly aware of the contamination present at N Springs and the need to prevent intruder access.

4. **Comment:** The documents discuss cases where radiological contaminants either exist or may exist at concentrations above cleanup standards at depths greater than 4.6 meters below grade (for example, DOE/RL-97-30, page 8, and DOE/RL-96-102, page 12). Are these cleanup standards the soil concentrations corresponding to 15 mrem/y from contaminants in the first 4.6 meters below grade, for example those listed in Table 3, page 12 of DOE/RL-97-30?

   Response: The cleanup standards for these actions will be applied from current grade to 4.6 meters below grade. As described on page 16 of DOE/RL-97-30 and page 12 of DOE/RL-96-

102 for those sites which have residual contamination above the cleanup standards at a depth greater than 4.6 meters several factors will be considered to determine the extent of additional remediation. These factors include reduction of risk by decay of short-lived radionuclides, protection of human health and the environment, remediation costs, size of ERDF, worker safety, presence of ecological and cultural resources, the use of institutional controls, and long-term monitoring. The cleanup standards are listed in Table 3, page 12 of DOE/RL-97-30 and in Table 2, page 9 of DOE/RL-96-102. The constituent concentrations listed in both tables represent an individual contaminate level equivalent to 15 mrem/y and would therefore result in a more restrictive cleanup concentration when more than one constituent is present at a waste site

5. **Comment:** Exactly how contaminants at depth are dealt with, and how they correspond to the depths of concern for the two exposure scenarios (4.6m for rural residential and 3m for ranger/industrial), is not clear. For example, the discussion in the CMS for the 116-N-1 Trench (DOE/RL-96-39) indicates remediation to 21 feet (6.4m) below grade, or 5 feet below the bottom of the engineered structure (located 16 feet below grade) for both exposure scenarios. The document did not make it clear why remediation to this depth was needed to meet the dose criterion for these scenarios, particularly for the ranger/industrial scenario.

   Response: The background information for the excavation depth to five feet below the normally required depth of 4.6 meters for these sites can be found in DOE/RL-96-39, page 4-6, Section 4.5. This section, entitled, Area of Contamination for Radiological Sites, refers to the Limited Field Investigation (DOE/RL 1996b), which documents the results of boreholes drilled along side and through the 1301 crib and trench and the 1325 crib. The samples collected from this event indicate a concentrated layer of radionuclides including plutonium-239-240, approximately 3-5 feet thick at a depth of 20 feet below surrounding grade. The Tri-Parties have agreed that this layer of concentrated soil could not be left behind and would therefore be part of the planned excavation.

Comments by an Individual

1. **Comment:** The use of an interim action containing 15 mrem/y does not accomplish MTCA cleanup by 2011 as promised by the Tri-Parties.

   Response: The Tri-Party commitment to complete cleanup in the 100 Area is documented in Milestone M-16 of the Tri-Party Agreement. It is anticipated that the milestone completion date of 2018 will be achieved using the agreed upon path forward.

2. **Comment:** 15 mrem/y is inconsistent with MTCA's 1 x 10-5 cumulative risk level for carcinogens.

   Response: The use of 15 mrem/y above background and MTCA is consistent. MTCA provides for the use of reasonable restoration timeframes which would include natural processes in the form of decay. The 15 mrem/y cleanup standard is consistent with EPA guidance for cleanup of radiological contamination at Superfund sites, WDOH Hanford Guidance for Radiological Cleanup and is less than the current NRC standard approved in 1997.

   The Tri-Parties have examined cleanup levels above 15 to 25 mrem/y and found them not protective of human health and the environment at Hanford. In many cases, existing field measurement methods cannot accurately measure less than 15 mrem above background. Laboratory quality analyses would be required but will only measure low enough in some

cases. Further, it is anticipated that the WDOH will adopt the NRC regulation which uses 25 mrem/y as the cleanup standard by July, 2000.

3. **Comment:** The N documents recommend a rural residential cleanup scenario while a native subsistence scenario is more likely.

Response: The Tri-Parties issued the Interim Action Record of Decision for the 100-BC, DR, and HR operable units using the rural residential land use scenario so as not to preclude future land uses as may be determined by the appropriate agencies. The agencies responsible for land use determination have yet to make such a determination on the Hanford site. Therefore, the rural residential scenario being applied at 100-N is consistent with previous actions in absence of other determinations. The Tri-Parties will continue to engage in dialogue with stakeholders concerning the Native American subsistence scenario and other scenarios which may be applicable to the Hanford site cleanup evaluations.

APPENDIX B

SUMMARY INFORMATION FOR 100-NR-1 SOURCE WASTE SITES

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
1	100-N-1 SWMU 6 HGP Settling Pond WIDS	Received discharges from condenser pit, HGP floor drains, demineralized backwash, roof and parking lot runoff	TPH; radionuclides; chrome, lead, nickel, zinc, copper, calcium; morpholine, hydrazine, ammonia	Soil		RAD	320,925
2	100-N-3 SWMU 9 HGP Maintenance Garage Septic System (french drain) WIDS	Received septic and garage waste (oils, etc.)	Petroleum products	Soil		PET	329,895
3	100-N-4 SWMU 5 HGP Tile Field WIDS	HGP sanitary sewer and tile field; received lab waste and sanitary waste	Morpholine and hydrazine	Soil		MISC	386,783
4	100-N-5 SWMU 10 HGP Bone Yard WIDS	Open storage of metals, electrical equipment, and scrap iron	Potential for PCB, TPH, metals; ion exchange resin beds and sandblast grit	Soil		MISC	349,327
5	100-N-6 Burn Pit WIDS	East of 1120-N Building	Construction debris; VOC, TPH, PCB, and metals not detected	Soil		BURN	94,113
6	100-N-7 182-N Unplanned Release WIDS	19-L (5-gal) release of lubricating oil to the river	Oil	Water	X		NA
7	100-N-8 108-N Unplanned Release WIDS	Leak in transfer line	Sodium hydroxide	Soil	X		NA
8	100-N-9 120-N-5 Unplanned Release WIDS	Leak in acid/caustic transfer trench	Caustic and sulfuric acid	Soil Concrete	X		NA
9	100-N-10 120-N-5 Unplanned Release WIDS	Leak in acid/caustic transfer trench	Caustic	Soil Concrete	X		NA
10	100-N-11 120-N-5 Unplanned Release WIDS	Leak in acid/caustic transfer trench	Sulfuric acid	Soil Concrete	X		NA
11	100-N-12 184-N Pipeline WIDS	Spill inside the 184-N Building leaked to the outside	TPH	Soil		PET	94,334

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
25	100-N-27 108-N Neutralization Pit WIDS	Structure used to neutralize floor drain effluents	Acid waste and neutralizer	Concrete	X		NA
26	100-N-28 Resin Disposal Pit No. 2 WIDS	Disposal pit for reactor decontamination solutions	Decon solutions	Soil		RAD	**
27	100-N-29* 10" Blowdown Pipe No. 1 WIDS	From steam generators to 1300-NBasin	Low-level fission products	Soil		RAD	130,884
28	100-N-30* 10" Blowdown Pipe No. 2 WIDS	From steam generators to 1300-N Basin	Low-level fission products	Soil		RAD	130,884
29	100-N-31* 30" Pipeline WIDS	From steam generators to 1300-N Basin	Low-level fission products	Soil		RAD	130,884
30	100-N-32* 30" Pipeline No. 3 WIDS	From steam generators to 1300-N Basin	Low-level fission products	Soil		RAD	130,884
31	100-N-33 Military Site Ash Pit WIDS	Dumping ground for coal ash	Heavy metals	Soil		INORG	106,777
32	100-N-34 Dumping Area, Burn Pit WIDS	East of 1120-N Building	Construction debris, asphalt	Soil		BURN	93,817
33	100-N-35 Hanford Substation WIDS	HGP/BPA switchyard	PCBs to 7 ppm	Soil Concrete		PET	99,369
34	100-N-36 107-N Oil Stained Pad WIDS	Air compressor lube oil leakage and spillage	TPH	Concrete		PET	98,254
35	100-N-37 Asbestos Release WIDS	109-N asbestos release	Asbestos	Soil		MISC	197,021
36	100-N-38* Unplanned Release	From steam generators to 1300-N Basin	Low-level fission products	Soil		RAD	130,884
37	100-N-39 Substation Dumping Area WIDS	HGP construction dump	Construction debris and fluids	Soil Construction Debris		MISC	97,483
38	100-N-40 108-N Unplanned Release WIDS	Disconnected rail transfer line	Sodium hydroxide	Soil	X		NA

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
25	100-N-27 108-N Neutralization Pit WIDS	Structure used to neutralize floor drain effluents	Acid waste and neutralizer	Concrete	X		NA
26	100-N-28 Resin Disposal Pit No. 2 WIDS	Disposal pit for reactor decontamination solutions	Decon solutions	Soil		RAD	**
27	100-N-29* 10" Blowdown Pipe No. 1 WIDS	From steam generators to 1300-NBasin	Low-level fission products	Soil		RAD	130,884
28	100-N-30* 10" Blowdown Pipe No. 2 WIDS	From steam generators to 1300-N Basin	Low-level fission products	Soil		RAD	130,884
29	100-N-31* 30" Pipeline WIDS	From steam generators to 1300-N Basin	Low-level fission products	Soil		RAD	130,884
30	100-N-32* 30" Pipeline No. 3 WIDS	From steam generators to 1300-N Basin	Low-level fission products	Soil		RAD	130,884
31	100-N-33 Military Site Ash Pit WIDS	Dumping ground for coal ash	Heavy metals	Soil		INORG	106,777
32	100-N-34 Dumping Area, Burn Pit WIDS	East of 1120-N Building	Construction debris, asphalt	Soil		BURN	93,817
33	100-N-35 Hanford Substation WIDS	HGP/BPA switchyard	PCBs to 7 ppm	Soil Concrete		PET	99,369
34	100-N-36 107-N Oil Stained Pad WIDS	Air compressor lube oil leakage and spillage	TPH	Concrete		PET	98,254
35	100-N-37 Asbestos Release WIDS	109-N asbestos release	Asbestos	Soil		MISC	197,021
36	100-N-38* Unplanned Release	From steam generators to 1300-N Basin	Low-level fission products	Soil		RAD	130,884
37	100-N-39 Substation Dumping Area WIDS	HGP construction dump	Construction debris and fluids	Soil Construction Debris		MISC	97,483
38	100-N-40 108-N Unplanned Release WIDS	Disconnected rail transfer line	Sodium hydroxide	Soil	X		NA

Heggen, Dick

From: McManus, Elizabeth
Sent: Monday, October 04, 1999 4:52 PM
To: Ayres, Jeff; Coleman, Lynn; Cusack, Thomas; Davies, David; Dick, Brian; Donnelly, Jack; Elling, Michelle; Fujita, Hideo; Harrover, Robin; Heggen, Dick; Hervieux, Patricia; Jaraysi, Moses; Knudson, Jim; Lenssen, Gerald; Maeng, Byung; Malm, James; Masterson-Heggen, Tina; McManus, Elizabeth; Pang, Linda; Pearson, James; Petersen, Kaia; Polivka, Dave; Rhodes, Janet; Robb, Steve; Ruud, Laura; Safioles, Sally; Seiler, Kay; Sellick, Julie; Steeley, Howard; Stoffel, Keith; Tritt, Galen; Werner, Martin; Wigfield, Kim; Wilhelm, Leon; Yasuda, Dean
Subject: Subsurface Distribution of Contamination Model

Hi everyone -- I just thought I'd pass along the subsurface distribution model we've been using as part of the EPA Results Based Corrective Action Project Management Training. Those of you who attended the training in Seattle earlier this year may already have this; however, there have been a few improvements and updates lately. We use a "fugacity" model. This model is not meant to be the final word on fate and transport, but, it can be a useful tool to focus ones field sampling and analysis by highlighting where (in what phase) one might reasonably expect to find a contaminant given its physical and chemical characteristics. Here's the info:

- Simple environmental fate models can be useful for evaluating equilibrium chemical distribution between environmental phases. Although environmental systems are rarely in equilibrium, simple equilibrium models can be used as tools for sampling plan development, analysis of possible exposure pathways, feasibility assessment of possible remediation strategies, and for assessment of potential environmental fate of new chemicals.

- Chemicals are usually introduced to a particular phase of the environment (air, water, soil), but soon migrate into other phases as thermodynamic equilibrium is approached. "Fugacity" is considered to be the "escaping tendency" of a chemical from a specific environmental phase and is linearly related to the concentration of the chemical in a particular phase. The fugacity model depends on phase specific and chemical specific properties which define the "fugacity capacity" of an environmental phase and the fugacity of the chemical in that phase.

- The spreadsheet based model below is a simple level I fugacity model for calculating equilibrium phase distributions between the subsurface phases of a contaminated soil system including soil, air, water and a residual non-aqueous phase liquid (NAPL) often present in contaminated soils. The model is in EXCEL spreadsheet format and includes a database of chemical values for common contaminants that can be copied and pasted into the appropriate fields for model calculations. Other uses of the fugacity model can be found at the Environmental Modeling Centre at Trent University. <http://www.trentu.ca/academic/aminss/envmodel/welcome.html>

- To download the level I fugacity model, Level I Fugacity Model (Excel) <ftp://humpy.cee.usu.edu/fugacity/fugacity.xls>

Using the Model:

The first information displayed in the level I Fugacity model is for benzene. The information addresses: chemical characteristics of benzene; default site characteristics; and, three formats (pie chart, bar chart and table) for presenting information about the distribution of benzene among air, water, soil solids and NAPL. The table provides values for the concentration of benzene (mg/L) in each phase, based on a total amount of 1 gm of benzene and a total volume in all phases of 100 m(3).

Chemical characteristics are obtained from the tab labeled "chemical data." To get another chemical: access the "chemical data" tab; then, locate the chemical (they are listed in alphabetical order); then, block and copy the list of chemical characteristics for the chemical; then, past the list of chemical characteristics under "level I fugacity."

Site characteristics are listed under the "level 1 Fugacity" tab for a typical evaluative site and typical values are provided as default values. Site-specific data can be entered manually.

The volumes of each phase can be provided as input, but the total volume of the evaluative site must be 100 m(3). Therefore, the values for each phase represent the "percent" of that phase within the evaluative site. Ranges of values include:

	Range	Typical Unsaturated Soil	Typ. Aquifer
water	5 - 50%	25%	40%
air	0 - 40%	25%	0
soil	40 - 60 %	50 %	60%
NAPL	0 - 50%	0	0

Values for percent organic carbon in the soil phase and soil bulk density can be provided as input based on measured values for a particular site. Ranges of values include:

Range	Typical Unsaturated Soil	Typ. Aquifer

organic carbon	0.2 - 5 %	.5%	.2%
Bulk density	1.2 - 1.7	1.3	1.6

The default value for the mass of a compound in the system is one gram, but site-specific values can be provided as input. Calculation of the chemical concentration in each phase at equilibrium is provided.

Elizabeth McManus
Washington State Department of Ecology
(360) 407-6524

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
39	100-N-41 SWMU 9 1701-NE Septic System WIDS	Near 1701-NE Guardhouse	N/A	Soil	X		NA
40	100-N-45 SWMU 9 1703-N Septic System WIDS	Near NE corner of 1703-N office building and warehouse	N/A	Soil		MISC	149,807
41	100-N-46 HGP Oil Storage Tank.	75,708-L (20,000-gal) underground tank. Inactive	Diesel fuel oil	Soil		PET	75,261
42	100-N-47 Military Site WIDS	Former AAA Battalion Headquarters site	Unknown, solid waste	Soil		MISC	197,021
43	100-N-50 SWMU 4 Turbine Oil Filter Unit in HGP RCRA-FA	Turbine oil cleaning system in HGP basement; large spills could go to SWMU 3	Turbine oil; no information available on filter disposal	Concrete Soil		PET	++
44	100-N-51a SWMU 2 HGP Bldg. Oil Storage RCRA-FA	Basement storage room in HGP building for oil, lubricants, and petroleum; no outlet	Oil, lubricants, and small quantities of petroleum products	Concrete		PET	++
45	100-N-51b** SWMU 3 HGP Bldg. Floor Drains and Sumps RCRA-FA	Floor drains and central sump in HGP basement; received spills, leaks, and flood water. Discharged to 100-N-1 or 1908NE	Oil or maintenance spills and water	Water Soil		PET	++
46	100-N-52 SWMU 8 Maintenance Garage east of HGP RCRA-FA	Garage for servicing vehicles; floor drains and sink discharge to 100-N-3	Used oil, solvents, paint, gasoline, pesticides	Concrete Soil	X		NA
47	100-N-65 Diesel Burn Pit	Pit excavated adjacent to river to intercept and burn diesel oil spill (UPR-100-N-17)	Diesel oil	Soil		PET	++
48	116-N-4* Emergency Dump Basin TBR 4.4	Emergency cooling water and steam blowdown	Low-level fission products	Soil Groundwater		RAD	**
49	116-N-8 163-N Mixed/Hazardous Waste Container Storage Pad TBR 4.5	Active mixed solid-waste site located south of the 163-N Building	Pad tested and found to be free of chemical and rad contamination	Soil	X		NA

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
50	118-N-1* Spacer Silos TBR 4.6	Temporary storage of irradiated spacers	Sr-90, Cs-137, H-3, Pu-239/240, Eu-152, Eu-155	Soil Groundwater		RAD	**
51	120-N-3 163-N Neutralization Pit WP 3.25	Acid/caustic discharged to french drain	Sulfuric acid and sodium hydroxide	Soil		INORG	117,146
52	120-N-4 1310 Hazardous Waste Staging Area TBR 4.10	Active; concrete replaced gravel pad in 1985; no known spills	Oil, nonhazardous, nonradioactive waste	Soil	X		NA
53	120-N-5 108-N Transfer Line WP 3.24	Received acid/caustics from transfer line	Sulfuric acid and sodium hydroxide	Soil	X		NA
54	120-N-6 Five 108-N French Drains WP 3.24	Drains received condensate from acid tanks and lines	Sulfuric acid	Soil	X		NA
55	120-N-7 Unloading French Drain WP 3.23	Drains received intermittent amounts of acid discharges	Sulfuric acid, sodium hydroxide	Soil	X		NA
56	120-N-8 Sulfuric Vent French Drain WP 3.26	Received discharges from 163-N Water Treatment	Sulfuric acid	Soil	X		NA
57	124-N-1 Septic System WIDS	South of 163-N Building; active	N/A	Soil	X		NA
58	124-N-2 Septic System WIDS	East of 182-N Building	N/A	Soil		PET	212,349
59	124-N-3 Septic System No. 3 TBR 4.17	Serviced restroom facilities in 107-N Building	None	Soil		RAD	149,807
60	124-N-4 Septic System No. 4 TBR 4.18	Two septic tanks and a leach field	Surface radioactive contamination	Soil		RAD	766,864
61	124-N-5 Septic System No. 5	Septic tank and drain field; system abandoned in place	None	Soil	X		NA
62	124-N-6 Septic System No. 6	Septic tank and leach field; system abandoned in place	None	Soil	X		NA
63	124-N-7 Septic System No. 7	Septic tank and leach field; operated from 1984 to 1987	None	Soil	X		NA

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
64	124-N-8 Septic System No. 8	Septic tank and leach field; operated from 1983 to 1987	None	Soil	X		NA
65	124-N-9 Septic System No. 9	Two septic tanks and a leach field active since 1985	None	Soil	X		NA
66	124-N-10 Septic Lagoon System WIDS	Central sewer system; active site	N/A	Soil	X		NA
67	128-N-1 Burn Pit WIDS	Located NE of 1120-N Building	Municipal type waste, paints, solvents	Soil		BURN	140,531
68	130-N-1 Backwash Pond WIDS	Marsh-like pond received filter backwash from 183-N	Polyacrylamide and aluminum sulfate	Soil	X		NA
69	1908-N 102" Diameter Outfall WIDS	Active; cooling water from the reactor to the river	NA	Water	X		NA
70	1908-NE SWMU 7 HGP Outfall WIDS	Cooling water and settling pond discharges from the HGP facility to the Columbia River	Low-level fission products, and chemical contamination from 100-N-1	Water	X		NA
71	600-32 100-N Area Landfill WIDS	Former gravel pit	Surface debris, paint cans, transite, and concrete	Soil		MISC	2,046,397
72	600-35 Dumping Area WIDS	Borrow pit	Surface debris including drums, batteries	Soil		MISC	161,268
73	UPR-100-N-1 Inlet Valve Box Leak TBR 4.27	1304-N Emergency Dump Tank	Low-level fission products	Soil		RAD	176,709
74	UPR-100-N-2 FLV-858 Valve Leak TBR 4.28	Valve to isolate the return line	Low-level fission products	Soil		RAD	163,508
75	UPR-100-N-3* Transport Line Leak TBR 4.29	Dummy fuel transport line; see UPR-100-N-12	Co-60, Sr-90, Cs-137, Pu-239, Ce-144, H-3	Soil		RAD	253,288
76	UPR-100-N-4 1322-A Sump Overflow TBR 4.30	1322-A sump overflowed	Radioactive water	Soil		RAD	97,464

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
77	UPR-100-N-5 1310-N Tank Leak TBR 4.31	Underground leak of 340,000 L (90,000 gal) radioactive decontamination solution	Decontamination solutions and mixed chemicals; Co-60	Soil		RAD	335,922
78	UPR-100-N-6 Chemical Waste Line TBR 4.32	1.5-in. line leaked	Radioactive water, Co-60, Mn-54, Cs-137, Ru-103	Soil		RAD	104,056
79	UPR-100-N-7* Return Line Leak TBR 4.33	10-in. drainline from 105-N to 1304-N Dump Tank	Mn-154, Co-60, Ce-144	Soil		RAD	375,378
80	UPR-100-N-8 1322-A Sump Overflow TBR 4.34	1322-N sump overflowed	Radioactive water	Soil		RAD	95,409
81	UPR-100-N-9* Drain Line Leak TBR 4.35	Ruptured 2-in. drainline from the 119-N Building	Contaminated water	Soil		RAD	104,037
82	UPR-100-N-10* Lift Station Drain Leak TBR 4.36	Contaminated water from drains in the 105-N Building	Mixed waste; fission and activation products	Soil		RAD	95,409
83	UPR-100-N-11 500-lb Valve Bonnet TBR 4.37	The valve bonnet fell from a truck causing the uncontrolled release of surface contamination	Cleaned up	Soil		RAD	95,853
84	UPR-100-N-12* Spacer Line Leak TBR 4.38	Dummy fuel transport line (see UPR-100-N-3)	Co-60, Cs-137, Pu-239/240	Soil		RAD	459,863
85	UPR-100-N-13 1314-N Drywell Overflow TBR 4.39	Tank car overflowed to catch basin, sump, and soil	Radioactive, spent decon solution	Soil		RAD	88,873
86	UPR-100-N-14* Drain System Leak TBR 4.40	119-N leak during maintenance activity	Radioactive effluent water	Soil		RAD	95,409
87	UPR-100-N-15 Neutralization Sump Spill WP 3.24	108-N transfer line leaked to soil	Sulfuric acid	Soil	X		NA
88	UPR-100-N-17 166-N Supply Line Leak TBR 4.42	4-in. line in tank farm leaked to the ground; trench dug at the river shoreline (100-N-65) to intercept oil	TPH diesel oil	Soil Groundwater		PET	903,509
89	UPR-100-N-18 166-N Supply Line Leak TBR 4.43	4-in. diesel supply line between the 166-N and 184-N storage area	TPH diesel oil	Soil		PET	107,994

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
90	UPR-100-N-19 184-N Fuel Oil Spill TBR 4.44	Fuel oil day tank	TPH No. 6 fuel oil	Soil		PET	112,486
91	UPR-100-N-20 166-N Return Line Leak TBR 4.45	Leak from tank farm 2-in. return line	TPH No. 2 diesel oil	Soil		PET	105,660
92	UPR-100-N-21 184-N Tank Overflow TBR 4.46	Diesel oil day tank	TPH No. 2 diesel oil	Soil		PET	100,162
93	UPR-100-N-22 Diesel Supply Leak No. 1 TBR 4.47	Piping corrosion caused leak outside 184-N Building	TPH No. 2 diesel oil	Soil Groundwater		PET	108,696
94	UPR-100-N-23 184-N Leak No. 2 TBR 4.48	Supply line located near the diesel day tank	TPH No. 2 diesel oil	Soil Groundwater		PET	104,720
95	UPR-100-N-24 166-N Supply Line Leak TBR 4.49	Leak caused by corrosion on transfer line	TPH No. 6 fuel oil	Soil		PET	121,304
96	UPR-100-N-25 Uncontrolled Venting TBR 4.50	1310-N, contamination in bermed area	Phosphoric acid and diethylthiourea solution	Soil		RAD	97,779
97	UPR-100-N-26 Backflow of Waste TBR 4.51	Release occurred within the 1313-N facility	Phosphoric acid and diethylthiourea	Soil		RAD	99,908
98	UPR-100-N-29 Bypass Line Leak TBR 4.52	East side of 1304-N Dump Tank	Primary coolant water; Mn-56, Na-24	Soil		RAD	101,704
99	UPR-100-N-30 1304-N Dump Tank TBR 4.53	Spill to ground; stabilized with sand fines	Primary coolant water	Soil		RAD	117,313
100	UPR-100-N-31 Spill Near 1301-N TBR 4.54	Radioactive water leaked through 1301-N berm penetration; to be addressed with the 1301-N RCRA TSD	Radioactive water	Soil	X		NA
101	UPR-100-N-32 1304-N Bypass Line Leak TBR 4.58	Leaking check valve at the emergency dump tank	Low-level fission products	Soil		RAD	105,092
102	UPR-100-N-33 108-N Acid Transfer Spill WP 3.24	Spill during transfer from rail car outside 108-N	Sulfuric acid	Soil	X		NA

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+
103	UPR-100-N-34 Sulfuric Acid Line Break WP 3.25	Transfer line leak	Sulfuric acid	Soil Concrete	X		NA
104	UPR-100-N-35* Fuel Storage Basin Leak TBR 4.58	Pipe grouted beneath the 105-N Storage Basin	Mn-5, Co-60, Cs-137, Ce-144, I-131	Soil Groundwater		RAD	**
105	UPR-100-N-36 184-N Annex WIDS	Located near the diesel day tank, 184-N Powerhouse	TPH, diesel fuel, and motor oil	Soil		PET	97,408
106	UPR-100-N-37 SWMU 1 HGP Transformer Yard WIDS	Fenced area along northwest wall of the HGP; location of nine large transformers	Potential for asbestos, PCB	Soil Concrete		PET	93,983
107	UPR-100-N-38 116-N-2 Caustic Spill WIDS	Sodium hydroxide spill during off-loading of a truck	Sodium hydroxide	Soil	X		NA
108	UPR-100-N-39* Liquid Unplanned Release TBR 4.62	Scrub water spill outside the corridor 22 doorway	Low-level fission products	Soil		RAD	99,297
109	UPR-100-N-40 Regeneration Waste TBR 4.68	Leak in the transport line	Acid/caustics, heavy metals	Soil		INORG	143,993
110	UPR-100-N-41 Regeneration Waste WIDS	Spill from the 163-N Water Treatment Plant	Acid/caustic	Soil		INORG	94,761
111	UPR-100-N-42 184-N Diesel Oil Spill WIDS	Located near the diesel day tank, 184-N Powerhouse	TPH	Soil		PET	910,025
112	UPR-100-N-43 Pipelines WIDS	Oil supply pipeline from 116-N to 184-N	TPH and diesel oil	Soil Groundwater		PET	116,719
113	UPR-600-17 Patrol Boat Spill WIDS	Gas spilled in a patrol boat was discharged to the river	TPH and gasoline	N/A	X		NA
114	Shoreline Site	Soil contaminated by groundwater flows from 116-N-1 and 116-N-3 cribs and trenches	Radionuclides and possibly inorganics; petroleum	Soil			0 to 15,584,275 depending on the alternative selected
115	Piping	Piping sites will be remediated along with nearby waste sites	Radionuclides, petroleum, and inorganics	Soil Piping		RAD PET INORG	34,440,348
	Total						48,745,386

Summary Information and Estimated Remedial Cost for Source Waste Sites Located Within the 100-NR-1 Operable Unit, Hanford Site.

No.	Site Name Information Source	Site History	Contaminants	Media	Sites Not Addressed in the CMS	Waste Group	Estimated Remedial Cost ($)+

BPA = Bonneville Power Administration
BURN = Burn Pit Waste Group
HGP = Hanford Generating Plant
INORG = Inorganic Waste Group
MISC = Surface Solid Waste and Miscellaneous Waste Group
NA = not applicable
PCB = polychlorinated biphenyls
PET = Petroleum Waste Group
RAD = Radioactive Waste Group
RCRA = *Resource Conservation and Recovery Act of 1976*
RCRA-FA = RCRA Facility Assessment
SWMU = solid waste management unit
TBR = technical baseline report
TPH = total petroleum hydrocarbons
TSD = treatment, storage, and/or disposal
UPR = unplanned release
VOC = volatile organic compounds
WAC = *Washington Administrative Code*
WIDS = Waste Information Database System
WP = Work Plan

Ce-144 = cerium
Co-60 = cobalt
Cs-137 = cesium
Eu-152, Eu-155 = europium
I-131 = iodine
Mn-5 = manganese
Mn-56 = manganese
Mn-154 = manganese
Na-24 = sodium
Pu-239/240 = plutonium
H-3 = tritium
Ru-103 = ruthenium
Sr-90 = strontium

*Buffer zone site.
**Available information indicates that there may be no contaminants within the upper 4.6 m of the soil column. Further information will be acquired during design.
+ Costs do not include a 6 percent design/data collection cost.
++ Costs and/or additional costs for these sites will be established during design.

BREAKDOWN OF SITES BY WASTE GROUP

1. Sites within the 100-NR-1 OU that are **NOT** considered for remediation within this CMS:
   #6, 7, 8, 9, 10, 18, 19, 25, 38, 39, 46, 49, 52, 53, 54, 55, 56, 57, 61, 62, 63, 64, 65, 66, 68, 69, 70, 87, 100, 102, 103, 107, 113.

2. Radioactive Source Waste Sites Located Within the 100-NR-1 OU:
   #1, 12, 13, 20, 23, 24, 26, 27, 28, 29, 30, 36, 48, 50, 59, 60, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86,96, 97, 98, 99, 101, 104, 108.

3. Petroleum Source Waste Sites Located Within the 100-NR-1 OU:
   #2, 11, 33, 34, 41, 43, 44, 45, 47, 58, 88, 89, 90, 91, 92, 93, 94, 95, 105, 106, 111, 112.

4. Inorganic Source Waste Sites Located Within the 100-NR-1 OU:
   #21, 22, 31, 51, 109, 110.

5. Burn Pit
   #5, 14, 15, 16, 32, 67.

6. Surface Solid
   #3, 4, 17, 35, 37, 40, 42, 71, 72.