RECORD OF DECISION
HANFORD 200 AREA
200-ZP-1 SUPERFUND SITE
BENTON COUNTY, WASHINGTON

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RECORD OF DECISION
HANFORD 200 AREA
200-ZP-1 OPERABLE UNIT SUPERFUND SITE
BENTON COUNTY, WASHINGTON

PART I: DECLARATION OF THE RECORD OF DECISION

1.0 SITE NAME AND LOCATION

USDOE Hanford 200 Area

200-ZP-1 Groundwater Operable Unit

Benton County, Washington

CERCLIS ID: #WA 1890090078

2.0 STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedy for the 200-ZP-1 Groundwater Operable Unit (OU), which is part of the Hanford Site, 200 Area, in Benton County, Washington.

The selected remedy was 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* (SARA), the *Hanford Federal Facility Agreement and Consent Order* (also known as the Tri-Party Agreement), and, to the extent practicable, the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* [CFR] 300) (National Contingency Plan [NCP]). This decision is based on the information contained in the Administrative Record file for the 200-ZP-1 OU.

The State of Washington, through the Washington State Department of Ecology (Ecology), concurs with the selected remedy.

3.0 ASSESSMENT OF THE SITE

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare, or the environment, from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment. Such a release, or the threat of release, may present an imminent and substantial endangerment to public health, welfare, or the environment.

4.0 DESCRIPTION OF THE SELECTED REMEDY

4.1 OVERALL SITE CLEANUP STRATEGY

The Central Plateau (200 Area National Priorities List [NPL] site) encompasses approximately 190 km^2 (75 mi^2) near the center of the Hanford Site and contains multiple waste sites, contaminated facilities, and groundwater contamination plumes. To facilitate cleanup, these waste sites, facilities, and groundwater plumes have been grouped by geographic areas, process types, or cleanup components into several OUs.

The 200-ZP-1 OU is one of four groundwater OUs located on the Central Plateau. Each has its own plan of study and enforceable schedule and eventually will have its own ROD and cleanup actions as needed. Collectively, the four OUs and their RODs will define the necessary groundwater cleanup actions across the Central Plateau. The waste sites and soil above the 200-ZP-1 OU are the sources of the contamination in 200-ZP-1 OU groundwater and are, or will be, addressed as part of the cleanup of other OUs through separate CERCLA or RCRA actions.

4.2 PRINCIPAL THREAT WASTES AT THE SITE

The NCP states in 40 CFR 300.430(a)(iii)(A) and (B) that "EPA expects to use treatment to address the principal threats posed by the site…" and "…to use engineering controls, such as containment, for wastes that pose a relatively low long-term threat." There are no known contaminant source materials in the 200-ZP-1 OU groundwater, such as nonaqueous phase liquids (NAPLs) that would serve as a source of principal threat materials. The largest human health risk is exposure to contaminated groundwater containing dissolved contaminants at concentrations above health-based risk levels.

From a sitewide perspective, the wastes (i.e., source materials) present in the RCRA regulated units and the 24 source-control OUs on the Central Plateau overlying the four Central Plateau groundwater OUs represent the principal threat materials for the Hanford 200 Area NPL site. The remedial action decisions for the source-control OUs are being made under the enforcement strategies and schedules contained in the Hanford Tri-Party Agreement and will consider the nature and characteristics of the principal threat materials found in the source-control OUs. The closure and cleanup decisions made for the RCRA regulated units will also consider the nature and characteristics of the principal threat materials found in those units.

4.3 MAJOR COMPONENTS OF THE SELECTED REMEDY

The selected remedy for the 200-ZP-1 OU combines pump-and-treat, monitored natural attenuation (MNA), flow-path control, and institutional controls. A detailed description of each component of the selected remedy is provided below.

4.3.1 Groundwater Extraction and Treatment (Pump-and-Treat) Component

A groundwater pump-and-treat system will be designed, installed and operated in accordance with an approved remedial design/remedial action (RD/RA) work plan. The system will be designed to capture and treat contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium (chromium III and chromium VI), nitrate, trichloroethylene, iodine-129, and technetium-99, throughout the 200-ZP-1 OU by a minimum of 95% in 25 years. The pump-and-treat component will be designed and implemented in combination with

monitored natural attenuation to achieve cleanup levels listed in Table 11 for all COCs in 125 years. Carbon tetrachloride concentrations in the groundwater above 100 µg/L correspond to approximately 95% of the mass of carbon tetrachloride currently residing in the aquifer. The estimated pumping rate required to reduce the mass of COCs by 95% in 25 years is 1,600 gpm for this action. The fate and transport evaluation estimated that a system comprised of 27 extraction and 27 injection wells would be needed to achieve the design requirements.

Following extraction, the COCs in groundwater (except tritium) will be treated to achieve the cleanup levels listed in Table 11. The treated groundwater will then be returned to the aquifer through injection wells.

Specific extraction and injection well locations, treatment equipment design, operational requirements, and other system details will be determined during the remedial design phase and will be documented in the RD/RA work plan and its accompanying remedial design (the "RD/RA documents"). The RD/RA documents will be reviewed and approved by EPA.

The remedial design will also consider as necessary the need for treatment of other constituents (such as uranium) that may be captured by the 200-ZP-1 OU extraction wells. While not COCs for the 200-ZP-1 OU, such constituents may be encountered during restoration from sources related to the other adjacent groundwater OUs. There is no viable treatment technology to remove tritium from the groundwater. However, the half life of tritium is sufficiently short, so the tritium will decay below the cleanup standard before it leaves the industrial land-use zone.

4.3.2 Monitored Natural Attenuation (MNA) Component

In addition to the pump-and-treat system, natural attenuation processes will be used to reduce concentrations to below the cleanup levels.

Natural attenuation processes to be relied on as part of this component include abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring will be employed in accordance with the approved RD/RA documents to evaluate the effectiveness of the pump-and-treat system and natural attenuation processes. Fate and transport analyses conducted as part of the FS (DOE/RL-2007-28) indicate that the timeframe necessary to reduce the remaining COC concentrations to acceptable levels through MNA will be approximately 100 years. Modeling also indicates that this portion of the plume area will remain on the Central Plateau geographic area during this timeframe.

Monitoring is required to be conducted over the life of the action to evaluate its performance and optimize its effectiveness and shall be conducted in accordance with the approved RD/RA documents. For the MNA component, monitoring locations, points of compliance and specifications will be developed as part of the RD/RA documents that will provide data on performance, including data indicating whether the key mechanisms of natural attenuation are performing in a manner to satisfy selected remedy requirements and schedule.

The overarching requirement is to meet the groundwater cleanup levels identified in this ROD within 125 years. Monitoring shall be conducted to evaluate the performance of pump-and-treat system, flow path control and MNA and shall be designed and operated to:

1) Demonstrate whether or not the pump-and-treat system will remove at least 95% of the mass of COCs in 25 years or less and whether the remedial action being taken, including natural attenuation, will achieve cleanup levels for all COCs within 125 years,

2) Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of the pump-and-treat system, natural attenuation processes, and the flow path control actions,

3) Identify any potentially toxic and/or mobile transformation products,

4) Verify that the contamination is not expanding downgradient, laterally or vertically subsequent to the period of time over which the pump-and-treat component has been functional,

5) Detect new releases of contaminants of concern to the environment that could impact the effectiveness of the remedy,

6) Verify attainment of remediation requirements.

4.3.3 Flow-Path Control Component

Flow-path control is also required and shall be achieved by injecting the treated groundwater into the aquifer to the northeast and east of the groundwater contamination such that the treated injected water in these locations will slow the natural eastward flow of most of the groundwater and, as a result, keep COCs within the capture zone, as well as increase the time available for natural attenuation processes to reduce the contaminant concentrations not captured by the extraction wells.

Flow-path control shall also be used to minimize the potential for groundwater in the northern portion of the aquifer to flow northward through Gable Gap and toward the Columbia River. Injection wells will be located to re-direct the groundwater flow to the east, which is the longest groundwater flow path to the river (about 26 km [16 mi]).

Groundwater modeling is required to locate injection and extraction wells, to estimate required injection and extraction rates, and to determine the location of injection wells for flow-path control. This modeling and the design, installation and implementation of the flow path controls shall be conducted in accordance with the approved RD/RA documents.

4.3.4 Institutional Controls Component

200-ZP-1 OU groundwater use will be restricted through institutional and land use controls for the foreseeable future until cleanup levels are achieved.

The DOE is responsible for implementing, maintaining, reporting on, and enforcing the institutional and land use controls required under this ROD. Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, DOE shall retain ultimate responsibility for remedy integrity and institutional controls. The current implementation, maintenance, and periodic inspection requirements for the institutional controls at the Hanford Site are described in approved work plans and in the *Sitewide Institutional Controls Plan* (DOE/RL-2001-41) that was prepared by DOE and approved by EPA and Ecology in 2002. One requirement listed in the *Sitewide Institutional Controls Plan* is the commitment to notify EPA and Ecology immediately upon discovery of any activity that is inconsistent with the land use designation of a site.

No later than 180 days after the ROD is signed, DOE shall update the *Sitewide Institutional Controls Plan* to include the institutional controls required by this ROD and specify the implementation and maintenance actions that will be taken, including periodic inspections. The revised *Sitewide Institutional Controls Plan* shall be submitted to EPA and Ecology for review

and approval as a Tri Party Agreement primary document. The DOE shall comply with the *Sitewide Institutional Controls Plan* as updated and approved by EPA and Ecology.

The following institutional control performance objectives are required to be met as part of this remedial action. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and EPA authorizes the removal of restrictions.

Institutional controls required through the time of completion of the remedy are:

1) The DOE shall control access to prevent unacceptable exposure of humans to contaminants in the 200-ZP-1 OU groundwater addressed in the scope of this ROD until the remedy is complete. Visitors entering any site areas of the 200-ZP-1 OU will be required to be badged and escorted at all times.

2) No intrusive work shall be allowed in the 200-ZP-1 OU unless EPA has approved the plan for such work and that plan is followed.

3) The DOE shall prohibit well drilling in the 200-ZP-1 OU, except for monitoring, characterization or remediation wells authorized in EPA approved documents.

4) Groundwater use in the 200-ZP-1 OU is prohibited, except for limited research purposes, monitoring, and treatment authorized in EPA approved documents. The *Sitewide Institutional Controls Plan* will contain the institutional controls and implementing details prohibiting well drilling and groundwater use in the 200-ZP-1 OU, as defined in the Decision document for the 200-ZP-1 OU.

5) The DOE shall post and maintain warning signs along pipelines conveying untreated groundwater that caution site visitors and workers of potential hazards from the 200-ZP-1 OU groundwater.

6) In the event of any unauthorized access to the site (e.g., trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.

7) Activities that would disrupt or lessen the performance of the pump-and-treat, MNA, and flow-path control components of the remedy are to be prohibited.

8) The DOE shall prohibit activities that would damage the pump-and-treat, MNA, and flow-path control components (e.g., extraction wells, injection wells, piping, treatment plant, or monitoring wells).

9) The DOE shall report on the effectiveness of institutional controls for the 200-ZP-1 OU remedy in an annual report, or on an alternative reporting frequency specified by EPA. Such reporting may be for this OU alone or may be part of a Hanford sitewide report.

10) The DOE will provide notice to EPA at least six months prior to any transfer or sale of the any land above the 200-ZP-1 OU so EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective institutional controls. If it is not possible for DOE to notify EPA at least six months prior to any transfer or sale, then the DOE will notify EPA as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to institutional controls. In addition to the land transfer notice and discussion provisions above, the DOE further

agrees to provide EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. The DOE shall provide a copy of executed deed or transfer assembly to EPA.

11) The DOE will prevent the development and use of property above the 200-ZP-1 groundwater OU for residential housing, elementary and secondary schools, childcare facilities and playgrounds.

12) Land use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and exposure and EPA authorizes the removal of restrictions.

5.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP Section 300.430(f)(5)(ii), the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, or contaminants as a principal element, and a bias against offsite disposal of untreated wastes.

The preamble to the NCP states that when noncontiguous 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 noncontiguous facilities without having to obtain a permit. The 200-ZP-1 OU (addressed by this ROD) and the Environmental Restoration and Disposal Facility (ERDF) are reasonably close to one another, and the wastes are compatible for the selected disposal approach. Therefore, these two sites are considered to be a single site for response purposes.

A review (in accordance with 40 CFR 300.430[f][4][ii]) is required at a minimum every five years if a remedy is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. However, because the selected remedy will not achieve levels that allow for unlimited use and unrestricted exposure within five years, DOE and EPA have agreed to conduct five year reviews in accordance with EPA policy until COCs are reduced below the cleanup levels established in this ROD. Reviews begin five years after initiation of the remedial action to ensure that the selected remedy is protective of human health and the environment.

The selected remedy is protective of human health and the environment, complies with Federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. The selected remedy uses permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

6.0 RECORD OF DECISION DATA CERTIFICATION CHECKLIST

The information provided in Table 1, which consists of key remedy selection data, is derived from the Decision Summary (Part II) of this ROD. Additional information can be found in the Administrative Record file for this OU.

Table 1. 200-ZP-1 Operable Unit Record of Decision Data Certification Checklist.

Information	Location in Record of Decision
COCs and their respective concentrations	Table 3
Baseline risk represented by the COCs	Section 7.0
Cleanup levels established for COCs and the basis for these levels	Table 11
How source materials constituting principal threats are addressed	Section 4.2
Current and reasonably anticipated future land use and current and potential future beneficial uses of groundwater	Section 6.1 and 6.2
Potential land and groundwater use that will be available at the site as a result of the selected remedy	Section 6.4
Estimated capital, annual operations and maintenance, and total present-value costs, discount rate, and the number of years over which the remedy cost estimates are projected	Tables 9 and 10
Key factor(s) that led to selecting the remedy (i.e., describing how the selected remedy provides the best balance of trade-offs with respect to the balancing and modifying criteria, highlighting criteria key to the decision)	Section 13.0

COC = contaminant of concern

7.0 AUTHORIZING SIGNATURES

Signature sheet for the Record of Decision for the 200-ZP-1 Operable Unit at the USDOE Hanford 200 Area Site. The Record of Decision is selected by the U.S. Department of Energy and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

David A. Brockman

9/29/08

David A. Brockman
Manager, Richland Operations Office
U.S. Department of Energy

Date

Signature sheet for the Record of Decision for the USDOE Hanford Site 200-ZP-1 Operable Unit Remedial Action selected by the U.S. Department of Energy and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

9/25/2008

Daniel D. Opalski
Director, Office of Environmental Cleanup, Region 10
U.S. Environmental Protection Agency

Date

Signature sheet for the Record of Decision for the USDOE Hanford Site 200-ZP-1 Operable Unit Remedial Action selected by the U.S. Department of Energy and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Jane A. Hedges

Jane A. Hedges
Program Manager, Nuclear Waste Program
Washington State Department of Ecology

9/30/08
Date

PART II: DECISION SUMMARY

This Decision Summary provides an overview of the site characterization, the alternatives evaluated, and the analysis of those alternatives for the 200-ZP-1 OU at the Hanford Site. It also identifies the selected remedy for the OU and explains how the remedy fulfills statutory and regulatory requirements. Although some of the information in the Decision Summary is similar to that in the Declaration, this section discusses the topics in more detail and provides the rationale for the "summary declarations." This section is based on the information that is available in the Administrative Record for the 200-ZP-1 OU.

1.0 SITE NAME, LOCATION, AND DESCRIPTION

The U.S. Department of Energy's (DOE's) Hanford Site is a 1,517-km^2 (586-mi^2) Federal facility located in southeastern Washington State along the Columbia River (see Figure 1). The Hanford Site is situated north and west of the cities of Richland, Kennewick, and Pasco, an area commonly known as the Tri-Cities. This region includes the incorporated cities of Richland, Pasco, and Kennewick, as well as surrounding communities in Benton, Franklin, and Grant Counties. For administrative purposes, the Hanford Site was divided into four NPL (40 CFR 300, Appendix B) sites under CERCLA, one of which is the 200 Area. The CERCLA site identification number for the 200 Area is WA1890090078.

The 200 Area NPL site contains numerous waste sites, contaminated facilities, and groundwater contamination plumes. To facilitate cleanup, these wastes sites, contaminated facilities, and groundwater plumes were grouped by geographic areas, process types, and/or cleanup components into several OUs. The 200-ZP-1 OU includes several groundwater contamination plumes that cover an area of approximately 10 km^2 (4 mi^2) beneath part of the 200 West Area (Figure 1). The 200 West Area is a DOE-controlled area of approximately 8 km^2 (3 mi^2) near the middle of the Hanford Site (Figure 1); it is about 8 km (5 mi) south of the Columbia River and 11 km (6.8 mi) from the nearest Hanford Site boundary. The 200 West Area contains waste management facilities and former irradiated fuel-reprocessing facilities. The 200 West Area is located on an elevated, flat area, often referred to as the Central Plateau, and there are no wetlands, perennial streams, or floodplains.

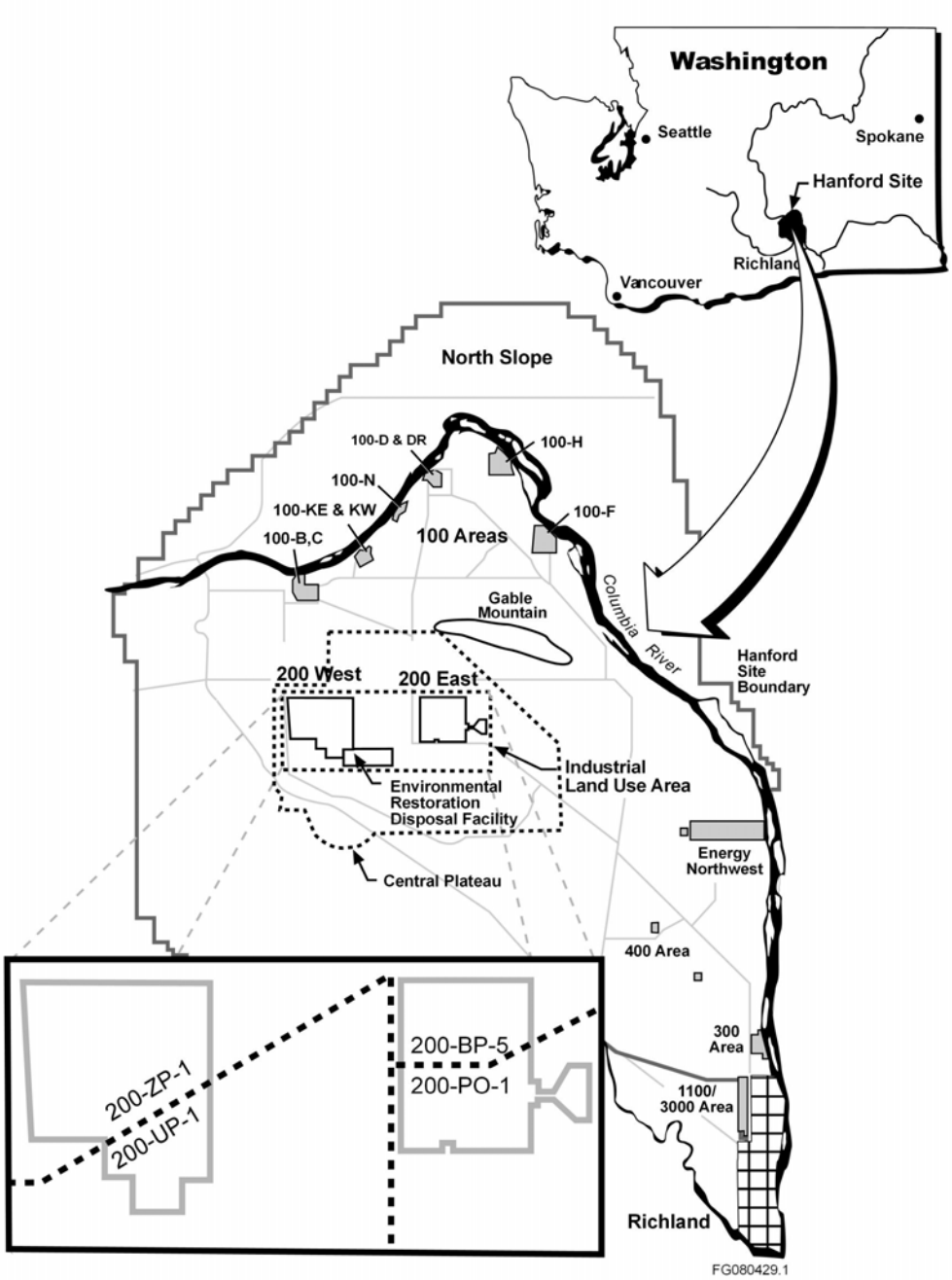
The major waste streams that contributed to groundwater contamination in the 200-ZP-1 OU were associated with plutonium-separation operations at the T Plant facilities and plutonium concentration and recovery operations at the Z Plant facilities in the 200 West Area. The liquid waste disposal in the cribs and trenches near these facilities resulted in several groundwater contamination plumes in the 200-ZP-1 OU. The major COC for the 200-ZP-1 OU is carbon tetrachloride. The other COCs are total chromium (trivalent [III] and hexavalent [VI]), nitrate, TCE, iodine-129, technetium-99, and tritium.

The DOE has operated an interim remedial measure (IRM) pump-and-treat system to prevent carbon tetrachloride from spreading in the 200-ZP-1 OU since 1994. Carbon tetrachloride concentrations have decreased in the original target area. The IRM pump-and-treat system was expanded by adding additional extraction wells between fiscal year 2005 (FY05) and FY08. In FY08, the pump-and-treat system included 16 extraction wells. Since 1994, more than 3.7 billion L (975 million gal) of groundwater have been extracted. More than 10,900 kg

(24,000 lb) of carbon tetrachloride have been removed from groundwater and treated since 1994. Additional information on the IRM is provided in the *Proposed Plan for Remediation of the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2007-33) and the *Feasibility Study Report for the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2007-28).

The DOE is the lead agency for remediation of the 200-ZP-1 OU. The U.S. Environmental Protection Agency (EPA) is the lead regulatory agency for remediation of this OU, as identified in Section 5.6 and Appendix C of the *Hanford Federal Facility Agreement and Consent Order Action Plan*.

Figure 1. Hanford Site.



2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

This section provides background information on past activities at the Hanford Site that have led to the current problems at the 200-ZP-1 OU. In addition, this section contains information on how CERCLA has been applied to the cleanup of this OU.

2.1 SITE OPERATIONAL HISTORY

From 1943 to 1990, the primary mission of the Hanford Site was the production of nuclear materials for national defense. Operations at the Hanford Site included nuclear fuel manufacturing, reactor operations, fuel reprocessing, chemical separation, plutonium and uranium recovery, processing of fission products, and waste partitioning. These processes generated both high- and low-radioactivity waste streams. High-activity waste streams were discharged to large underground tanks. Low-activity liquid wastes were discharged to trenches, cribs, drains, and ponds, most of which were unlined. The soil column discharges, along with solid waste disposal activities, resulted in contamination of the sediments above the water table (vadose zone) and underlying groundwater.

2.2 SITE ENFORCEMENT ACTIVITIES

In July 1989, the EPA placed the 100, 200, 300, and 1100 Areas of the Hanford Site on the NPL pursuant to CERCLA. In anticipation of the NPL listing, DOE, EPA, and Ecology entered into the Tri-Party Agreement in May 1989. This agreement established a procedural framework and schedule for developing, implementing, and monitoring CERCLA response actions on the Hanford Site. The agreement also addresses *Resource Conservation and Recovery Act of 1976* (RCRA) compliance and permitting.

The 200 Areas were divided into both source OUs that have either a geographic or waste process basis and include various types of soil waste sites, structures and pipelines, and groundwater OUs. These OUs are prioritized and scheduled for cleanup in accordance with the Tri-Party Agreement, Part Three, and the *Hanford Federal Facility Agreement and Consent Order Action Plan*.

The DOE has operated the IRM pump-and-treat system since 1994 to prevent carbon tetrachloride from spreading in the 200-ZP-1 OU in accordance with EPA/ROD/R10-95/114 (1995). The response action addressed by this ROD will implement the final components of the remedy for the 200-ZP-1 OU. The IRM will continue to operate until such time that the new system comes on line which is expected to occur by 2011.

A removal action using soil vapor extraction is currently ongoing as part of the 200-PW-1 source OU to remove carbon tetrachloride from the soil above the 200-ZP-1 groundwater OU. This removal action will continue and final actions for the soil will be addressed as part of the 200-PW-1 OU.

In accordance with the Tri-Party Agreement, Article XIV, Paragraph 54, DOE developed and proposed remedial actions for the 200-ZP-1 OU through completion and approval of a remedial investigation (RI) (*Remedial Investigation Report for the 200-ZP-1 Groundwater Operable Unit* [DOE/RL-2006-24]) and FS (*Feasibility Study for the 200-ZP-1 Groundwater Operable Unit* [DOE/RL-2007-28]).

3.0 COMMUNITY PARTICIPATION

This section describes how the public participation requirements of CERCLA and the NCP were met in the remedy selection process. As established in 40 CFR 300.430(f)(3), the lead agency must conduct a number of public participation activities throughout this process.

The Tri-Parties developed the *Hanford Site Tri-Party Agreement Public Involvement Community Relations Plan* (CRP) in April 1990 as part of the overall Hanford Site cleanup process. 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. The CRP was updated in 1993, 1996, and 2002 to enhance public involvement.

In accordance with 40 CFR 300.430(f)(3) and the CRP, there have been several briefings to the Hanford Advisory Board (HAB) and its River and Plateau Committee over the past several years specific to this action. All discussions/meetings were open to the public. The following activities were conducted as part of the formal community participation process under CERCLA:

- A 30-day public comment period for the Proposed Plan (DOE/RL-2007-33) ran from July 21 through August 19, 2008. This comment period was publicized via a newspaper advertisement in the *Tri-City Herald* on July 21, 2008, and a fact sheet was mailed or sent electronically to more than 1,500 individuals on the Tri-Party Agreement mailing list. The public was provided the opportunity for public meeting, but no request for a meeting was received.
- The Tri-Parties' responses to all significant comments received during this period are included in the Responsiveness Summary, which is Part III of this ROD.

The Administrative Record for the 200-ZP-1 OU was made available to the public during the review period. The Proposed Plan (DOE/RL-2007-33), the FS (DOE/RL-2007-28), and other supporting documents (such as the 200-ZP-1 OU RI report [DOE/RL-2006-24]) were part of the information made available to the public in both the Administrative Record and the Information Repositories maintained at the locations listed below:

ADMINISTRATIVE RECORD
(Contains documents that form the basis for selection of the remedial action)

U.S. Department of Energy
Richland Operations Office
Administrative Record Center
2440 Stevens Center
Richland, Washington 99354

INFORMATION REPOSITORIES
(Contains limited documentation)

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

Gonzaga University
Foley Center
E. 502 Boone
Spokane, Washington 99258

Portland State University
Branford Price Millar Library
Science and Engineering Floor
934 SW Harrison
Portland, Oregon 97207

DOE Richland Public Reading Room
Washington State University, Tri-Cities
Consolidated Information Center, Room 101L
2770 University Drive
Richland, WA 99354

Input from the public on the reasonably anticipated future land uses and potential future beneficial uses of groundwater was obtained during public review of the draft *Hanford Comprehensive Land Use Plan – Environmental Impact Statement* (HCP EIS) (DOE/EIS-0222-F) and associated ROD ("Record of Decision: Hanford Comprehensive Land Use Plan Environmental Impact Statement (HCP EIS)" [64 FR 61615]) in 1999, *The Future For Hanford: Uses and Cleanup – The Final Report of the Hanford Future Site Uses Working Group* in 1992, and advice from the HAB, which are included in the Administrative Record.

4.0 SCOPE AND ROLE OF THE RESPONSE ACTION

This section describes the overall site cleanup strategy, including the planned sequence of actions, the scope of the problems that the actions will address, and the authorities under which action will be implemented.

4.1 SCOPE OF THE RESPONSE ACTION

For administrative purposes, the Hanford Site is divided into four NPL sites under CERCLA, one of which is the 200 Area. The 200 Area NPL site contains numerous waste sites, contaminated facilities, and groundwater contamination plumes. To facilitate cleanup, these wastes sites, contaminated facilities, and groundwater plumes were grouped by geographic areas, process types, and/or cleanup components into several OUs. Dangerous waste treatment, storage and disposal units will be regulated and closed in accordance with RCRA and state dangerous waste requirements. Each OU has its own plan of study and enforceable schedule, and eventually will have its own ROD; the OUs have been prioritized for study and scheduled for cleanup in accordance with the Tri-Party Agreement, Part Three, and the *Hanford Federal Facility Agreement and Consent Order Action Plan*.

The 200-ZP-1 OU is one of four groundwater OUs in the 200 Area NPL site (Figure 1) and the first to complete the CERCLA RI/FS process. Collectively, the four OUs and their RODs will define the necessary groundwater cleanup actions across the 200 Area NPL site's Central Plateau. The waste sites and soil above the 200-ZP-1 OU are the sources of the contamination in

the 200-ZP-1 OU groundwater and are being addressed under RCRA or as part of other OUs through separate ongoing CERCLA actions.

The DOE has operated an IRM pump-and-treat system since 1994 to prevent carbon tetrachloride from spreading in the 200-ZP-1 OU, in accordance with the *Record of Decision for the USDOE Hanford 200-ZP-1 Operable Unit, 200 Area NPL Site Interim Remedial Measure* (EPA/ROD/R10-95/114) issued in 1995. The response action addressed by this ROD will implement the final components of the remedy for the 200-ZP-1 OU. The IRM will continue to operate until such time that the new system comes on-line, which is expected to occur by the year 2011.

4.2 INTEGRATION WITH CENTRAL PLATEAU CLEANUP

The Central Plateau (200 Area NPL site), near the center of the Hanford Site, contains numerous waste sites, contaminated facilities, and groundwater contamination plumes. To facilitate cleanup, these waste sites, facilities, and groundwater plumes have been grouped by geographic areas, process types, or cleanup components into 24 source-control OUs and 4 groundwater OUs. These 28 OUs in the 200 Area NPL site are following the CERCLA or RCRA past-practice process to identify and select remedies that address COCs in their OUs. The sequence and timing of remedy development for these OUs are listed in the Tri-Party Agreement, Part Three.

There are also a number of former operating plants located above the 200-ZP-1 Groundwater OU that are currently undergoing cleanup under CERCLA. In addition, there are treatment, storage, and disposal (TSD) units located above the 200-ZP-1 Groundwater OU. These units are within Low-Level Management Area 3, Low-Level Management Area 4, and the T, and TX-TY Tank Farms. Requirements applicable to these units under the Dangerous Waste Program will be established in the Hanford Dangerous Waste Permit.

Nitrate is widespread at Hanford and is present in groundwater across major portions of the Central Plateau, extending beyond the 200-ZP-1 OU boundaries into those of the other three Central Plateau CERCLA groundwater OUs. Because the four OUs on the Central Plateau are all adjacent to each another (see Figure 1), nitrate will be managed comprehensively and will be addressed in each of the four OUs. The 200-ZP-1 OU groundwater extraction and treatment component will treat the nitrate encountered in extracted groundwater to achieve the cleanup level before returning the treated water to the aquifer through the injection wells.

5.0 SITE CHARACTERISTICS

The following sections provide information on the Hanford Site characteristics, and specifically on the 200-ZP-1 OU. Background information in this section on the Hanford Site, the 200 West Area, and the 200-ZP-1 OU is provided for the following:

- Site overview
  - Local geology
  - Local hydrogeology
  - Groundwater
  - Surface water
  - Meteorology

  - Ecology
  - Cultural resources
- Conceptual site model (CSM)
- Nature and extent of contamination.

5.1 SITE OVERVIEW

The following subsections contain information on the local geology, hydrogeology, groundwater, surface water, meteorology, ecology, and cultural resources.

5.1.1 Local Geology

The Hanford Site lies in a sediment-filled basin on the Columbia Plateau in southeastern Washington. The Central Plateau is a relatively flat, prominent terrace near the center of the Hanford Site. The 200-ZP-1 OU underlies the northern portion of the 200 West Area, which is on the western end of the Central Plateau.

Basalt of the Columbia River Basalt Group and a sequence of overlying sediments comprise the local geology. The overlying sediments are approximately 169 m (555 ft) thick and primarily consist of the Ringold Formation and Hanford formation, which are composed of sand and gravel with some silt layers. Surface elevations range from approximately 200 to 217 m (660 to 712 ft).

5.1.2 Local Hydrogeology

The sediment thickness in the 200 West Area above the water table (the vadose zone) ranges from 40 to 75 m (132 to 246 ft). Sediments in the vadose zone are the Ringold Formation (the uppermost Ringold Unit E and the Upper Ringold unit), the Cold Creek unit, and the Hanford formation. Erosion during cataclysmic flooding removed some of the Ringold Formation and Cold Creek unit. Perched water (water above the water table) has historically been documented above the Cold Creek unit at locations in the 200 West Area. However, since most liquid waste discharges to the area were stopped in 1995, perched water is infrequently encountered in the vadose zone.

Recharge to the unconfined aquifer in the 200 West Area is from artificial and natural sources. Any natural recharge originates from precipitation. Estimates of recharge from precipitation at the Hanford Site range from 0 to 10 cm/year (0 to 4 in./year) and are largely dependent on soil texture and the type and density of vegetation. Artificial recharge historically occurred when effluents such as cooling water and process wastewater were disposed to the ground. The largest sources of artificial recharge were stopped in 1995. The artificial recharge in the Central Plateau that does continue is largely limited to onsite sanitary sewage treatment and disposal systems; leaks from potable and raw water lines; two state-approved land disposal structures; and small-volume, uncontaminated, miscellaneous waste streams. A small volume of uncontaminated water may be used for dust and contamination control during construction phases. Refurbishing of Central Plateau water lines to minimize the potential for water leaks that could contribute to artificial recharge is an ongoing activity.

5.1.3 Groundwater

Groundwater beneath the Hanford Site is found in an upper primarily unconfined aquifer system and in deeper confined aquifers within the basalt. The Columbia River is the primary discharge area for both the unconfined and confined aquifers.

The unconfined aquifer in the 200-ZP-1 OU area of the Central Plateau occurs in the Ringold Formation. Groundwater in the unconfined aquifer flows from areas where the water table is higher (west of the Hanford Site) to areas where it is lower (the Columbia River). In general, groundwater flow through the Central Plateau occurs in a predominantly easterly direction from the 200 West Area to the 200 East Area. Historical discharges to the ground greatly altered the groundwater flow regime, especially around the 216-U-10 Pond in the 200 West Area and the 216-B-3 Pond in the 200 East Area. Discharges to the 216-U-10 Pond resulted in a groundwater mound developing in excess of 26 m (85 ft). Discharges to the 216-B-3 Pond created a hydraulic barrier to groundwater flow coming from the 200 West Area, deflecting it to the north through Gable Gap, between Gable Mountain and Gable Butte, or to the south of the 216-B-3 Pond. As the hydraulic effects of these two discharge sites diminish, groundwater is expected to flow on a more easterly course through the Central Plateau, with some flow possibly continuing through Gable Gap.

The depth to the water table in the 200 West Area varies from about 50 m (164 ft) in the southwest corner near the former 216-U-10 Pond to greater than 100 m (328 ft) in the north. The groundwater flow is primarily to the east, except in the northern portion of the 200 West Area where the flow is to the east-northeast. Groundwater flow is locally influenced by the 200-ZP-1 OU IRM pump-and-treat system and permitted effluent discharges at the State Approved Land Disposal Site. The groundwater flow rates typically range from 0.0001 to 0.5 m/day (0.00033 to 1.64 ft/day) across the 200-ZP-1 OU. However, the water table continues to decline at a rate of approximately 0.21 m/year (0.69 ft/year) because the large influx of artificial recharge that created the elevated water table was eliminated when production ceased at Hanford. Additional information is contained in the 200-ZP-1 OU RI report (DOE/RL-2006-24) and in annual Hanford Site groundwater monitoring reports.

The natural groundwater quality at Hanford is generally very good; however, the unconfined groundwater aquifer throughout the Central Plateau was contaminated from past activities. In the 200-ZP-1 Groundwater OU, the major COC is carbon tetrachloride. The other COCs are total chromium (trivalent [III] and hexavalent [VI]), nitrate, TCE, iodine-129, technetium-99, and tritium. The range of concentrations of these COCs based on samples collected between 2001 and 2005 from 107 wells within the 200-ZP-1 OU is summarized in Table 2.

The IRM pump-and-treat system for the 200-UP-1 Groundwater OU previously operated to remediate the uranium and technetium-99 plumes. The IRM pump-and-treat system for the 200-ZP-1 Groundwater OU is currently operating to remediate the carbon tetrachloride plume.

5.1.4 Surface Water

Hanford Site surface water includes the Columbia River (northern and eastern sections), Columbia Riverbank springs, springs on Rattlesnake Mountain, an intermittent pond named West Lake, and water systems directly east and across the Columbia River from the Hanford Site. In addition, the Yakima River flows along a short section of the southern boundary of the Hanford Site. The 200 West Area is located approximately 8 km (5 mi) south of the Columbia River. There is no surface water (wetlands, perennial streams, or floodplains) in the

200 West Area. Under natural conditions the 200-ZP-1 groundwater will eventually discharge to the Columbia River.

Table 2. Comparison of 200-ZP-1 Operable Unit Groundwater Contaminant Concentrations to Federal Drinking Water Standards.

Contaminant	Federal Standard (MCL)	Percentile[a] Value in 200-ZP-1 Operable Unit Groundwater Wells		
		90th Percentile	50th Percentile	25th Percentile
Carbon tetrachloride (ppb or µg/L)	5	2,900	505	6.5
Trichloroethylene (TCE) (ppb or µg/L)	5	10.9	1.7	0.15
Total chromium (ppb or µg/L)	100	130	10.3	3.6
Hexavalent chromium (ppb or µg/L)	N/A[b]	203	10.9	7.0
Nitrate (ppb or µg/L) (expressed as total nitrogen)[c]	10,000[c]	81,050	21,900	14,000
Technetium-99 (pCi/L)	900	1,442	180	59
Iodine-129 (pCi/L)	1	1.2	0.03	ND
Tritium (pCi/L)	20,000	36,200	3,605	514

[a] Percentiles describe the distribution of data. For instance, the 90th percentile is the concentration value at which 90% of the sample concentrations lie below that value. As recommended by EPA, one-half of the method reporting limit was used as a surrogate concentration for nondetect results in the percentile calculations (*Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* [EPA 540/1-89/002]). This results in some values being less than the method reporting limit.

[b] There is no MCL specific to hexavalent chromium.

[c] Nitrate may be expressed as total nitrate (NO_3) or as total nitrogen (N). The MCL for nitrate as NO_3 is 45,000 µg/L, and the same concentration expressed as N is 10,000 µg/L. Note that the EPA's drinking water regulations are published as 10,000 µg/L.

EPA = U.S. Environmental Protection Agency
MCL = maximum contaminant level
N/A = not applicable
ND = not detected
ppb = parts per billion
pCi/L = picocuries per liter (a measure of radioactivity)
µg/L = micrograms per liter

5.1.5 Meteorology

The Hanford Site is located in a semi-arid region characterized by low annual rainfall of approximately 16 cm/year (6.3 in./year). The summer months are typically hot and dry, and winters are moderately cold. Prevailing wind directions near the surface on Hanford's Central Plateau are from the northwest in all months of the year. Winds from the southwest also have a high frequency of occurrence on the Central Plateau. Windblown dust accompanies strong winds on the Hanford Site.

5.1.6 Ecology

Public access to the Hanford Site has been restricted for more than 50 years. The portion of the Site occupied by DOE's nuclear activities is only a small fraction of the total land area. As a result, much of Hanford is relatively undisturbed and the ecological resources are abundant. However, much of the 200 West Area was disturbed by industrial activities and has little vegetative cover.

5.1.6.1 Vegetation. The Hanford Site was classified primarily as a shrub-steppe grassland. Washington State considers the pristine shrub-steppe habitat a priority habitat because of its relative scarcity in the state and its requirement as a nesting/breeding habitat by several state and Federal species of concern.

Sagebrush/cheatgrass and/or Sandberg's bluegrass characterize the ecology of the 200 Areas. Dominant plants in the 200 Areas are big sagebrush, rabbitbrush, cheatgrass, and Sandberg's bluegrass. Although no Hanford Site plant species are identified from the Federal list of threatened and endangered species, eight species of Hanford Site plants are included in the Washington State listing as threatened or endangered. Several sensitive species are on or near the Central Plateau:

- Few flowered collinsia
- Gray cryptantha
- Piper's daisy
- Palouse milkvetch
- Coyote tobacco.

5.1.6.2 Animals. Approximately 17 species of amphibians and reptiles, 246 species of birds, and 42 species of mammals were found at the Hanford Site. No mammals on the Federal list of threatened and endangered species were found. The bald eagle and two species of fish (steelhead and spring run Chinook salmon) are on the list and are found regularly on the Hanford Site, although not on the 200 Area Central Plateau.

The Hanford Site is the permanent home for a number of avian species. It is located on the Pacific Flyway and serves as a resting place for many migratory birds. Hanford's shrub and grassland habitat provides nesting and foraging for many passerine bird species, including horned larks, western meadowlarks, long billed curlews, and vesper sparrows. Species dependent on undisturbed shrub habitat include the sage sparrow, sage thrasher, sage grouse, and loggerhead shrike. The burrowing owl also nests in the grass covered uplands. Game birds (hunted off the Hanford Site) include chukar, partridge, California quail, and Chinese ring necked pheasant. Common raptor species (e.g., ferruginous, Swainson's and red-tailed hawks) also use Hanford's shrub and grassland habitat.

Rocky Mountain elk and mule deer are the largest mammals at the Hanford Site. The elk are found predominantly on the Fitzner-Eberhardt Arid Lands Ecology Reserve (ALE) but are occasionally observed on the 200 Area Central Plateau. Mule deer are found throughout the Hanford Site but are most often found along the Columbia River and on the ALE. Other mammal species include coyotes, badgers, blacktail jackrabbits, ground squirrels, and several species of mice. The Great Basin pocket mouse is the most abundant small mammal. Mammals

that are present and associated with buildings and facilities include cottontails, house mice, Norway rats, and some bat species.

There are no wildlife species of concern found on the land overlying the 200-ZP-1 OU.

5.1.7 Cultural Resources

In 1987 and 1988, a comprehensive archaeological resources review of the Central Plateau was conducted, including an examination of a stratified random sample of the undisturbed portions of the 200 West Area. That inventory reported no significant surface archaeological sites. The only evaluated pre-Hanford historic site is the old White Bluffs freight road that crosses diagonally through the 200 West Area. The road, which originated as an Indian trail, played a role in Native American migration, Euro-American immigration, development, agriculture, and Hanford Site operations. This road is eligible for placement on the National Register of Historic Places, although segments that pass through the 200 West Area are not eligible because they no longer exist due to previous construction activities.

5.2 CONCEPTUAL SITE MODEL

Information generated during the RI/FS process was incorporated into the CSM for the 200-ZP-1 OU. The CSM identifies current and potential future site conditions and illustrates contaminant sources, release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors that could be exposed to contaminants in the groundwater of the 200-ZP-1 OU. Two CSMs were evaluated in the baseline risk assessment. Figure 2 shows the CSM under the current industrial land-use scenario, and Figure 3 shows the CSM under a future unrestricted land-use scenario. Only the complete groundwater pathways are within the scope of this ROD as it only addresses groundwater; separate RODs for the source OUs will address the soil pathways shown on the CSM figures. The summary of site risks, based on these CSMs, is provided in Section 7.0.

In addition, future Native American use CSMs were developed and evaluated. The details of those CSMs are contained in Appendix J of the FS (DOE/RL-2007-28).

5.2.1 Human Conceptual Model

The human CSM for the 200-ZP-1 OU consists of two exposure scenarios: the industrial land-use exposure scenario and the future unrestricted land-use scenario. Current and reasonably anticipated future land uses are the basis for these exposure scenarios.

5.2.2 Ecological Conceptual Model

Ecological risk from 200-ZP-1 OU contaminants is not expected because of lack of direct or indirect exposure by ecological receptors to groundwater now or in the future. The 200-ZP-1 OU is located about 8 km (5 mi) south of the Columbia River (Figure 1). This is the shortest path for groundwater to flow toward the river. Most of the 200-ZP-1 OU groundwater flows to the east-southeast for approximately 26 km (16 mi) before reaching the Columbia River.

Figure 2. Present Human Health Conceptual Site Model Depicting the Populations and Exposure Pathways Evaluated in the Risk Assessment Under a Current Industrial Land-Use Scenario.

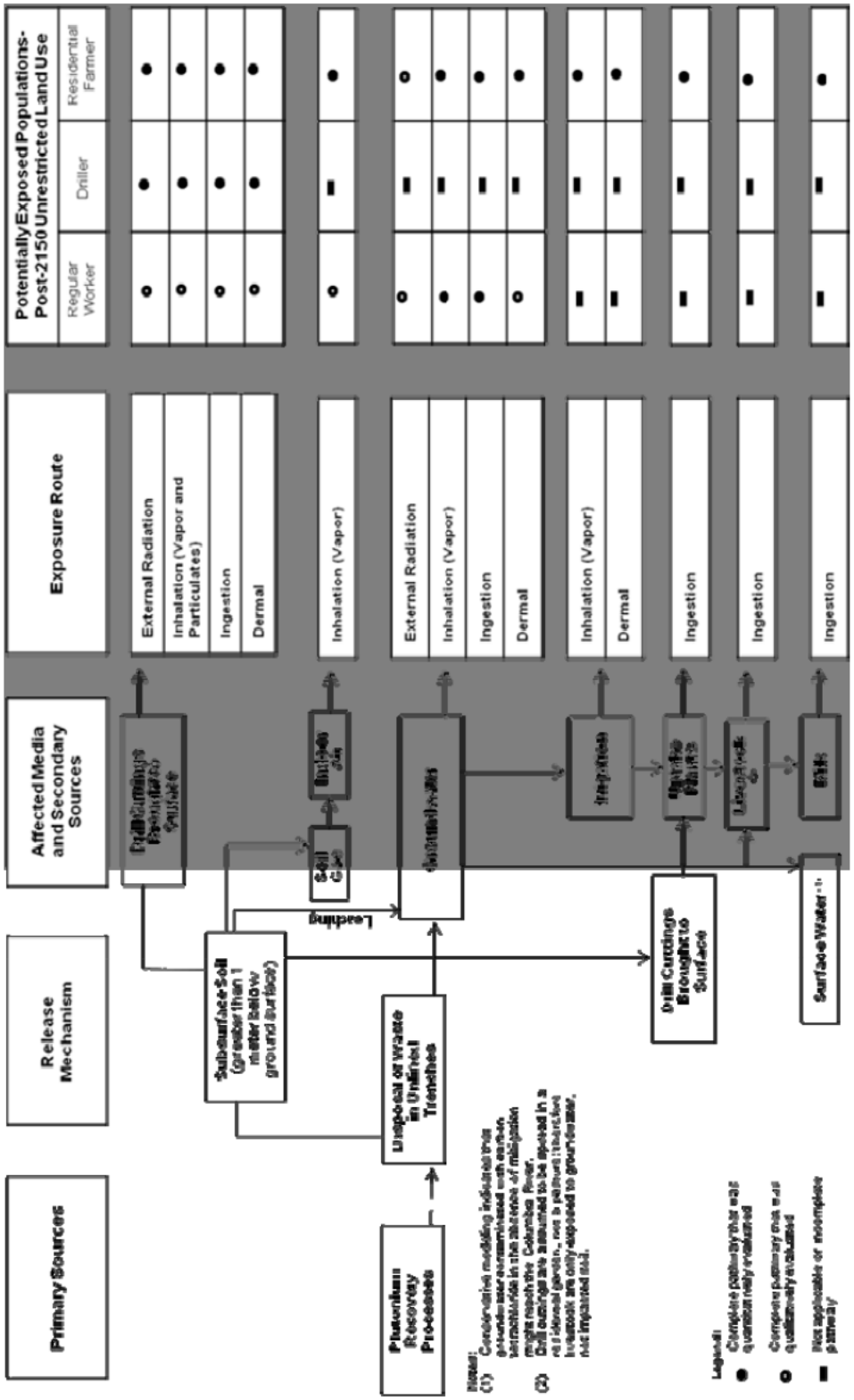
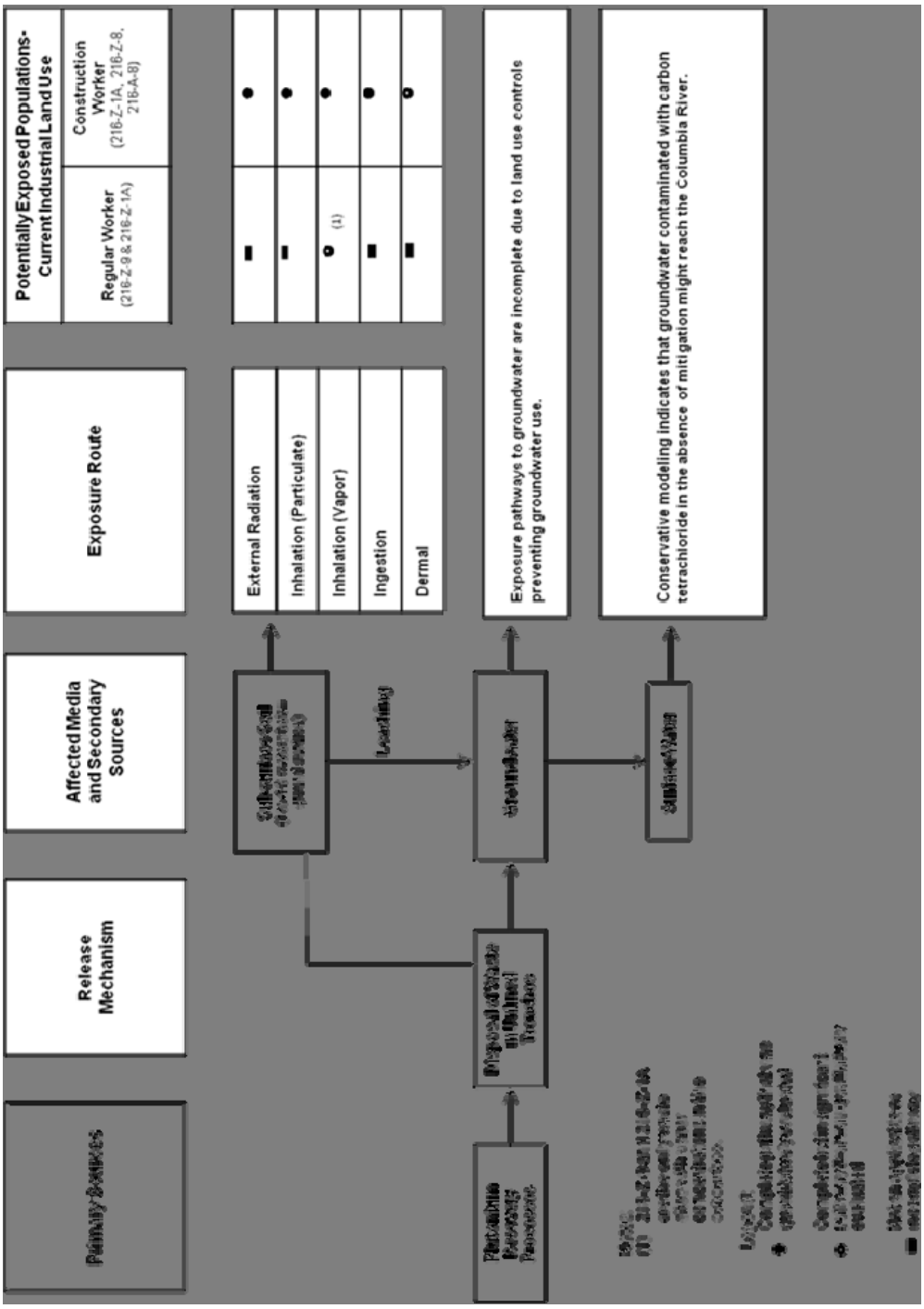


Figure 3. Human Health Conceptual Site Model Depicting the Populations and Exposure Pathways Evaluated in the Baseline Risk Assessment Under a Future Unrestricted Land-Use Scenario.



The 200-ZP-1 OU RI report (DOE/RL-2006-24) evaluated baseline ecological risks to the Columbia River from 200-ZP-1 OU contaminated groundwater using a bounding analysis with three exposure scenarios: no dilution, 50% dilution (to represent the hyporheic mixing zone), and 100-fold dilution (to represent groundwater mixed with Columbia River water). Using current average groundwater concentrations to represent 200-ZP-1 OU contaminated groundwater that could reach the Columbia River in the absence of any remedial action, the analysis found no evidence for potential ecological risk in the river, but it did identify a potential for adverse ecological effects in the hyporheic zone. Using the current 50th percentile groundwater concentrations to represent 200-ZP-1 OU contaminated groundwater that could reach the Columbia River in the absence of any remedial action and the same exposure scenarios, carbon tetrachloride is the only 200-ZP-1 OU COC that could have potential ecological risk in the hyporheic zone but not in the river.

Evaluation of the human health risks (as discussed below in Section 7.0) established the need for action. The actions that are necessary for human health risk mitigation and to restore the aquifer for beneficial use will also prevent contaminants from reaching the Columbia River. The actions will therefore address potential future ecological risks associated with the groundwater pathway and its connection to the river. Therefore, no further baseline quantitative ecological risk evaluation was performed in support of the need to take action.

5.3 NATURE AND EXTENT OF CONTAMINATION

The following subsections discuss the nature and extent of contamination in the 200-ZP-1 OU.

5.3.1 Characterization Strategy

The 200-ZP-1 OU was characterized by well drilling and groundwater sampling that began in the 1940s and continues to the present. Monitoring wells drilled since the mid-1990s generally also have depth-discrete groundwater samples collected as the well was drilled. The depth-discrete sample results were used to place the well screen at the depth where the maximum concentration of contaminants was found. Currently, there are over 100 monitoring wells in the 200-ZP-1 OU.

The sampling frequency for wells in the 200-ZP-1 OU monitoring well network ranges from quarterly to biennially (i.e., every 2 years), depending on how recently the well was installed and the results of past sampling events. Wells drilled during FY03 and later years have been sampled quarterly during the year following installation, semi-annually during the second year after installation, and annually thereafter. Wells located near a contaminant plume perimeter have been sampled biennially, if the contaminant concentrations are stable for several years. The sampling frequency has been more frequent in wells where contaminant concentrations have been irregular or increasing.

5.3.2 Characterization Activities and Results

In addition to the monitoring well drilling and sampling (described above, from 2004 to 2006) the DOE conducted a major characterization effort of the vadose zone above and the groundwater in the 200-ZP-1 OU to identify and locate carbon tetrachloride dense nonaqueous phase liquid (DNAPL) source term(s). The results of this characterization are documented in *Carbon Tetrachloride Dense Non-Aqueous Phase Liquid (DNAPL) Source Term Interim Characterization Report* (DOE/RL-2006-58) and its addendum (DOE/RL-2007-22). The conceptual site model developed in those reports supports a DNAPL source term in the vadose zone at the 216-Z-9 Trench at a depth of 19.8 m (65 ft). This source term will be addressed by

the 200-PW-1 OU interim and final remedies. The data obtained do not indicate a DNAPL source in the 200-ZP-1 OU groundwater.

The primary cribs and trenches that contributed contaminants to the 200-ZP-1 OU groundwater included 216-Z-1A Trench, 216-Z-9 Crib, 216-Z-18 Trench, 216-Z-19 Ditch, 216-Z-20 Crib, and 216-U-10 Crib. Bulk liquid waste discharges that contributed the majority of contamination to the subsurface occurred from 1945 to the early 1970s.

After effluents were discharged to these vadose zone disposal sites, more mobile contaminants migrated to the groundwater. Less mobile contaminants (as well as residual contamination of higher mobility contaminants) remain in the vadose zone and will be addressed in the vadose zone OU remedies (e.g., 200-PW-1 OU).

Contaminant distributions in 200-ZP-1 OU groundwater are changing in response to multiple influences, including (1) general downgradient transport of contaminants in the direction of groundwater flow; (2) pump-and-treat operations from the 200-ZP-1 OU IRM, which is containing much of the high-concentration portion of the carbon tetrachloride plume in the upper portion of the aquifer; (3) decreasing groundwater elevations from the termination of effluent releases to surrounding cribs, ponds (primarily T and U Ponds), and trenches; and (4) continued operation of the soil vapor extraction (SVE) IRM in the 200-PW-1 OU.

Contaminant distributions within the 200-ZP-1 OU can be represented by three categories:

- A high-concentration zone close to the ponds, cribs, and trenches that were used to dispose the liquid wastes. Data do not indicate the presence of significant DNAPL in groundwater acting as a continuing source.
- A larger, dispersed or low-concentration zone that has migrated from the discharge locations or overlies the high-concentration zone. This less contaminated groundwater can occur above the high-concentration zone where large quantities of lower concentration effluent were discharged during or after the high-concentration waste discharges.
- An area of technetium-99 contamination near WMA T and WMA TX/TY. The results from depth-discrete groundwater sampling in the newly installed wells in these areas show that the peak concentration of technetium-99 is typically found within the upper 15 m (50 ft) of the aquifer. These results will be considered in the final design and implementation of the remedy for the 200-ZP-1 OU groundwater.

Groundwater contamination is present from the top to the base of the unconfined aquifer, which is approximately 61 m (200 ft) thick. Distribution maps for the contaminants that exceed the maximum contaminant levels (MCLs) in the 200-ZP-1 OU groundwater are shown in Figure 4 through Figure 10. For scaling purposes, the extent of carbon tetrachloride contamination shown by the heavy line in each figure encompasses an area of approximately 10 km^2 (4 mi^2). The FS (DOE/RL-2007-28) includes additional maps that divide the aquifer into specific depth intervals for further presentation of the existing contamination conditions.

Figure 4. Estimated Lateral Extent of Carbon Tetrachloride at a Depth of 20 to 30 m (66 to 98 ft) Below the Water Table.

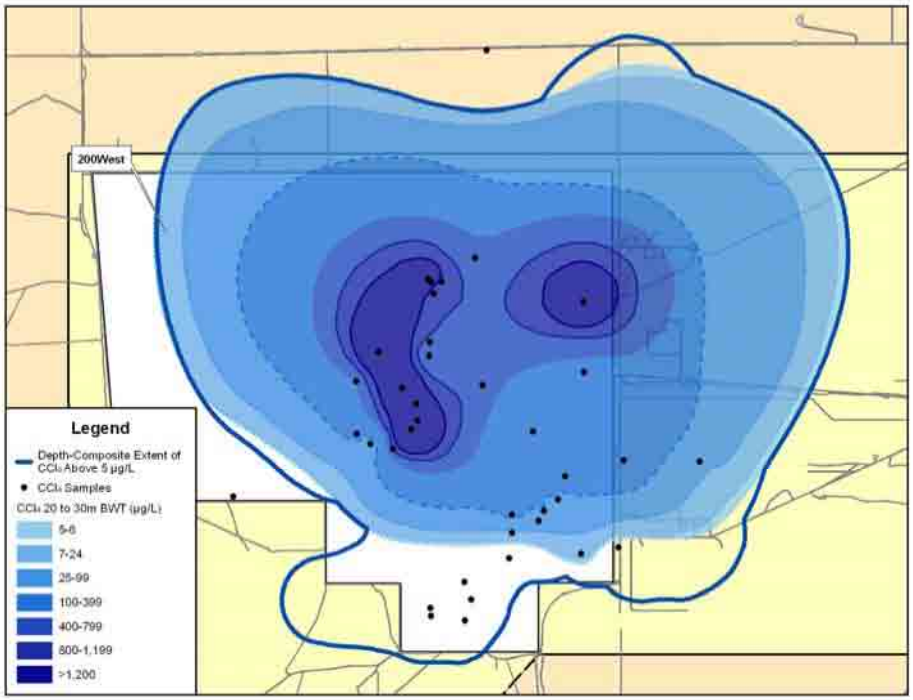


Figure 5. Estimated Lateral Extent of Trichloroethylene 10 to 20 m (33 to 66 ft) Below the Water Table.

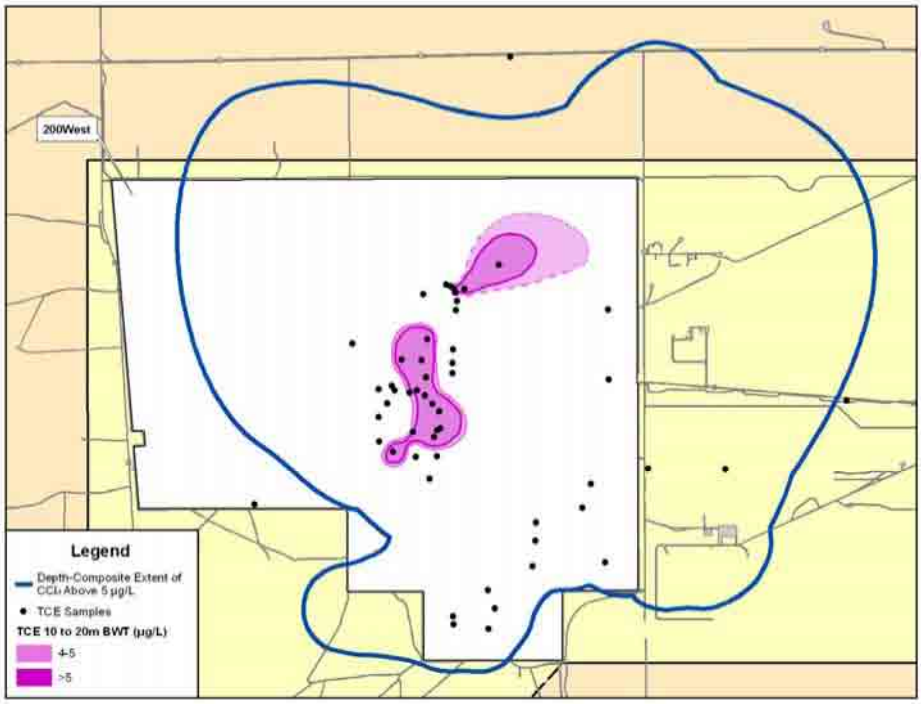


Figure 6. Estimated Lateral Extent of Chromium (Total) in Groundwater.

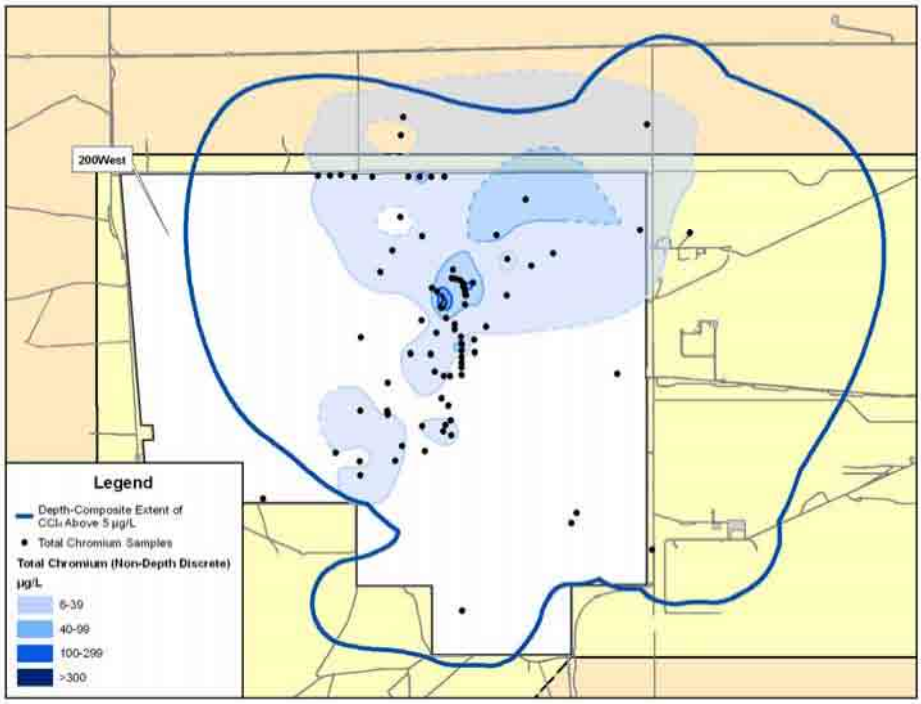


Figure 7. Estimated Lateral Extent of Nitrate in Groundwater.

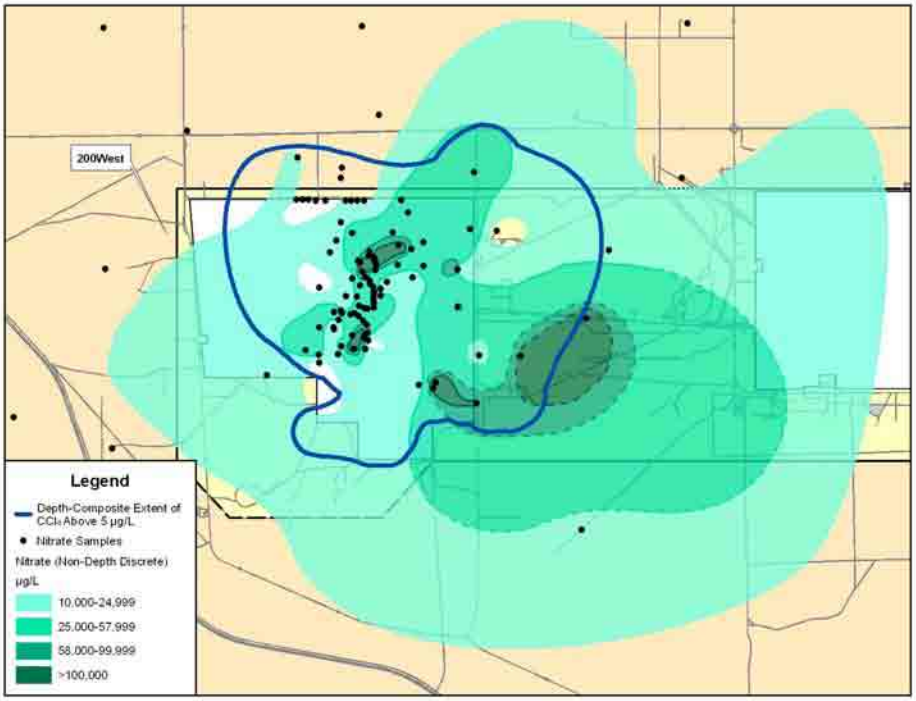


Figure 8. Estimated Lateral Extent of Technetium-99 0 to 10 m (0 to 33 ft) Below the Water Table.

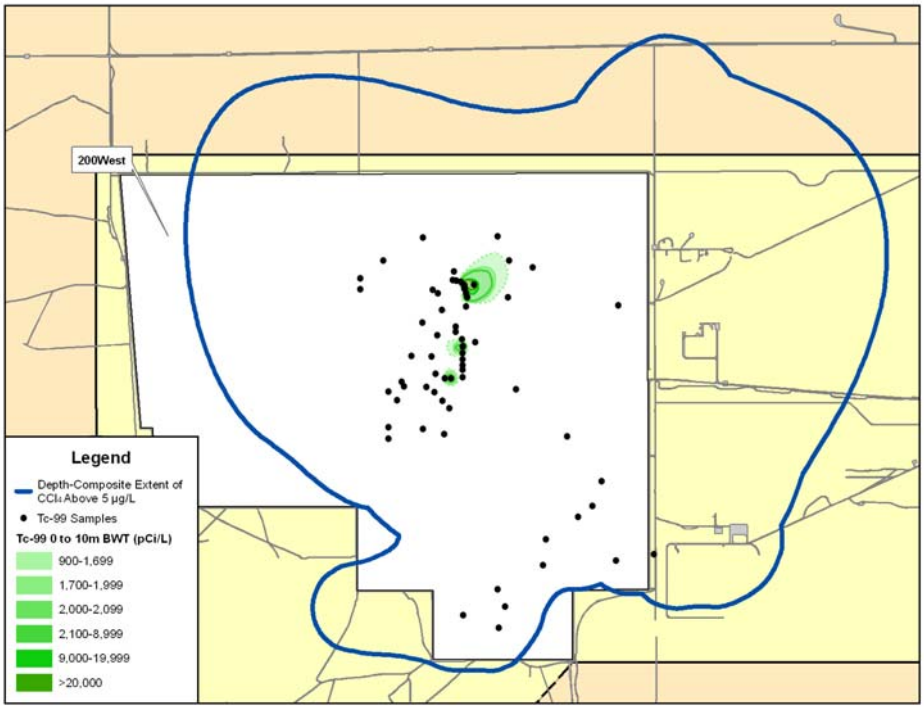


Figure 9. Estimated Lateral Extent of Iodine-129 in Groundwater.

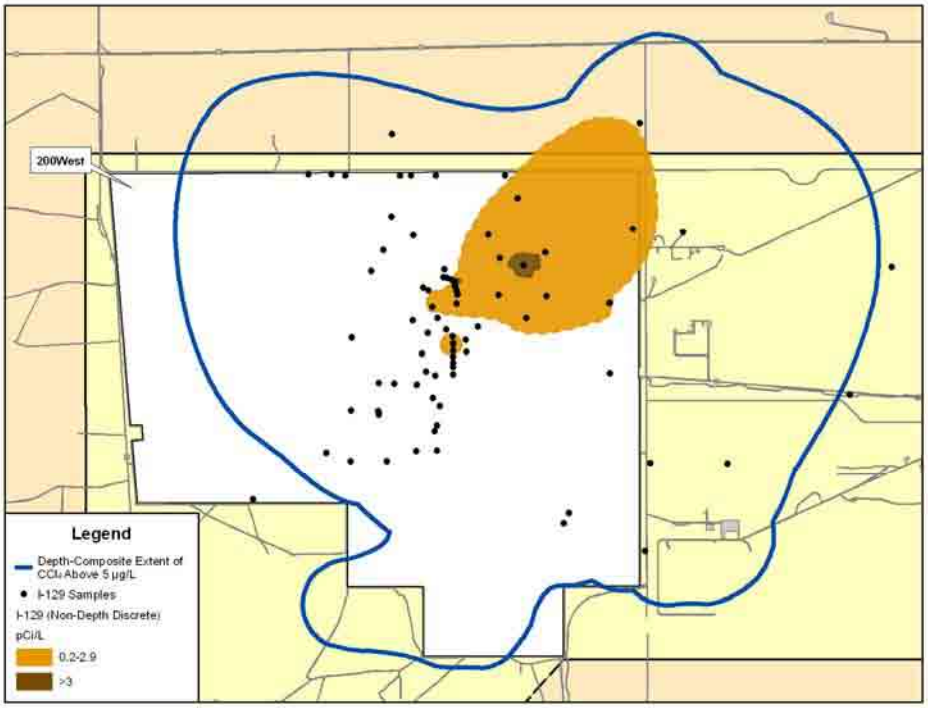
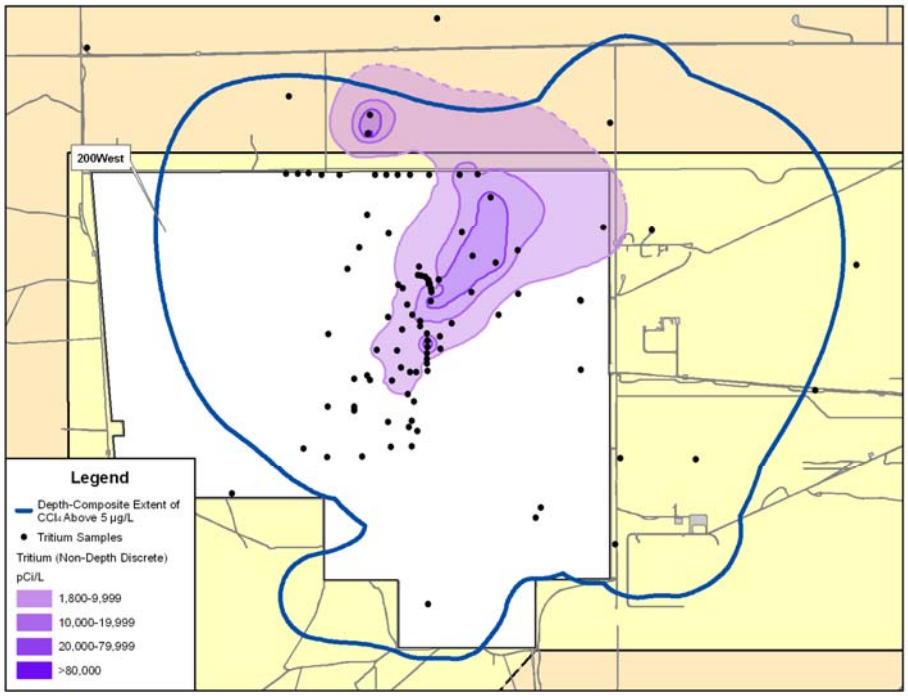


Figure 10. Estimated Lateral Extent of Tritium in Groundwater.



Mixtures of carbon tetrachloride and other organics were used at the Plutonium Finishing Plant to recover plutonium from the processing waste streams. TCE is not known to have been used in plutonium recovery processing. Chloroform may be a degradation product of carbon tetrachloride, while TCE may have been used as a maintenance chemical and as a solvent. A number of spent solvents, including carbon tetrachloride and TCE are listed wastes under RCRA.

5.3.3 Fate and Transport Modeling

To aid in evaluating potential risks, fate and transport modeling was used to predict the migration of site contaminants through the environment, assuming no additional cleanup actions are taken. The models were also used to conceptually design, evaluate, and compare the performance of remedial actions, including the selected remedial action for achieving cleanup standards.

The models used data obtained during the RI, such as contaminant concentrations, the physical characteristics of the local geology, surface water hydrology, and groundwater hydrology to predict the movement of the contaminants through the environment.

The following fate and transport models were used to support the evaluations:

- THEIS-GRID
- GRID-TRACK
- ATRANS.

During the modeling, simplifying assumptions were made to support the analysis:

- The aquifer is homogeneous and isotropic.
- The groundwater flow is uniform and three-dimensional flow is negligible.

- The contaminant concentrations are represented by the 2000 to 2005 data set.

The modeling results were used to support the selection of the final remedy from among the alternatives considered, and to predict performance of the final remedy over its full lifecycle.

6.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

The current and reasonably anticipated future land use above the 200-ZP-1 OU groundwater, as well as the current use and future beneficial groundwater use, are discussed in the following subsections. Land use forms part of the basis for exposure assessment assumptions and risk characterization conclusions.

6.1 CURRENT LAND USE

All current land-use activities associated with the Central Plateau are industrial in nature. The facilities located in the Central Plateau processed irradiated fuel from the plutonium-production reactors in the 100 Area. Most of the facilities directly associated with fuel reprocessing are now inactive and awaiting final disposition. The Plutonium Finishing Plant is currently storing plutonium that was encapsulated in cans. Several waste management facilities operate in the Central Plateau, including permanent waste disposal facilities such as the ERDF, low-level radioactive waste burial grounds, and RCRA-permitted mixed-waste trenches. Construction of high-level waste treatment facilities in the Central Plateau began in 2002. The 200 East Area is the planned disposal location for the vitrified low-activity tank wastes. Non-Hanford Site DOE organizations and the U.S. Department of the Navy use the 200 East Area TSD units. In addition, US Ecology, Inc. operates a commercial low-level radioactive waste disposal facility on a 40-ha (100-ac) tract of land at the southwest corner of the 200 East Area that is leased to Washington State.

6.2 ANTICIPATED FUTURE LAND USE

The reasonably anticipated future land use for the core zone of the Central Plateau is industrial (DOE worker) for at least 50 years and then industrial (DOE or non-DOE worker) thereafter.

The DOE worked for several years with cooperating agencies to define land-use goals for the Hanford Site. The cooperating agencies and stakeholders included the National Park Service, Tribal Nations, the states of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests. A 1992 report, *The Future for Hanford: Uses and Cleanup – The Final Report of the Hanford Future Site Uses Working Group*, was an early product of the efforts to develop land-use assumptions. The report recognized that the Central Plateau would be used to some degree for waste management activities for the foreseeable future. Following the report, DOE issued the HCP EIS (DOE/EIS-0222-F) and associated HCP EIS ROD (64 FR 61615) in 1999. The HCP EIS analyzes the potential environmental impacts of alternative land-use plans for Hanford and considers the land-use implication of ongoing and proposed activities. Under the preferred land-use alternative selected in the HCP EIS ROD, the Central Plateau was designated for industrial exclusive use, defined as areas suitable and desirable for TSD of hazardous, dangerous, radioactive, and nonradioactive wastes, as well as related activities.

Subsequent to the HCP EIS, the HAB issued HAB Advice #132 ("Exposure Scenarios Task Force on the 200 Area" [HAB 132 2002.T]). The HAB acknowledged that some waste would remain in the core zone of the Central Plateau when cleanup is complete. The goal identified within HAB Advice #132 is that the core zone be as small as possible and not include contaminated areas outside the Central Plateau's fenced areas. HAB Advice #132 further stated that waste within the core zone should be stored and managed to make it inaccessible to inadvertent intruding humans and biota, and that the DOE should maximize the potential for any beneficial use of the accessible areas of the core zone. The HAB advised that risk scenarios for the waste management areas of the core zone should include a reasonable maximum exposure to a worker/day user and to an intruder.

In response to HAB Advice #132 ("Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area" [Klein et al. 2002]), and for the purposes of the 200-ZP-1 OU remedial action, the Tri-Parties have agreed to assume the following reasonably anticipated future land use: industrial for at least 50 years, which may include TSD of hazardous, dangerous, radioactive, and nonradioactive wastes. Following that period, the area above the 200-ZP-1 OU area is anticipated to be industrial. Starting at least 100 years after active waste management (roughly 150 years from present), the potential for inadvertent intrusion into subsurface waste may increase because knowledge of hazards may not be widely held. As long as residual contamination remains above levels that allow for unrestricted use, institutional controls will be required.

6.3 CURRENT GROUND AND SURFACE WATER USES

Groundwater in the Central Plateau is currently contaminated and not withdrawn from the aquifer for beneficial use (drinking water or industrial use). An alternate source of water derived from the Columbia River is provided to current industrial workers conducting activities on the Central Plateau.

The Columbia River is the second largest river in the contiguous United States in terms of total flow and is the dominant surface-water body on the Hanford Site. The Columbia River is the principal source of drinking water for the Tri-Cities and the Hanford Site. In addition, the river is used regionally for irrigation and recreation, which includes fishing, hunting, boating, water skiing, diving, and swimming.

6.4 POTENTIAL FUTURE GROUND AND SURFACE WATER USES

The NCP establishes the following national expectation for cleanup of groundwater at CERCLA sites: "EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" (cited in the NCP, 40 CFR 300.430). The EPA generally defers to state agency definitions of useable groundwater provided under the various comprehensive state groundwater protection programs (CSGWPPs) administered by the states across the country.

Based on physical yield and natural water quality, the State of Washington, through its groundwater protection program, has determined that the aquifer setting for the 200-ZP-1 OU meets the Washington Administrative Code (WAC) definition for potable groundwater, and for beneficial use, and has been recognized by the state as a potential source of domestic drinking water. For the next 150 years, as long as the anticipated land use remains industrial, it is unlikely

that the 200-ZP-1 OU groundwater will be used as a drinking water source because drinking water is provided from a central water treatment facility.

Current uses of the Columbia River are anticipated to continue in the future. Given the local hydrogeology at the 200-ZP-1 OU (discussed in Section 5.1), the remedial action for the 200-ZP-1 OU groundwater will also protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU.

7.0 SUMMARY OF SITE RISKS

This section of the ROD summarizes the site risks associated with the 200-ZP-1 OU groundwater, as identified in the baseline risk assessment. This section of the ROD includes information on the human health risk assessment (HHRA) and ecological risk assessment and states the basis for taking action at the site.

Site risks were evaluated to determine if remedial actions are necessary for the groundwater in the 200-ZP-1 OU. The COCs for 200-ZP-1 OU include both hazardous chemicals (i.e., carbon tetrachloride, TCE, total chromium [both chromium (III) and chromium (VI)], and nitrate) and radionuclides (i.e., technetium-99, iodine-129, and tritium). The results of the HHRA determined that there was a basis for taking action at the 200-ZP-1 OU. The remedial actions selected in this ROD are necessary to protect human health and the environment from actual or threatened releases of hazardous substances into the environment.

7.1 SUMMARY OF THE HUMAN HEALTH RISK ASSESSMENT

The HHRA was part of the baseline risk assessment conducted to estimate risk for complete exposure pathways to both nonradiological and radiological contaminants in the 200-ZP-1 OU groundwater assuming that no remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the HHRA.

7.1.1 Identification of Human Health Chemicals of Concern

The HHRA used a subset of the data set evaluated in the 200-ZP-1 RI report (DOE/RL-2006-24). Specifically, the last 5 years of data were selected as representative of current conditions (samples collected between the years 2001 through 2005). In addition, of the 116 wells evaluated in the 200-ZP-1 RI report, 107 wells were selected for the HHRA because their screen intervals were the most applicable for the depth that a groundwater-supply well might be screened. These 107 wells include the wells with the highest contaminant concentrations found in groundwater between 2001 and 2005. All data have been collected following DOE and EPA requirements, and the data are of sufficient quality for use in risk assessment.

The RI initially screened the 200-ZP-1 OU groundwater data set against target action levels (TALs) that were either risk-based cleanup levels from Ecology's *Model Toxics Control Act* (MTCA) Method B for groundwater, or were MCLs from state and Federal drinking water regulations. In the FS, only the last 5 years of groundwater monitoring data were compared to the RI TALs. This process identified 12 contaminants of potential concern (COPCs) in groundwater for quantitative evaluation in the HHRA.

The nature and extent of contamination are discussed in Section 5.3 and are summarized in Figure 4 through Figure 10 of this ROD. Impacted groundwater in the 200-ZP-1 OU is widely dispersed and consists of overlapping groundwater plumes (i.e., all the highest concentrations or the lowest concentrations do not occur at the same location). Because the purpose of the HHRA is to determine if remedial action is needed and to provide the information necessary to make remedial decisions, a range of concentrations for each COPC were evaluated, with the high-end of the range sufficient to cover the reasonable maximum exposure (RME) to groundwater, rather than on a well-by-well basis. The range of concentrations selected for exposure point concentrations (EPCs) are the 25th, 50th, and 90th percentile values for each COPC from the current groundwater data set (i.e., from 2001 to 2005).

These EPCs were used to evaluate "low," "medium," and "high" groundwater concentrations for the groundwater exposure routes. This methodology does not provide risks at a specific location but instead results in information on the range of possible risks for each COPC at the current concentrations.

Eight of the COPCs exceeded the Federal MCL at the 90th percentile concentration (Table 2), and these were identified as COCs in the risk assessment. Table 3 provides information on the range of detected or estimated concentrations and the frequency of detection (i.e., the number of times the contaminant was detected in the samples collected at the site) of each COC.

Table 3. Summary of Contaminants of Concern for Groundwater Exposure Pathways.

Scenario Timeframe: Current
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	COC	Concentration Detected		Units	Frequency of Detection	EPC Percentiles			EPC Units
		Min	Max			25th	50th	90th	
Ground-water inhalation, ingestion and direct contact	Carbon tetrachloride	0.15	5,200	ppb	468/574	6.5	505	2,900	ppb
	Chromium (total)	0.406	769	ppb	688/835	3.6	10.3	130	ppb
	Chromium (VI)	3	730	ppb	27/29	7.0	10.9	203.4	ppb
	Nitrate (as nitrogen)	38	1,720,000	ppb	1013/1015	14,000	21,900	81,050	ppb
	TCE	0.17	36	ppb	353/581	0.15	1.7	10.9	ppb
	Iodine-129	0.765	36.7	pCi/L	29/386	ND	0.03	1.17	pCi/L
	Technetium-99	3.4	27,400	pCi/L	747/799	59	180	1,442	pCi/L
	Tritium	3.59	2,170,000	pCi/L	722/903	513.75	3,605	36,200	pCi/L

COC = contaminant of concern
EPC = exposure-point concentration
ND = not detected
TCE = trichloroethylene

7.1.2 Exposure Assessment

The exposure assessment component of the HHRA identified the populations that could be exposed; the routes by which these individuals could become exposed; and the magnitude, frequency, and duration of potential exposures. The potential pathways for exposure are depicted on the CSMs in Figures 2 and 3 of this ROD and described in Appendix A of the FS. Because the HHRA was integrated with the risk assessment for 200-PW-1, 200-PW-3, and 200-PW-6 Vadose Zone OUs and the 200-ZP-1 Groundwater OU, the CSMs show both soil and groundwater exposure pathways. However, only the groundwater exposure pathways are addressed in this ROD. In addition, future Native American use CSMs were developed and evaluated. The details of those CSMs are contained in Appendix J of the FS (DOE/RL-2007-28).

7.1.3 Potentially Complete Human Exposure Pathways and Receptors

Five exposure scenarios were developed in the HHRA. Two scenarios, the current and future industrial worker (Scenarios 1 and 2 below), were established to represent the populations most likely to be exposed to site contaminants based on expectations that the land above the 200-ZP-1 OU will be used for industrial purposes until at least the year 2150 (response to HAB Advice #132).

A domestic groundwater-use scenario (Scenario 3 below) was evaluated in addition to the two industrial worker exposure scenarios to support the NCP expectation to return useable groundwater to beneficial use wherever practicable, and in this case, to the state's recognized beneficial use as a domestic drinking water supply.

At the request of the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), two risk exposure scenarios provided by the Tribal Nations (Scenarios 4 and 5 below) were also evaluated and presented in the FS to assist interested parties in providing input on the alternatives presented in the Proposed Plan.

The five baseline risk exposure scenarios are summarized below.

7.1.3.1 Scenario 1, "Current (Industrial) Land Use with Existing Controls." For this scenario, the Hanford 200 Area, inclusive of the 200-ZP-1 OU groundwater area, are assumed to remain under Federal ownership with current access restrictions and industrial land uses maintained. Under this scenario, there are no uses of the contaminated groundwater for either industrial or drinking water purposes, and the scenario assumes that all existing access controls are adhered to by hypothetical industrial users. As a result, there are no exposure pathways and, therefore, no risks to the hypothetical receptors associated with this first current condition scenario.

7.1.3.2 Scenario 2, "Industrial Land Use Without Controls on the Use of Groundwater." For this scenario, the current industrial land use is assumed to be maintained, but it is then assumed, for risk calculation purposes, that access controls are not in place to prevent exposure to contaminated groundwater. Exposure pathways therefore include direct ingestion of contaminated groundwater during industrial land-use activity at the existing 200-ZP-1 OU contamination levels, along with the potential to inhale volatile contaminants that may be present in the groundwater. Receptors assumed to be hypothetically exposed under Scenario 2 include future industrial site workers who are assumed to have access to the contaminated groundwater during the workday.

7.1.3.3 Scenario 3, "Future Residential Land Use Without Controls on the Use of Groundwater." For this scenario, a hypothetical future beneficial groundwater-use scenario was evaluated, which assumes that Federal ownership of the land area above the 200-ZP-1 OU is discontinued, land-use-based institutional controls are not maintained, and the land area above the aquifer has returned to unrestricted use as a hypothetical family farm with associated domestic groundwater use. Under this scenario, the receptors assumed to be exposed to the contaminated groundwater include adults and children occupying the hypothetical family farm. It is assumed that a domestic water supply well has been installed using 200-ZP-1 OU groundwater for beneficial-use (domestic drinking water) purposes and that water is withdrawn for use by the residents at current contaminant concentration levels.

7.1.3.4 Scenarios 4 and 5, "Yakama Nation and Confederated Tribes of the Umatilla Indian Reservation Scenarios." For these scenarios, groundwater was assumed to be consumed by Tribal members as drinking water, used to irrigate the home garden and water domestic livestock, and used as the water source in a sweatlodge at current contaminant concentration levels.

7.1.4 Human Exposure Assumptions

The exposure estimation requires numerous assumptions to describe potential exposure scenarios. Upper bound exposure assumptions were used to estimate RME conditions to provide a bounding exposure estimate.

The current groundwater concentration EPCs used in the risk assessment equations for each of the COCs at the 25th, 50th, and 90th percentiles are summarized in Table 3. In addition to using the groundwater data directly to estimate health risks from drinking the water, modeling equations were used to estimate the amount of contaminants in plants, beef, and milk transferred to these media from water used for irrigation and stock watering, respectively. The modeling methodology and selected transfer factors are described in detail in Appendix A, Section A3.2.3 of the FS (DOE/RL-2007-28). Tissue concentrations (i.e., concentrations in plants and animals) used in the risk calculations, modeling equations, and contaminant-specific transfer factors are presented in Appendix A, Tables A3-5 through A3-9 of the FS (DOE/RL-2007-28).

The formulas and exposure factors that were used together with the EPCs to quantify doses for the complete and significant pathways shown in Figure 3 are presented in Appendix A, Tables A3-10 through A3-18 of the FS (DOE/RL-2007-28). The tables also indicate the sources of the factors. In general, *EPA's Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (OSWER Directive 9285.6-03) and *Exposure Factors Handbook* (EPA/600/P-95-002Fa) default exposure factors were used for residential and industrial exposures. Default exposure factors are discussed in Appendix A, Attachment A-4 of the FS (DOE/RL-2007-28). Where site-specific factors rather than accepted defaults were used, the rationale for their selection is provided in Appendix A, Section A3.3 of the FS (DOE/RL-2007-28).

The groundwater EPCs shown in Table 3 were also used to assess Native American exposures. The formulas and exposure factors that were used together with the EPCs to quantify doses for the complete and significant pathways are presented in Appendix J, Tables J3-9 through J3-14 of the FS (DOE/RL-2007-28). The tables also indicate the sources of the factors. In general, Harper and Harris (2004) was used as the source for CTUIR exposure factors, and Ridolfi (2007) was used as the source for Yakama Nation exposure factors. Both the CTUIR and Yakama

Nation assume subsistence exposures occur 365 days per year, for a 70-year lifetime (apportioned out as 64 years adult and 6 years child). Where parameters were not provided by these sources, EPA's default exposure factors were used (EPA/600/P-95-002Fa; OSWER Directive 9285.6-03). Default exposure factors are discussed in Appendix J, Attachment J-4 of the FS (DOE/RL-2007-28).

7.1.5 Toxicity Assessment

Toxicity assessment is the process of characterizing the relationship between the intake of a substance and the incidence of an adverse health effect in the exposed populations. Toxicity assessments consider the results from laboratory animal studies or human epidemiological studies. These evaluations are used to extrapolate from high levels of exposure for which adverse effects are known to occur to low levels of environmental exposures for which effects can be postulated. The EPA uses the results of these extrapolations to establish quantitative indicators of toxicity (or toxicity values).

Tables 4 and 5 present the carcinogenic toxicity criteria for the nonradionuclides and the radionuclides, respectively, for the COCs in this assessment. Table 6 lists the noncarcinogenic toxicity criteria used for the COCs in this assessment. Additional toxicological information for the COCs is discussed in Appendix A, Attachment A-5 of the FS (DOE/RL-2007-28). The same toxicity criteria summarized in Tables 4 through 6 were used in the Native American assessment.

Table 4. Carcinogenic Toxicity Criteria for Nonradionuclide Contaminants of Concern.

Contaminant	Oral Cancer: Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Cancer: Slope Factor $(mg/kg\text{-}day)^{-1}$	Tumor Type	EPA Cancer Classification[a]	Reference
Carbon tetrachloride	0.13	0.053	Liver (mice)	B2	IRIS
Chromium (total)	—	—	—	D	IRIS
Chromium (VI) (hexavalent)	—	290[b]	Lung (human)	A	IRIS
Nitrate	—	—	—	D	IRIS
TCE	0.013	0.0007	Liver, kidney, lymph, cervical, prostate	B1	CalEPA

[a] EPA's weight-of-evidence classification system:
Group A = human carcinogen (sufficient evidence in humans)
Group B1= probable human carcinogen (limited human data available)
Group B2= probable human carcinogen (sufficient evidence in animals, inadequate or no evidence in humans)
Group C = possible human carcinogen (limited evidence in animals)
Group D = not classifiable as to human carcinogenicity

[b] The inhalation pathway for hexavalent chromium is considered incomplete/insignificant in groundwater (see Appendix A, Attachment 5 of the FS for toxicity profile information of hexavalent chromium).

CalEPA = California Environmental Protection Agency
EPA = U.S. Environmental Protection Agency
IRIS = Integrated Risk Information System - Online Database (EPA 2007)
TCE = trichloroethylene

Table 5. Radionuclide Toxicity Criteria for Contaminants of Concern.[a]

Radionuclide	Ingestion (Risk/pCi)		Inhalation (Risk/pCi)	External (Risk/Year per pCi/g)
	Food	Water		
I-129	3.2E-10[c]	1.50E-10	6.10E-11	6.10E-09
Tc-99	4.00E-12	2.80E-12	1.41E-11	8.14E-11
Tritium	1.40E-13	5.10E-14	5.6E-14[d]	[b]

[a] EPA classifies all radionuclides as Group A, known human carcinogens. Values are from EPA's *Health Effects Assessment Summary Tables* (EPA 540/R-97-036), update April 16, 2001, which is based on Federal Guidance Report No. 13 (EPA 402-R-99-001).
[b] Radionuclide not evaluated by this pathway.
[c] This value is protective of ingestion of iodine-129 in dairy products. For non-dairy products, the criterion is one-half this value, or 1.6E-10.
[d] This value is protective of inhalation exposures of tritium vapors.
EPA = U.S. Environmental Protection Agency

Exposure to contaminants can result in cancer or non-cancer effects, which are characterized separately. Essential dose-response criteria are the EPA slope factor (SF) values for assessing cancer risks and the EPA-verified reference dose (RfD) values for evaluating non-cancer effects. The following hierarchy was used to select toxicity criteria for nonradionuclides:

1. EPA's Integrated Risk Information System (IRIS) database
2. EPA Interim Toxicity Criteria published by the National Center for Environmental Assistance (NCEA)
3. *Health Effects Assessment Summary Tables* (HEAST) (EPA 540/R-97-036)
4. Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profiles.

7.1.6 Risk Characterization

Two types of potential human health effects due to contact with groundwater contaminants were evaluated for the 200-ZP-1 OU: an increase in cancer risk, and noncarcinogenic health risks. For carcinogens, risks generally are expressed as an individual's incremental probability of developing cancer over a lifetime as a result of exposure to the carcinogen. The following equation is used to calculate excess lifetime cancer risk (ELCR):

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where:

risk = a unit-less probability (e.g. 2×10^{-5}) of an individual's developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

SF = slope factor, expressed as $(\text{mg/kg-day})^{-1}$.

Table 6. Noncarcinogenic Chronic and Subchronic Toxicity Criteria for Contaminants of Concern. (2 sheets)

Contaminant	Chronic RfD (mg/kg-day)	Toxic Endpoint	Critical Study	Chronic RfD UF[a]	RfD Source	Adjustment from Chronic to Subchronic	Subchronic RfD (mg/kg-day)
Inhalation Exposures							
Carbon tetrachloride	None[b]	--	--	--	--	--	--
Chromium (total)	None[b]	--	--	--	--	--	--
Chromium (VI) (hexavalent)-inhaled and particulate dust	2.90E-05[c]	Respiratory toxicity	Subchronic rat	300	IRIS	NC	NC
Chromium (VI) (hexavalent)-mists and aerosols	2.3E-06[c]	Nasal septum atrophy	Subchronic human occupational	90	IRIS	NC	NC
Nitrate	None[b]	--	--	--	--	--	--
TCE	1.10E-02	Central nervous system, liver, and endocrine toxicity	Subchronic human occupational	1,000	EPA 2001	NC	NC
Oral Exposures							
Carbon tetrachloride	7.0E-04	Liver lesions	Subchronic rat	1,000	IRIS	Used unadjusted NOAEL; removed UF of 10 for subchronic to chronic.[d]	1.0E-02
Chromium (total) (trivalent toxicity criteria used)	1.5E+00	None observed	Chronic oral rat study	1,000	IRIS	NC	NC
Chromium (VI) (hexavalent)	3.0E-03	None reported	One-year rat drinking water study	1,000	IRIS	NC	NC
Nitrate	1.6E+00	Methemoglobinemia in infants	Human epidemiological studies	1	IRIS	NC	NC

Table 6. Noncarcinogenic Chronic and Subchronic Toxicity Criteria for Contaminants of Concern. (2 sheets)

Contaminant	Chronic RfD (mg/kg-day)	Toxic Endpoint	Critical Study	Chronic RfD UF[a]	RfD Source	Adjustment from Chronic to Subchronic	Subchronic RfD (mg/kg-day)
TCE	3.0E-04	Central nervous system, liver, and endocrine toxicity	Subchronic mouse	3,000	EPA 2001	NC	NC

[a] EPA indicates that there are generally five areas of uncertainty where an application of a UF may be warranted:

1. Variation between species (applied when extrapolating from animal to human).
2. Variation within species (applied to account for differences in human response and sensitive subpopulations).
3. Use of a subchronic study to evaluate chronic exposure.
4. Use of a LOAEL, rather than a NOAEL.
5. Deficiencies in the database.

[b] There is no non-cancer toxicity criteria for this contaminant for this pathway.

[c] The inhalation pathways for CrVI are incomplete; therefore these toxicity criteria were not used in this assessment.

[d] EPA adjusted the 5-day/week exposure of the NOAEL to a 7-day NOAEL to account for continuous exposure (chronic), rather than subchronic, exposures.

COC = contaminant of concern
COPC = contaminant of potential concern
EPA = U.S. Environmental Protection Agency
IRIS = EPA Integrated Risk Information System (on-line database) (EPA 2007)
LOAEL = lowest-observed-adverse-effect level
NC = not calculated (subchronic criteria were not derived for these contaminants because these contaminants were not selected as COPCs for the subchronic pathways)
NCEA = EPA's National Center for Environmental Assessment
NOAEL = no-observed-adverse-effect level
RfD = reference dose
TCE = trichloroethylene
UF = uncertainty factor

These risks are probabilities that are usually expressed in scientific notation (e.g., 1×10^{-6}). An ELCR of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an ELCR because this probability is in addition to the cancer risks that individuals face from other causes (e.g., smoking or exposure to too much sun). The chance of an individual's developing cancer from all other causes is estimated to be as high as one in three. EPA's generally acceptable ELCR risk range for site-related exposures is 10^{-6} to 10^{-4}. Cancer risks were estimated separately for nonradiological constituents and radionuclides.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to have any harmful effect. The ratio of toxicity exposure is called a hazard quotient (HQ). An HQ < 1 indicates that a receptor's dose of a single contaminant is less than the RfD and toxic noncarcinogenic effects from that chemical are unlikely. The hazard index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver or kidney) or act through the same action mechanism within a medium or across all media to which a given individual may reasonably be exposed. An HI < 1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health. The HQ is calculated as follows:

$$\text{Non-cancer HQ} = \text{CDI}/\text{RfD}$$

where:

CDI = chronic daily intake (mg/kg-day)

RfD = reference dose (mg/kg-day).

The CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short term).

7.1.6.1 Calculated Cancer Risks. Under Scenario 1, it is assumed that the groundwater access controls in place for the current industrial-use setting are functioning as intended and will continue to do so. As a result, there are no exposure pathways and, therefore, no risks to the current industrial land-use receptor associated with Scenario 1.

Under Scenarios 2, 3, 4, and 5, access controls are assumed to not be present or are rendered ineffective in preventing contact with the contaminated groundwater under the future industrial land use (Scenario 2) or for future hypothetical non-industrial land uses (Scenarios 3, 4, and 5). Exposure pathways assumed in the four scenarios, therefore, result in the ELCRs summarized in Table 7.

The risk assessment indicated that carbon tetrachloride is the largest contributor to ELCR for all scenarios. The other four COCs shown in Table 7 are those constituents with concentrations that exceeded Federal or State of Washington drinking water MCLs at their 90th percentile concentrations (shown earlier in Table 3). Note that the COCs that were found to exceed their respective MCLs in 200-ZP-1 OU groundwater were all included in the risk assessment consistent with EPA guidance (EPA OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*). These constituents contribute to the ELCR for each scenario at the levels shown in Table 7.

Table 7. Excess Lifetime Cancer Risks from Consumption of Drinking Water Extracted from the 200-ZP-1 Operable Unit Groundwater Under Current Contamination Conditions.

Contaminant	Excess Lifetime Cancer Risks[a]		
	Industrial Scenario (Scenario 2)	Residential Scenario (Scenario 3)	Yakama Nation and CTUIR Scenarios[b] (Scenarios 4 and 5)
Carbon tetrachloride	30 in 10,000	200 in 10,000	600 in 10,000
Trichloroethylene (TCE)	0.01 in 10,000	0.08 in 10,000	0.3 in 10,000
Technetium-99	0.2 in 10,000	0.8 in 10,000	4 in 10,000
Iodine-129	0.01 in 10,000	0.04 in 10,000	0.2 in 10,000
Tritium	0.1 in 10,000	0.4 in 10,000	2 in 10,000

NOTE: This table summarizes the pre-cleanup excess lifetime cancer risks under current contamination conditions.

[a] Risks calculated using existing contaminant concentrations at the 90th percentile as shown in Table 3. During the baseline risk assessment, the calculated excess lifetime cancer risks are compared to EPA's acceptable National Contingency Plan risk range of 0.01 in 10,000 to several in 10,000 to determine whether risk-based remedial actions may be necessary.

[b] Exposure assumptions were provided by the Yakama Nation and the CTUIR. They are included at the request of the Tribal Nations.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation
EPA = U.S. Environmental Protection Agency

7.1.6.2 Calculated Non-Cancer Risks. Under Scenario 1, it is assumed that the groundwater access controls in place for the current industrial-use setting are functioning as intended and will continue to do so. As a result, there are no exposure pathways and, therefore, no non-cancer health risks to the current industrial land-use receptor associated with Scenario 1.

Under Scenarios 2, 3, 4, and 5, access controls are assumed to not be present or are rendered ineffective in preventing contact with the contaminated groundwater under the future industrial land use (Scenario 2) or for future hypothetical non-industrial land uses (Scenarios 3, 4, and 5). Exposure pathways assumed in these four scenarios result in the HQ values summarized in Table 8.

The risk assessment indicated that carbon tetrachloride is the largest contributor to non-cancer health risk for all scenarios. The other four COCs shown in Table 8 are those constituents with concentrations that exceeded Federal or State of Washington drinking water MCLs at their 90th percentile concentrations (shown earlier in Table 3). These constituents contribute to the non-cancer health risks at the levels shown, and were included in the risk assessment consistent with the EPA baseline risk assessment guidance (EPA OSWER Directive 9355.0-30).

7.1.6.3 Uncertainty Evaluation. Estimating and evaluating health risk from exposure to environmental contaminants is a complex process with inherent uncertainties. Uncertainty reflects limitations in knowledge, such that simplifying assumptions must be made to quantify health risks. Some key areas of uncertainty evaluated in the HHRA are discussed below. A more detailed discussion regarding uncertainties in the HHRA process is presented in Appendix A, Section A6.0 of the FS (DOE/RL-2007-28).

Table 8. Hazard Quotients Associated with Consumption of Drinking Water Extracted from the 200-ZP-1 Operable Unit Groundwater Under Current Contamination Conditions.

Contaminant	Hazard Quotient[a]			
	Industrial Scenario (Scenario 2)	Residential Scenario (Scenario 3)	Yakama Nation and CTUIR Scenarios[b] (Scenarios 4 and 5)	
			Yakama	CTUIR
Carbon tetrachloride	41	304 (child) 130 (adult)	582 (child) 268 (adult)	453 (child) 268 (adult)
Trichloroethylene (TCE)	0.4	3 (child) 1 (adult)	5 (child) 2 (adult)	4 (child) 2 (adult)
Total chromium	0.0008	0.007 (child) 0.003 (adult)	0.01 (child) 0.006 (adult)	0.01 (child) 0.006 (adult)
Hexavalent chromium	0.7	5 (child) 2 (adult)	11 (child) 5 (adult)	9 (child) 5 (adult)
Nitrate	0.5	3 (child) 1 (adult)	6 (child) 3 (adult)	5 (child) 3 (adult)

NOTE: This table summarizes the pre-cleanup HQs under current contamination conditions.

[a] The HQs are calculated using the current contaminant concentration levels in the 200-ZP-1 OU groundwater, at the 90th percentile levels shown in Table 3. During the baseline risk assessment, the calculated HQ values are compared to the HQ threshold value of 1 to determine whether risk-based remedial actions may be necessary. The HQ values greater than 1 generally indicate that remedial actions may be warranted.

[b] Exposure assumptions were provided by the Yakama Nation and the CTUIR. They are included at the request of the Tribal Nations.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation
HQ = hazard quotient

Unfiltered sample data are not available for metals, except uranium. Use of filtered data for antimony, iron, total chromium, and hexavalent chromium potentially under-estimate the total concentrations present in groundwater. Because antimony concentrations are at background levels and iron concentrations are orders of magnitude below a health-based level, the exclusion of these metals from the quantitative risk analysis does not likely affect the conclusions of the risk assessment. A detailed discussion about the uncertainty associated with the use of filtered chromium and hexavalent chromium results is provided in Appendix A of the FS (Section A.6.1.2 of DOE/RL-2007-28). Health risks associated with the analysis of hexavalent chromium are not likely under-estimated because it is primarily present in a dissolved state. Similarly, because health hazards for total chromium are well below a target health goal, it is not expected that exposures will be considerably under-estimated by the use of filtered data.

7.2 SUMMARY OF THE ECOLOGICAL RISK ASSESSMENT

Ecological risk from 200-ZP-1 OU contaminants is not expected because of lack of direct or indirect exposure by ecological receptors to groundwater now or in the future. The 200-ZP-1 OU is located about 8 km (5 mi) south of the Columbia River (Figure 1). This is the

shortest path for groundwater to flow toward the river. Most of the 200-ZP-1 OU groundwater flows to the east southeast for about 26 km (16 mi) before reaching the Columbia River.

The 200-ZP-1 OU RI report evaluated baseline ecological risks to the Columbia River from 200-ZP-1 OU contaminated groundwater using a bounding analysis with three exposure scenarios: no dilution, 50% dilution to represent the hyporheic mixing zone, and 100-fold dilution to represent groundwater mixed with Columbia River water. Using current average groundwater concentrations to represent 200-ZP-1 OU contaminated groundwater that could reach the Columbia River in the absence of any remedial action, the analysis found no evidence for potential ecological risk in the river, but identified a potential for adverse ecological effects in the hyporheic zone. Using the current 50th percentile groundwater concentrations to represent 200-ZP-1 OU contaminated groundwater that could reach the Columbia River in the absence of any remedial action and the same exposure scenarios, carbon tetrachloride is the only 200-ZP-1 OU COC that could have potential ecological risk in the hyporheic zone but not in the river.

The evaluation of the human health risks (as discussed above in Section 7.1) established the need for action. The actions that are necessary for human health risk mitigation and to restore the aquifer for beneficial use will also prevent contaminants from reaching the Columbia River at concentrations that could be a potential risk to ecological receptors, which will therefore mitigate potential future ecological risks associated with the groundwater pathway and its connection to the river. Therefore, no further baseline quantitative ecological risk evaluation was performed in support of the need to take action.

7.3 BASIS FOR ACTION

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants or contaminants into the environment. Such a release or threat of release may present an imminent and substantial endangerment to public health, welfare, or the environment.

A response action is necessary for the 200-ZP-1 OU groundwater because of the following conditions:

- The cumulative excess carcinogenic risk to an individual exceeds 10^{-4} using RME assumptions for potential beneficial use of the groundwater.
- The non-carcinogenic hazard index is greater than one using RME assumptions for potential beneficial use of the groundwater.
- Chemical-specific standards (e.g. drinking water standards) that define acceptable risk levels are exceeded and exposure to contaminants above these acceptable levels is predicted for the RME for potential beneficial use of the groundwater.

8.0 REMEDIAL ACTION OBJECTIVES

This section presents the remedial action objectives (RAOs) for the 200-ZP-1 OU groundwater. The RAOs provide a general description of cleanup objectives and served as the design basis for the remedial alternatives described in Section 9.0.

8.1 BASIS AND RATIONALE FOR THE REMEDIAL ACTION OBJECTIVES

The NCP establishes a national expectation for cleanup of groundwater at CERCLA sites through the following statement: "EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" (40 CFR 300.430). The EPA generally defers to state agency definitions of useable groundwater provided under the various comprehensive state groundwater protection programs administered by the states across the country. Based on physical yield and natural water quality, the State of Washington, through its groundwater protection program, has determined that the aquifer setting for the 200-ZP-1 OU meets the *Washington Administrative Code* (WAC) definition for potable groundwater and has been recognized by the state as a potential source of domestic drinking water.

Consistent with the state's beneficial-use determination, the contaminated 200-ZP-1 OU groundwater must be restored to a level that supports future use as a potential domestic drinking water supply. For the purposes of this remedy, "beneficial use" has been defined as the use of the groundwater as a domestic drinking water source.

8.2 SPECIFIC REMEDIAL ACTION OBJECTIVES

- **RAO #1:** Return the 200-ZP-1 OU groundwater to beneficial use (restore groundwater to achieve domestic drinking water levels) by achieving the cleanup levels (provided later in Table 11). This objective is to be achieved within the entire 200-ZP-1 OU groundwater plumes. The estimated timeframe to achieve cleanup levels is within 150 years.
- **RAO #2:** Apply institutional controls to prevent the use of groundwater until the cleanup levels (provided later in Table 11) have been achieved. Within the entire OU groundwater plumes, institutional controls must be maintained and enforced until the cleanup levels are achieved, which is estimated to be within 150 years.
- **RAO #3:** Protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU. This final objective is applicable to the entire 200-ZP-1 OU groundwater plume. Protection of the Columbia River from impacts caused by 200-ZP-1 OU contaminants must last until the cleanup levels are achieved, which is estimated to be within 150 years.

9.0 DESCRIPTION OF ALTERNATIVES

The following subsections provide a brief explanation of the remedial alternatives developed for the 200-ZP-1 OU which were evaluated in the FS:

- No Action alternative
- Alternative 1 – Institutional Controls and Monitored Natural Attenuation (MNA)
- Alternative 2 – Pump-and-Treat, MNA, Flow-Path Control, and Institutional Controls.

9.1 DESCRIPTION OF REMEDY COMPONENTS

9.1.1 No Action Alternative

The NCP requires that a "no action" alternative be evaluated as a baseline for comparison with other remedial alternatives. The no action alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied to the 200-ZP-1 OU groundwater. No action implies "walking away from the waste site" and allowing the wastes to remain in their current configuration, affected only by natural processes. No maintenance or other activities are instituted or continued. Selecting the no action alternative requires that the current groundwater contamination pose no unacceptable threat to human health or the environment.

9.1.2 Alternative 1 – Institutional Controls and Monitored Natural Attenuation

Alternative 1 employs two elements to protect human health and to restore the aquifer to the cleanup levels presented later in Table 11: (1) the use of institutional controls to control access to the groundwater contamination during the remediation timeframe, and (2) MNA processes to reduce contaminant concentration levels in the affected portions of the aquifer to the degree possible and achievable through natural means. Alternative 1 does not rely on any engineered restoration measures (e.g., groundwater extraction and treatment) to actively reduce contaminant concentration levels or speed the restoration timeframe. These active restoration measures are included with Alternative 2. The absence of the active restoration processes is the principal difference between Alternatives 1 and 2.

Under Alternative 1, the natural processes are likely to take centuries or more to reduce contaminant concentration levels to the cleanup levels. The main drawback of Alternative 1 is the absence of remediation components aimed at shortening the restoration timeframe. The trade-off with Alternative 1 is low capital costs (because of the absence of active restoration components), at the expense of a much longer restoration timeframe compared to Alternative 2. Alternative 1 was developed to assess the trade-offs and to develop preferences between restoration time and initial capital costs required to shorten the time for cleanup.

9.1.2.1 Institutional Controls Component. Institutional controls are instruments, such as administrative and/or legal restrictions, that are designed to control or eliminate specific pathways of exposure to contaminants. For instance, for groundwater at the Hanford Site, institutional controls are in place prohibiting the installation and use of groundwater wells for purposes other than monitoring, characterization, and cleanup. An existing source of potable

water is provided to facilities on the Central Plateau and will continue to be available, so there is no demand for groundwater. Under Alternative 1, groundwater use would be restricted until cleanup levels are achieved.

The *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions* (DOE/RL-2001-41) identifies the current institutional controls for the Hanford Site. It also describes how the institutional controls are implemented and maintained, serving as a reference point for the selection of institutional controls for the future. The current plan provides a foundation from which to identify the long-term controls needed to prevent exposure during the restoration timeframe accompanying Alternative 1. The details would be refined as part of remedy design, if this alternative were selected as the final alternative.

9.1.2.2 Monitored Natural Attenuation (MNA) Component. The natural processes and monitoring steps that would be relied on and implemented are the same as those discussed below for Alternative 2. The difference, however, is that under Alternative 2, the starting concentrations would be initially reduced in the high-concentration areas (the greater than 100 µg/L carbon tetrachloride contamination area) via the active restoration components. The process of MNA is most effective in lower concentration zones with no continuing source of contamination. One of the key reasons that the restoration timeframe for Alternative 1 is on the order of centuries is because of the higher initial concentrations to be addressed using MNA compared to Alternative 2.

9.1.3 Alternative 2 – Pump-and-Treat, MNA, Flow-Path Control, and Institutional Controls

Alternative 2 was developed to assess the trade-offs associated with higher capital costs for active restoration features (components such as wells, pumps, and water treatment systems) and to assess the ability of these components to shorten restoration time. A summary of the principal components comprising Alternative 2 is provided below.

9.1.3.1 Pump-and-Treat Component. Groundwater pump-and-treat technology will be used to capture and treat the contaminated groundwater with a design requirement of reducing the mass of carbon tetrachloride, the predominant contaminant in the groundwater, by 95%. Carbon tetrachloride concentrations in the groundwater above 100 µg/L correspond to approximately 95% of the mass of carbon tetrachloride currently residing in the aquifer. An initial pumping rate of 1,600 gpm for this alternative was evaluated through fate and transport analysis in the FS (DOE/RL-2007-28), which results in an estimated time of about 25 years to capture and remove 95% of the carbon tetrachloride mass. The fate and transport evaluation estimated that a system comprised of 27 extraction and 27 injection wells would be necessary to achieve the design objectives.

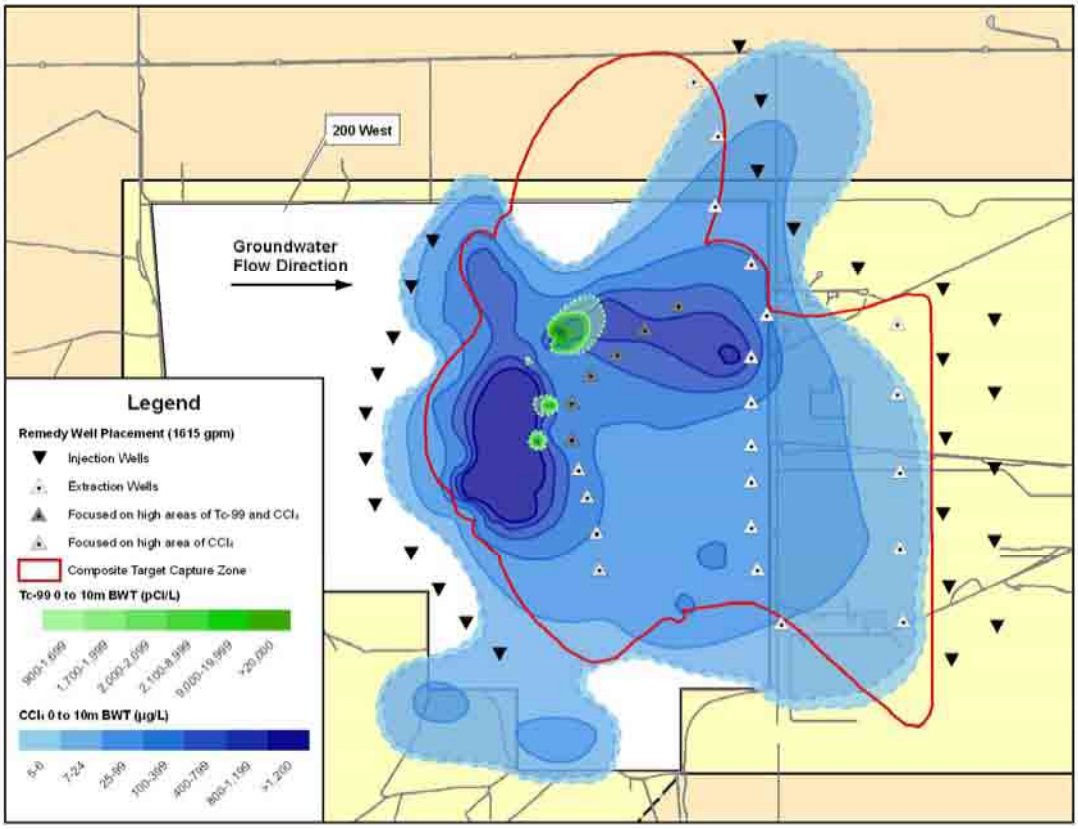
Following extraction, the COCs in groundwater will be treated to achieve cleanup levels. The treated groundwater will then be returned to the aquifer through injection wells. Except for tritium, all of the other groundwater COCs reside within the boundaries of the carbon tetrachloride contamination and will be addressed concurrently with the pump-and-treat component designed for carbon tetrachloride until cleanup levels are achieved.

Specific extraction and injection well locations, treatment equipment design, and other system details would be determined during the remedial design phase. The preliminary locations of the extraction and injection wells as determined in the FS (DOE/RL-2007-28) are shown in Figure 11.

Nitrate has a number of sources, both from within and outside of the Hanford Site, and is widespread in Hanford groundwater. It is found within all four groundwater OUs on the Central Plateau, and each OU will address nitrate within its boundaries. Like the other COCs, nitrate that is captured by pumping will be treated to meet the cleanup level before it is injected into the aquifer.

A series of treatment technologies, known as a treatment train, will be used to remove the contaminants from the groundwater once it has been extracted from the ground. Different treatment technologies are used to treat different contaminants to achieve the cleanup levels. For example, air stripping is currently used to treat the volatile compounds carbon tetrachloride, TCE, and their degradation products. Ion exchange is used to treat chromium, technetium-99, iodine-129, and nitrate.

Figure 11. The Preliminary Locations of Proposed Extraction and Injection Wells for Alternative 2.



Specific details regarding the treatment trains to be used will be identified during the remedial design phase. The remedial design will also consider as necessary the need for treatment of other constituents (e.g., uranium) that may be captured by the 200-ZP-1 OU extraction wells. While not COCs for the 200-ZP-1 OU, such constituents may be encountered during restoration from sources related to the other adjacent groundwater OUs, several of which are still in their characterization phase and may identify different COCs for cleanup in their areas. Design and construction is expected to be complete by the end of the year 2011.

There is no viable treatment technology to remove tritium from the groundwater. However, the half-life of tritium is sufficiently short, so the tritium will decay below the cleanup standard before it leaves the industrial land-use zone.

9.1.3.2 Monitored Natural Attenuation (MNA) Component. For the remaining portion of the carbon tetrachloride and nitrate not captured by the pump-and-treat component (the remaining 5% of the mass), natural attenuation processes will be used to reduce concentrations to the cleanup levels. The process of MNA will also be used to reduce tritium concentrations in the aquifer to the cleanup level. The other COCs will be treated as part of the pump-and-treat component of this remedy.

Natural attenuation processes to be relied on as part of this component include abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring will be employed to evaluate the effectiveness of the natural attenuation processes, as well as to optimize the performance of the pump-and-treat component. Fate and transport analyses conducted as part of the FS indicate that the timeframe necessary to reduce the remaining carbon tetrachloride, nitrate, and tritium concentrations to acceptable levels through MNA will be approximately 100 years. The estimated MNA timeframe is appropriate for the 200-ZP-1 OU because the Hanford Site is expected to remain under Federal control with institutional controls in place until at least the year 2150 to prevent groundwater use until cleanup levels have been achieved.

Consistent with EPA guidance, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (EPA OSWER Directive 9200.4-17P), MNA is most appropriate when used in conjunction with other active remediation measures, which is how it would be implemented as part of Alternative 2. The process of MNA was identified as an effective component of this alternative because of the three factors, which EPA guidance considers to be the most important when considering MNA as part of a remedy:

- **Factor 1:** MNA can effectively remediate organic groundwater contaminants such as carbon tetrachloride by both biological and non-biological (abiotic) processes. Biological degradation products of carbon tetrachloride (chloroform and methylene chloride) are present in the 200-ZP-1 OU. However, due to the high degree of variability of the rates of biological degradation and to ensure conservatism in the remedy analysis, biological degradation was not considered a natural attenuation mechanism for carbon tetrachloride in the estimates of natural attenuation for the 200-ZP-1 OU remedy development. Abiotic degradation of carbon tetrachloride occurs with no hazardous products and was considered a dependable natural attenuation mechanism. Abiotic degradation rate data are available in the literature, and additional studies are underway to refine the rate information under site-specific conditions. Denitrification along with sorption and dispersion are natural processes that will attenuate nitrate over time.
- **Factor 2:** MNA is most effective in lower concentration zones with no continuing source of contamination. The active pump-and-treat system will remove approximately 95% of the carbon tetrachloride mass so MNA can be most effective for the residual carbon tetrachloride.
- **Factor 3:** Fate and transport modeling indicates that MNA can remediate the lower concentration plume area within a reasonable timeframe (approximately 100 years). The modeling also indicates that this portion of the plume area will remain on the Central Plateau geographic area during this timeframe (see Figure 1).

Alternative 2 will require monitoring to be conducted over the life of the action to evaluate its performance and optimize its effectiveness. For the MNA component, monitoring locations and specifications will be developed that include data collection aimed at determining whether the key mechanisms of natural attenuation are performing as expected. The monitoring results will be reviewed as part of the CERCLA 5-year review process.

9.1.3.3 Flow-Path Control Component. Alternative 2 also uses flow-path control by injecting the treated groundwater into the aquifer to the northeast and east of the groundwater contamination (see Figure 11). The injected groundwater in these locations will slow the natural eastward flow of most of the groundwater and, as a result, will keep the higher concentration contamination within the capture zone, as well as increasing the time available for natural attenuation processes to reduce the contaminant concentrations not captured by the extraction wells.

Flow-path control will also be used to minimize the potential for groundwater in the northern portion of the aquifer to flow northward through Gable Gap and toward the Columbia River. The injection wells will be located to re-direct the groundwater flow to the east, which is the longest groundwater flow path to the river (about 26 km [16 mi]).

Groundwater modeling would be required to locate injection and extraction wells, to estimate required injection and extraction rates, and to determine the location of injection wells for flow-path control.

9.1.3.4 Institutional Controls Component. Similar to Alternative 1, Alternative 2 will also require institutional controls to be in place as long as the contaminant concentrations in the aquifer remain above the cleanup levels. There are no institutional controls required for Alternative 2 that are different than those described above for Alternative 1; the main difference is the length of time for which they may be necessary. Because Alternative 2 would restore the aquifer much faster through active measures, the length of time that the controls would be necessary during the remedial action is much shorter for Alternative 2.

9.2.1 Treatment Residuals

The No Action alternative and Alternative 1 would not generate any treatment residuals (other than investigation-derived wastes from monitoring performed as part of Alternative 1). Alternative 2 would generate additional treatment residuals from the treatment of extracted groundwater. Most of the treatment residuals are expected to meet waste disposal criteria for onsite disposal at the ERDF. Waste that does not meet ERDF waste acceptance criteria will be sent offsite for treatment and disposal. Any offsite disposal will require a facility acceptability determination by EPA that the facility can receive CERCLA waste.

9.2.2 Period of Performance

The No Action alternative and Alternative 1 both rely entirely on natural attenuation processes to achieve cleanup levels, which are estimated to take centuries or more. Alternative 2 is expected to take approximately 25 years for the pump-and-treat system to reduce the carbon tetrachloride contaminant mass by 95%, followed by about 100 years of MNA to achieve cleanup levels.

10.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section of the ROD summarizes the comparative analysis of alternatives presented in Section 7.0 of the FS (DOE/RL-2007-28). The major objective of the analysis was to evaluate the relative performance of the alternatives with respect to the nine CERCLA evaluation criteria, as described in 40 CFR 300.430(f)(5)(i), so the advantages and disadvantages of each are clearly understood.

The nine CERCLA evaluation criteria are as follows:

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance.

The first two criteria, overall protection and compliance with ARARs, are defined under CERCLA as "threshold criteria." Threshold criteria must be met by an alternative to be eligible for selection. The next five criteria are defined as "primary balancing criteria." These criteria are used to weigh major trade-offs among alternatives. The last two criteria, state and community acceptance, are defined as "modifying criteria." In the final comparison of alternatives to select a remedy, modifying criteria are of equal importance to the balancing criteria.

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment considering how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

Alternative 2 would protect human health and the environment through the pump-and-treat system that would be designed to capture and treat the high-risk portion of the carbon tetrachloride contamination represented by 95% of the carbon tetrachloride mass and to minimize contaminant migration. This capture zone would also capture the other COC plumes within the 200-ZP-1 OU. The process of MNA would be used to remediate the tritium plume and the portion of the carbon tetrachloride plume that is less than approximately 100 µg/L. Institutional controls would be used to prevent groundwater use until cleanup levels have been achieved (approximately 100 years after the active extraction and treatment component has ended).

Alternative 1 would protect human health and the environment through institutional controls that prevent groundwater use and thereby prevent potential exposure until natural attenuation could reduce contaminant concentrations to below cleanup levels (likely to take centuries or more). An adequate level of protection would exist as long as institutional controls remain in effect.

The No Action alternative would not provide adequate protection of human health and the environment because no measures would be implemented either to control potential exposures to contaminated groundwater or to reduce risks to human health from groundwater ingestion. It does not meet the threshold criteria. Therefore, the No Action alternative is not discussed further in this summary.

10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of CERCLA and 40 CFR 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and state requirements, standards, criteria, and limitations, which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4). Compliance with ARARs addresses whether a remedy will meet all of the ARARs or provide a basis for invoking a waiver.

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

Alternative 2 will attain its Federal and state ARARs during construction and operation of this remedial action and will attain the ARAR-based cleanup levels in a shorter timeframe (about 125 years) compared to Alternative 1 (centuries or more).

10.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Both Alternatives 1 and 2 would have similar residual risks at the end of the remedy, since both are designed to achieve the same cleanup levels with the same residual risks. Alternative 2, however, achieves the cleanup levels in less time than Alternative 1 and provides a greater degree of long-term effectiveness and permanence with the removal and treatment of 95% of the mass of groundwater contaminants. Both alternatives also rely on the same institutional controls during the time that the remedial actions are underway and contamination remains above the

cleanup levels. Alternative 2, as stated above, achieves the cleanup levels in less time, so the duration of institutional controls under Alternative 2 is shorter than under Alternative 1.

Reviews at least every 5 years, as required, would be necessary to evaluate the effectiveness of either alternative until the cleanup levels have been achieved.

10.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternative 2 uses active, engineered treatment processes to remove and treat contamination from extracted groundwater. Alternative 2 uses treatment as a principal element of the remedy Although not considered treatment, MNA for the tritium contamination and the residual portion of the carbon tetrachloride and nitrate contamination will reduce the mass, mobility, and volume of contaminants in the groundwater.

Alternative 1 uses no treatment of contaminants other than natural processes that take place over time within the aquifer through MNA.

10.5 SHORT-TERM EFFECTIVENESS

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, or the environment during construction and operation of the remedy until cleanup levels are achieved.

Implementation of both Alternatives 1 and 2 can be achieved with little or no additional risk to workers, the community, or the environment. The potential for slight, temporary increases in worker risk due to particulate emissions during construction of a pump-and-treat system and well installation for Alternative 2 would be controlled with dust-control technologies (e.g., water or foam sprays) and existing worker safety programs. Both Alternatives 1 and 2 effectively protect human health in the short term by implementing institutional controls during the action to prevent groundwater use. Alternative 1 is estimated to take centuries to achieve cleanup; Alternative 2 is estimated to take 25 years of active restoration and an additional 100 years of MNA to reach cleanup levels. Therefore, Alternative 2 achieves cleanup levels in significantly less time and with little or no additional risk to workers, the community, and the environment.

10.6 IMPLEMENTABILITY

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

The institutional controls and monitoring of natural attenuation mechanisms required during the action for both alternatives are readily implementable. The pump-and-treat and flow-path control technologies in Alternative 2 are proven, and the equipment and materials are generally available, so these aspects of Alternative 2 are also readily implementable. Both alternatives are judged to be implementable, although Alternative 2 is more complex because it requires construction and operation of a treatment facility.

10.7 REMEDIAL ALTERNATIVE COST ESTIMATES

The estimated present-value costs, not including the No Action alternative, are $2.3 million for Alternative 1 and $174 million for Alternative 2.

10.8 STATE ACCEPTANCE

The State of Washington Department of Ecology (Ecology) provided the following state acceptance statement for inclusion in this ROD:

> *Ecology is the supporting regulatory agency for the 200-ZP-1 OU final remedy. Ecology supports the proposed 200-ZP-1 OU final remedy.*
>
> *Ecology has considered the likelihood that the proposed remedy, as implemented, will protect human health and the environment. Under Washington's RCRA-authorized Hazardous Waste Management Act (HWMA) and dangerous waste regulations, Ecology has corrective action jurisdiction over the 200-ZP-1 OU concurrent with CERCLA. Under the Hanford Facility RCRA Permit, Dangerous Waste Portion (Sitewide Permit), issued under the HWMA, Ecology allows for work under other cleanup authorities or programs to be used to satisfy corrective action requirements, provided such work protects human health and the environment (Sitewide Permit Condition II.Y.2). Ecology specifically accepts work under the Tri-Party Agreement and the CERCLA program as satisfying corrective action requirements, subject to certain reservations (Sitewide Permit Condition II.Y.2.a). These reservations include a qualification that "a final decision about satisfaction of corrective action requirements will be made in the context of issuance of a final ROD" (Sitewide Permit Condition II.Y.2.a.ii).*
>
> *In addition to jurisdiction asserted under the RCRA Permit, certain HWMA corrective action requirements are ARARs under CERCLA. Ecology has evaluated protection of human health and the environment by considering how the selected remedy will address state corrective action requirements under WAC 173-303-64620(4), "Dangerous Waste Regulations." This regulation provides that corrective action must, at a minimum, be consistent with certain provisions of Washington's MTCA regulations, including the remedy selection requirements of WAC 173-340-360.*
>
> *Although this is not a MTCA cleanup, the state evaluated this ROD against the seven MTCA requirements for a final remedy: (1) protect human health and environment, (2) comply with the cleanup standards, (3) comply with applicable state and federal laws, (4) provide for compliance monitoring, (5) use of permanent solution to the maximum extent practicable, (6) provide a reasonable restoration timeframe, and (7) consider public concerns. MTCA also has additional remedy selection requirements that include groundwater cleanup actions, actions in residential areas or near schools, institutional controls, releases and migration, and dilution and dispersion. Ecology evaluated the 200-ZP-1 OU remedy using these criteria.*
>
> *Ecology believes that the 200-ZP-1 OU remedy provides for protection of human health and the environment during the remedy action by using institutional controls to restrict access and groundwater use for drinking and irrigation water while cleanup standards are attained. The remedy will be protective in the future upon attaining the specified cleanup levels which satisfy MTCA cleanup standards of 10^{-5} excess cancer risk and a hazard quotient of 1 for hazardous constituents throughout the groundwater plume. State and Federal ARARs will be attained once the cleanup standards are met.*

Compliance monitoring must be addressed in corrective action, and Ecology notes that the ROD requires the development of a monitoring plan for the CERCLA action. In addition, independent of any corrective action requirements, Ecology must regulate groundwater compliance and closure/post-closure for TSD units. The remedy intends to remediate past and potential future contaminants coming into groundwater from the single-shell tank farms (T, TX, and TY) or Low-Level Waste Management Areas 3 and 4. These units are geographically located above the 200-ZP-1 OU.

Ecology will review any monitoring plan required by this ROD. Ecology will either determine that the monitoring plan meets HWMA requirements for regulated units as alternative requirements under WAC 173-303-645(1)(e) and are satisfactory to serve as monitoring for other TSD units, or Ecology will impose required unit monitoring through conditions in the Sitewide Permit.

The selected remedy meets the state's requirements for permanent solution to the maximum extent practicable because the intent is to return the groundwater to beneficial uses, including use as a drinking water source. The remedy selected is an active remedial measure that will remove 95% of the mass of carbon tetrachloride and a substantial portion of the other contaminants within 25 years. The remedy relies on MNA after the 25 years to meet the cleanup levels and institutional controls will be in effect, precluding the use of groundwater until the cleanup levels are met. The state finds this to be a reasonable restoration timeframe for the Hanford Site.

The public comment period and responsiveness summary address the public's concerns. After evaluating the remedy, the state has determined that Alternative 2, "Pump-and-Treat, MNA, Flow-Path Control, and Institutional Controls," is acceptable as a final remedy, subject to the above comments.

10.9 COMMUNITY ACCEPTANCE

Overall the public was supportive of this action. The public's comments, along with the Tri-Parties' responses, are included in the Responsiveness Summary in Part III of this ROD.

11.0 PRINCIPAL THREAT WASTES

The NCP states in 40 CFR 300.430(a)(iii)(A) and (B) that "EPA expects to use treatment to address the principal threats posed by the site…" and "…to use engineering controls, such as containment, for wastes that pose a relatively low long-term threat." There are no known contaminant source materials such as NAPLs in the 200-ZP-1 OU groundwater that would serve as a source of principal threat materials. The largest human health risk is exposure to contaminated groundwater containing dissolved contaminants at concentrations above health-based cleanup levels.

From a sitewide perspective, the wastes (i.e., source materials) present in the TSD units and 24 source-control OUs on the Central Plateau overlying the four Central Plateau groundwater OUs represent the principal threat materials for the Hanford 200 Area NPL site. The TSD closure and remedial action decisions for the source-control OUs are being made separately under the enforcement strategies and schedules contained in the Tri-Party Agreement and will consider the nature and characteristics of the principal threat materials found in the source-control OUs.

12.0 SELECTED REMEDY

This ROD presents the selected final remedial action for the 200-ZP-1 OU in the Hanford Site, 200 Area, Benton County, Washington, in accordance with CERCLA, as amended by SARA, and to the extent practicable, the NCP. This decision is based on the information contained in the Administrative Record, which includes the public comments on the Proposed Plan for this OU. An IRM is currently ongoing in the OU and will continue to operate under the requirements established in the 200-ZP-1 IRM ROD until the treatment system required by this ROD becomes operational. The remedy specified in this ROD is expected to occur by the end of the year 2011.

The following subsections provide details on the rationale for the selected remedy, the description of the selected remedy, the summary of estimated remedy costs, and expected outcomes of the selected remedy.

12.1 SUMMARY OF THE RATIONALE FOR THE SELECTED REMEDY

The NCP establishes a national expectation for cleanup of groundwater at CERCLA sites: "EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site" (cited in the NCP, 40 CFR 300.430). Based on the results of the detailed analysis of alternatives and public comments, DOE and EPA have determined that Alternative 2 represents the best alternative to return the groundwater to a level that supports future use as a potential domestic drinking water supply in a timeframe that is considered reasonable given the particular circumstances associated with the 200-ZP-1 OU, as discussed in Section 10.0.

Three principal site-specific factors were considered: They are the 1) scale and 2) complexity of the contamination at the 200-ZP-1 OU and 3) the goal of returning this aquifer to use as a drinking water source. Because of the scale and complexity of the contamination, the No Action alternative and Alternative 1 would not be able to return the aquifer to beneficial use within 150 years. Alternative 2 requires restoration in 125 years by using active treatment to achieve long term risk reduction. Alternative 2 is supported by the State and community, and was considered to represent the best balance of tradeoffs with respect to the balancing and modifying criteria under CERCLA.

There is no single technology capable of meeting the cleanup levels for the 200-ZP-1 OU within 150 years. Alternative 2 uses multiple components (i.e., pump-and-treat, MNA, flow-path control, and institutional controls) to address the key factors of scale, complexity, and restoration timeframe. Pump-and-treat is used to contain and capture a large fraction of the mass of contamination (i.e., 95% of the mass of carbon tetrachloride) early in the remedy's lifecycle (25 years). However, the effectiveness of pump-and-treat will diminish over time, whereas the effectiveness of natural attenuation is relatively constant. As a result, natural attenuation eventually will become the dominant mechanism for continued reduction of contaminant concentrations. The effectiveness of the remedy is further enhanced by controlling the direction and rate of groundwater flow throughout the 200-ZP-1 OU using strategically placed extraction and injection wells in the flow-path control component.

Treatment residuals will be generated as part of this action and are expected to meet waste disposal criteria for on site disposal in the ERDF. Waste that does not meet ERDF waste acceptance criteria will be sent offsite for treatment and disposal. Any offsite disposal will

require a facility acceptability determination by EPA that the facility can receive CERCLA waste.

Institutional controls provide protection from exposure to groundwater contamination for both site workers and potential future users of groundwater until cleanup levels are achieved.

12.2 DETAILED DESCRIPTION OF THE SELECTED REMEDY

The selected remedy for the 200-ZP-1 OU is Alternative 2, "Pump-and-Treat, MNA, Flow-Path Control, and Institutional Controls." A detailed description of each component of the selected remedy is provided in this section.

12.2.1 Pump-and-Treat Component

A groundwater pump-and-treat system will be designed, installed and operated in accordance with an approved RD/RA work plan. The system will be designed to capture and treat contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium (chromium III and chromium VI), nitrate, trichloroethylene, iodine-129, and technetium-99, throughout the 200-ZP-1 OU by a minimum of 95% in 25 years. The pump-and-treat component will be designed and implemented in combination with monitored natural attenuation to achieve cleanup levels listed in Table 11 for all COCs in 125 years. Carbon tetrachloride concentrations in the groundwater above 100 µg/L correspond to approximately 95% of the mass of carbon tetrachloride currently residing in the aquifer. The estimated pumping rate required to reduce the mass of carbon tetrachloride by 95% in the expected timeframe is 1,600 gpm for this action. The fate and transport evaluation estimated that a system comprised of 27 extraction and 27 injection wells would be needed to achieve the design requirements.

Following extraction, the COCs in groundwater will be treated to achieve the cleanup levels listed in Table 11 (provided later in this ROD). The treated groundwater will then be returned to the aquifer through injection wells.

Specific extraction and injection well locations, treatment equipment design, operation requirements, and other system details will be determined during the remedial design phase and will be documented in the RD/RA documents. The RD/RA documents will be reviewed and approved by EPA. The remedial design will also consider as necessary the need for treatment of other constituents (such as uranium) that may be captured by the 200-ZP-1 OU extraction wells. While not COCs for the 200-ZP-1 OU, such constituents may be encountered during restoration from sources related to the other adjacent groundwater OUs.

There is no viable treatment technology to remove tritium from the groundwater. However, the half-life of tritium is sufficiently short, so the tritium will decay below the cleanup standard before it leaves the industrial land-use zone (see Figure 1).

12.2.2 Monitored Natural Attenuation (MNA) Component

In addition to the pump-and-treat system, natural attenuation processes will be used to reduce concentrations to below the cleanup levels.

Natural attenuation processes to be relied on as part of this component include abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring will be employed in accordance with the approved RD/RA documents to evaluate the effectiveness of the pump-and-treat system and natural attenuation processes. Fate and transport analyses

conducted as part of the FS indicate that the timeframe necessary to reduce the remaining COC concentrations to acceptable levels through MNA will be approximately 100 years. Modeling also indicates that this portion of the plume area will remain on the Central Plateau geographic area during this timeframe.

Monitoring is required to be conducted over the life of the action to evaluate its performance and optimize its effectiveness and shall be conducted in accordance with the approved RD/RA documents. For the MNA component, monitoring locations, points of compliance and specifications will be developed as part of the RD/RA documents that will provide data on performance, including data indicating whether the key mechanisms of natural attenuation are performing in a manner to satisfy selected remedy requirements and schedule.

The overarching requirement is to meet the groundwater cleanup levels identified in this ROD within 125 years. Monitoring shall be conducted to evaluate the performance of pump-and-treat system, flow path control, and MNA and shall be designed and operated to:

1) Demonstrate whether or not the pump-and-treat system will remove at least 95% of the mass of COCs in 25 years or less and whether the remedial action being taken, including natural attenuation, will achieve cleanup levels for all COCs within 125 years,
2) Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of the pump-and-treat system, natural attenuation processes, and the flow path control actions,
3) Identify any potentially toxic and/or mobile transformation products,
4) Verify that the contamination is not expanding downgradient, laterally or vertically subsequent to the period of time over which the pump-and-treat component has been functional,
5) Detect new releases of contaminants of concern to the environment that could impact the effectiveness of the remedy,
6) Verify attainment of remediation requirements.

12.2.3 Flow-Path Control Component

Flow-path control is also required and shall be achieved by injecting the treated groundwater into the aquifer to the northeast and east of the groundwater contamination (see Figure 11) such that the treated injected water in these locations will slow the natural eastward flow of most of the groundwater and, as a result, keep COCs within the capture zone, as well as increase the time available for natural attenuation processes to reduce the contaminant concentrations not captured by the extraction wells.

Flow-path control shall also be used to minimize the potential for groundwater in the northern portion of the aquifer to flow northward through Gable Gap and toward the Columbia River. Injection wells will be located to re-direct the groundwater flow to the east, which is the longest groundwater flow path to the river (about 26 km [16 mi]).

Groundwater modeling is required to locate injection and extraction wells, to estimate required injection and extraction rates, and to determine the location of injection wells for flow-path control. This modeling and the design, installation and implementation of the flow path controls shall be conducted in accordance with the approved RD/RA documents.

12.2.4 Institutional Controls Component

200-ZP-1 OU groundwater use will be restricted for the foreseeable future until cleanup levels are achieved.

The DOE is responsible for implementing, maintaining, reporting on, and enforcing the institutional and land-use controls required under this ROD. Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, DOE shall retain ultimate responsibility for remedy integrity and institutional controls. The current implementation, maintenance, and periodic inspection requirements for the institutional controls at the Hanford Site are described in approved work plans and in the *Sitewide Institutional Controls Plan* (DOE/RL-2001-41) that was prepared by DOE and approved by EPA and Ecology in 2002. One requirement listed in the *Sitewide Institutional Controls Plan* is the commitment to notify EPA and Ecology immediately upon discovery of any activity that is inconsistent with the land-use designation of a site.

No later than 180 days after the ROD is signed, DOE shall update the *Sitewide Institutional Controls Plan* to include the institutional controls required by this ROD and specify the implementation and maintenance actions that will be taken, including periodic inspections. The revised *Sitewide Institutional Controls Plan* shall be submitted to EPA and Ecology for review and approval as a Tri-Party Agreement primary document. The DOE shall comply with the *Sitewide Institutional Controls Plan* as updated and approved by EPA and Ecology.

The following institutional control performance objectives are required to be met as part of this remedial action. Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and EPA authorizes the removal of restrictions.

<u>Institutional controls required through the time of completion of the remedy are</u>:

1) The DOE shall control access to prevent unacceptable exposure of humans to contaminants in the 200-ZP-1 OU groundwater addressed in the scope of this ROD until the remedy is complete. Visitors entering any site areas of 200-ZP-1 OU will be required to be badged and escorted at all times.

2) No intrusive work shall be allowed in the 200-ZP-1 OU unless EPA has approved the plan for such work and that plan is followed.

3) The DOE shall prohibit well drilling in the 200-ZP-1 OU, except for monitoring, characterization or remediation wells authorized in EPA-approved documents.

4) Groundwater use in the 200-ZP-1 OU is prohibited, except for limited research purposes, monitoring, and treatment authorized in EPA-approved documents. The *Sitewide Institutional Controls Plan* will contain the institutional controls and implementing details prohibiting well drilling and groundwater use in the 200-ZP-1 OU, as defined in the Decision document for the 200-ZP-1 OU.

5) The DOE shall post and maintain warning signs along pipelines conveying untreated groundwater that caution site visitors and workers of potential hazards from the 200-ZP-1 OU groundwater.

6) In the event of any unauthorized access to the site (e.g., trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.

7) Activities that would disrupt or lessen the performance of the pump-and-treat, MNA, and flow-path control components of the remedy are to be prohibited.

8) The DOE shall prohibit activities that would damage the pump-and-treat, MNA, and flow-path control components (e.g., extraction wells, injection wells, piping, treatment plant, monitoring wells).

9) The DOE shall report on the effectiveness of institutional controls for the 200-ZP-1 OU remedy in an annual report, or on an alternative reporting frequency specified by EPA. Such reporting may be for this OU alone or may be part of a Hanford Sitewide report.

10) The DOE will provide notice to EPA at least six months prior to any transfer or sale of the any land above the 200-ZP-1 OU so EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for DOE to notify EPA at least six months prior to any transfer or sale, then the DOE will notify EPA as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, the DOE further agrees to provide EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. The DOE shall provide a copy of executed deed or transfer assembly to EPA.

11) The DOE will prevent the development and use of property above the 200-ZP-1 groundwater OU for residential housing, elementary and secondary schools, childcare facilities and playgrounds.

12) Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and exposure and EPA authorizes the removal of restrictions.

12.2.5 Land-Use Control Boundary for the 200-ZP-1 Operable Unit

For federal facility RODs, EPA requires the inclusion of a land use control boundary map. For the 200-ZP-1 OU, the land use control boundary is shown on Figure 12.

12.2.6 Five-Year Review Component for the Selected Remedy

A review (in accordance with 40 CFR 300.430[f][4][ii]) is required at a minimum every five years if a remedy is selected that results in hazardous substances, pollutants or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. However, because the selected remedy will not achieve levels that allow for unlimited use and unrestricted exposure within five years, DOE and EPA have agreed to conduct 5 year reviews in accordance with EPA policy until cleanup levels established in this ROD are attained. Reviews will begin 5 years after initiation of the remedial action to help ensure that the selected remedy is protective of human health and the environment.

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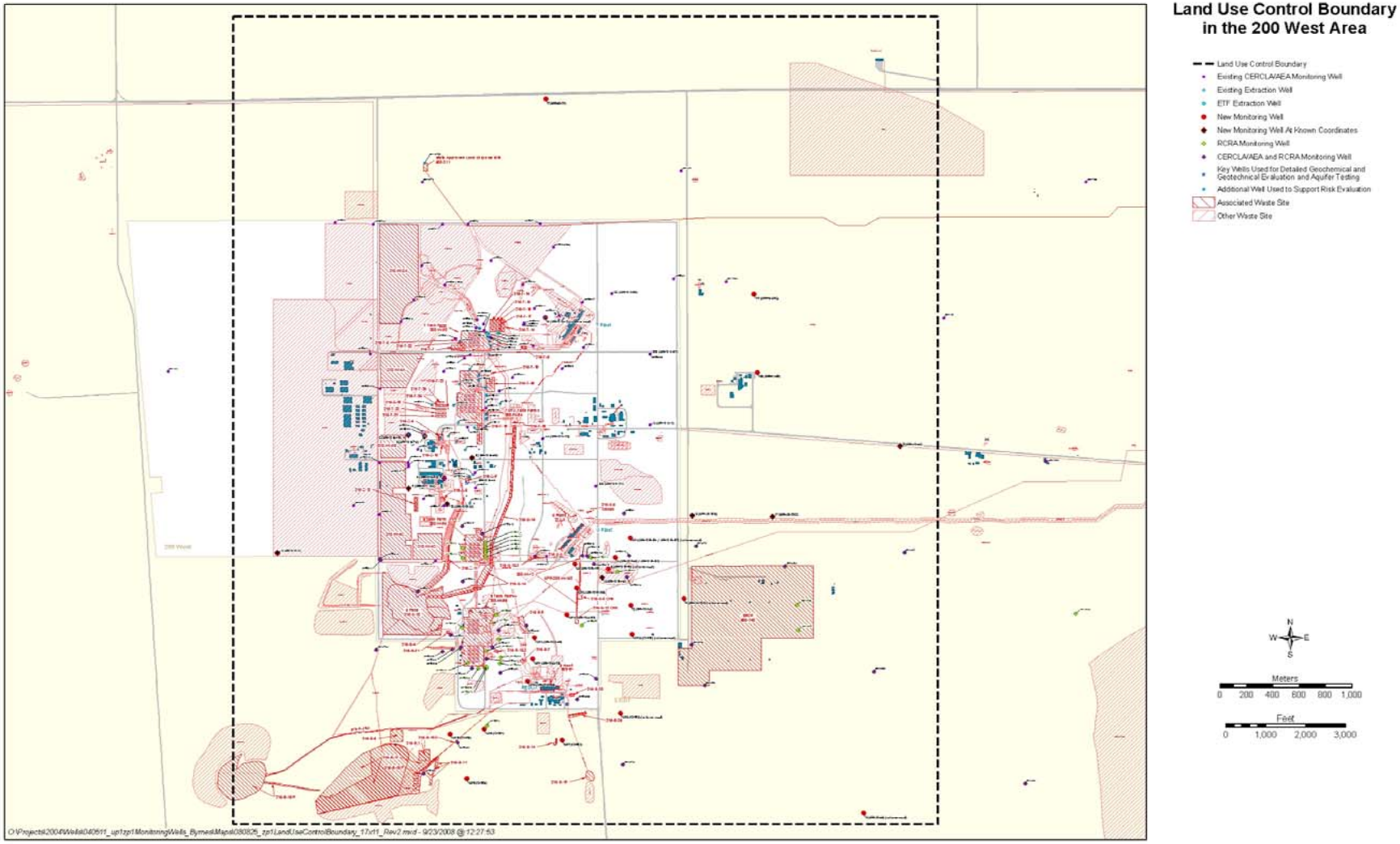
Figure 12. Land-Use Control Boundary for the 200-ZP-1 Operable Unit.



12.3 SUMMARY OF THE ESTIMATED REMEDY COST

The summary of costs for the selected remedy is shown below in Tables 9 and 10. Table 9 presents the estimated capital, annual, and other periodic costs for the selected remedy, in non-discounted dollars. Table 10 then summarizes the present worth costs for the selected remedy over its full life cycle (estimated 125 years). The present worth cost of the selected remedy, as shown in Table 10, is $174 million.

The cost elements and the resulting present worth cost estimate provide an order-of-magnitude engineering cost estimate that is expected to be +50% to -30% of the actual project cost. Changes in the cost elements are likely to occur because of new information and data collected during the engineering design of the selected remedy. Major changes will be documented in the form of a memorandum in the Administrative Record file, an explanation of significant difference, or a ROD amendment, as appropriate.

Table 9. Estimated Capital, Annual, and Periodic Costs for the 200-ZP-1 Operable Unit Selected Remedy.

Description	Quantity	Unit	Unit Cost	Cost
Capital Costs				
Extraction and injection wells	54	Well	$308,227.50	$16,644,285
Piping	344,250	Linear foot	$46.69	$16,073,033
Treatment facility	1	Lump sum	$22,800,000	$22,800,000
Institutional controls	1	Lump sum	$20,000	$20,000
Subtotal				$55,537,318
Contingency (25%)				$14,608,516
Project management and support				$2,896,745
Total capital cost				**$73,042,579**
Annual Costs				
Well inspection				$6,422
Radiation surveys				$31,940
Weed and pest control				$6,041
Well O&M				$29,203
Performance monitoring				$793,215
Treatment facility O&M				$3,300,062
Total annual costs				**$4,166,883**
Periodic Costs				
MNA performance monitoring				$40,723
CERCLA reviews and reporting every 5 years				$38,473
25% of wells and piping replaced every 10 years				$8,179,329
Replacement of three monitoring wells every 20 years				$540,000
Decommission treatment facility, piping, and 54 wells in year 25				$33,185,984

All costs are in non-discounted dollars.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
MNA = monitored natural attenuation
O&M = operations and maintenance

Table 10. Summary of Present Worth Analysis. (4 sheets)

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 3.0%[a]	Present Worth
0	$73,042,579	$0	$73,042,579	1.0000	$73,042,579
1		$4,166,883	$4,166,883	0.9709	$4,045,627
2		$4,166,883	$4,166,883	0.9426	$3,927,704
3		$4,166,883	$4,166,883	0.9151	$3,813,115
4		$4,166,883	$4,166,883	0.8885	$3,702,276
5		$4,205,356	$4,205,356	0.8626	$3,627,540
6		$4,166,883	$4,166,883	0.8375	$3,489,765
7		$4,166,883	$4,166,883	0.8131	$3,388,093
8		$4,166,883	$4,166,883	0.7894	$3,289,338
9		$4,166,883	$4,166,883	0.7664	$3,193,499
10		$12,384,686	$12,384,686	0.7441	$9,215,445
11		$4,166,883	$4,166,883	0.7224	$3,010,157
12		$4,166,883	$4,166,883	0.7014	$2,922,652
13		$4,166,883	$4,166,883	0.6810	$2,837,648
14		$4,166,883	$4,166,883	0.6611	$2,754,727
15		$4,205,356	$4,205,356	0.6419	$2,699,418
16		$4,166,883	$4,166,883	0.6232	$2,596,802
17		$4,166,883	$4,166,883	0.6050	$2,520,964
18		$4,166,883	$4,166,883	0.5874	$2,447,627
19		$4,166,883	$4,166,883	0.5703	$2,376,374
20		$12,924,686	$12,924,686	0.5537	$7,156,399
21		$4,166,883	$4,166,883	0.5375	$2,239,700
22		$4,166,883	$4,166,883	0.5219	$2,174,696
23		$4,166,883	$4,166,883	0.5067	$2,111,360
24		$4,166,883	$4,166,883	0.4919	$2,049,690
25		$37,391,340	$37,391,340	0.4776	$17,858,104
26		$40,723	$40,723	0.4637	$18,883
27		$40,723	$40,723	0.4502	$18,333
28		$40,723	$40,723	0.4371	$17,800
29		$40,723	$40,723	0.4243	$17,279
30		$79,196	$79,196	0.4120	$32,629
31		$40,723	$40,723	0.4000	$16,289
32		$40,723	$40,723	0.3883	$15,813
33		$40,723	$40,723	0.3770	$15,352

Table 10. Summary of Present Worth Analysis. (4 sheets)

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 3.0%[a]	Present Worth
34		$40,723	$40,723	0.3660	$14,905
35		$79,196	$79,196	0.3554	$28,146
36		$40,723	$40,723	0.3450	$14,049
37		$40,723	$40,723	0.3350	$13,642
38		$40,723	$40,723	0.3252	$13,243
39		$40,723	$40,723	0.3158	$12,860
40		$619,196	$619,196	0.3066	$189,845
41		$40,723	$40,723	0.2976	$12,119
42		$40,723	$40,723	0.2890	$11,769
43		$40,723	$40,723	0.2805	$11,423
44		$40,723	$40,723	0.2724	$11,093
45		$79,196	$79,196	0.2644	$20,939
46		$40,723	$40,723	0.2567	$10,454
47		$40,723	$40,723	0.2493	$10,152
48		$40,723	$40,723	0.2420	$9,855
49		$40,723	$40,723	0.2350	$9,570
50		$79,196	$79,196	0.2281	$18,065
51		$40,723	$40,723	0.2215	$9,020
52		$40,723	$40,723	0.2150	$8,755
53		$40,723	$40,723	0.2088	$8,503
54		$40,723	$40,723	0.2027	$8,254
55		$79,196	$79,196	0.1968	$15,586
56		$40,723	$40,723	0.1910	$7,778
57		$40,723	$40,723	0.1855	$7,554
58		$40,723	$40,723	0.1801	$7,334
59		$40,723	$40,723	0.1748	$7,118
60		$619,196	$619,196	0.1697	$105,078
61		$40,723	$40,723	0.1648	$6,711
62		$40,723	$40,723	0.1600	$6,516
63		$40,723	$40,723	0.1553	$6,324
64		$40,723	$40,723	0.1508	$6,141
65		$79,196	$79,196	0.1464	$11,594
66		$40,723	$40,723	0.1421	$5,787
67		$40,723	$40,723	0.1380	$5,620
68		$40,723	$40,723	0.1340	$5,457

Table 10. Summary of Present Worth Analysis. (4 sheets)

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 3.0%[a]	Present Worth
69		$40,723	$40,723	0.1301	$5,298
70		$79,196	$79,196	0.1263	$10,002
71		$40,723	$40,723	0.1226	$4,993
72		$40,723	$40,723	0.1190	$4,846
73		$40,723	$40,723	0.1156	$4,708
74		$40,723	$40,723	0.1122	$4,569
75		$79,196	$79,196	0.1089	$8,624
76		$40,723	$40,723	0.1058	$4,308
77		$40,723	$40,723	0.1027	$4,182
78		$40,723	$40,723	0.0997	$4,060
79		$40,723	$40,723	0.0968	$3,942
80		$619,196	$619,196	0.0940	$58,204
81		$40,723	$40,723	0.0912	$3,714
82		$40,723	$40,723	0.0886	$3,608
83		$40,723	$40,723	0.0860	$3,502
84		$40,723	$40,723	0.0835	$3,400
85		$79,196	$79,196	0.0811	$6,423
86		$40,723	$40,723	0.0787	$3,205
87		$40,723	$40,723	0.0764	$3,111
88		$40,723	$40,723	0.0742	$3,022
89		$40,723	$40,723	0.0720	$2,932
90		$79,196	$79,196	0.0699	$5,536
91		$40,723	$40,723	0.0679	$2,765
92		$40,723	$40,723	0.0659	$2,684
93		$40,723	$40,723	0.0640	$2,606
94		$40,723	$40,723	0.0621	$2,529
95		$79,196	$79,196	0.0603	$4,776
96		$40,723	$40,723	0.0586	$2,386
97		$40,723	$40,723	0.0569	$2,317
98		$40,723	$40,723	0.0552	$2,248
99		$40,723	$40,723	0.0536	$2,183
100		$619,196	$619,196	0.0520	$32,198
101		$40,723	$40,723	0.0505	$2,056
102		$40,723	$40,723	0.0490	$1,995
103		$40,723	$40,723	0.0476	$1,938

Table 10. Summary of Present Worth Analysis. (4 sheets)

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 3.0%[a]	Present Worth
104		$40,723	$40,723	0.0462	$1,881
105		$79,196	$79,196	0.0449	$3,556
106		$40,723	$40,723	0.0436	$1,776
107		$40,723	$40,723	0.0423	$1,723
108		$40,723	$40,723	0.0411	$1,674
109		$40,723	$40,723	0.0399	$1,625
110		$79,196	$79,196	0.0387	$3,065
111		$40,723	$40,723	0.0376	$1,531
112		$40,723	$40,723	0.0365	$1,486
113		$40,723	$40,723	0.0354	$1,442
114		$40,723	$40,723	0.0344	$1,401
115		$79,196	$79,196	0.0334	$2,645
116		$40,723	$40,723	0.0324	$1,319
117		$40,723	$40,723	0.0315	$1,283
118		$40,723	$40,723	0.0306	$1,246
119		$40,723	$40,723	0.0297	$1,209
120		$619,196	$619,196	0.0288	$17,833
121		$40,723	$40,723	0.0280	$1,140
122		$40,723	$40,723	0.0272	$1,108
123		$40,723	$40,723	0.0264	$1,075
124		$40,723	$40,723	0.0256	$1,043
125		$79,196	$79,196	0.0249	$1,972
Total Present-Worth Cost					**$173,566,839**
Total Non-Discounted Cost			**$235,033,404**		

[a] Discount rate column is a calculated annual multiplier where discount rate = $(1-e)^n$ where e = 3.0% and n = year (1 - 125).

12.4 EXPECTED OUTCOME FOR THE SELECTED REMEDY

The expected outcome of the selected remedy is to return the 200-ZP-1 OU groundwater to a level that supports future use as a potential domestic drinking water supply in 125 years, which is a timeframe that is considered reasonable given the particular circumstances associated with the 200-ZP-1 OU. The selected remedy is expected to take approximately 25 years for the pump-and-treat system to reduce the carbon tetrachloride contaminant mass by 95%, followed by about 100 years of MNA to achieve cleanup levels. Institutional controls will need to be maintained and enforced by DOE until the cleanup levels have been achieved. Maintaining institutional controls for approximately 125 years is appropriate for the 200-ZP-1 OU because

the Hanford Site is expected to remain under Federal control with institutional controls in place until at least the year 2150.

The final cleanup levels for the 200-ZP-1 OU groundwater are Federal and state drinking water MCLs and state groundwater cleanup standards (where more stringent than the MCLs) that are ARARs for the selected remedy. These cleanup levels define acceptable risk levels for potential beneficial use of the groundwater as drinking water.

The final cleanup levels listed in Table 11 for the COCs in the 200-ZP-1 OU groundwater were developed using Federal MCLs and the criteria and equations in the MTCA Method B cleanup levels for potable groundwater (WAC 173-340-720[4][b][iii][A] and [B], and WAC 173-340-720[7][b]) and the Federal and state water standards for radionuclides.

Table 11. Final Cleanup Levels for 200-ZP-1 Operable Unit Groundwater.

COC	90th Percentile Concen-tration	Federal MCL	State MCL	Model Toxics Control Act Method B Cleanup Levels		Final Cleanup Level
				Non-Carcinogens	Carcinogens at 10^{-5} Risk Level	
Carbon tetrachloride	2,900	5	5	5.6	3.4	3.4
Chromium (total)	130	100	100	24,000	-	100
Hexavalent chromium	203	N/A[a]	N/A[a]	48	-	48
Nitrate	81,050	10,000	10,000	25,600	-	10,000
Trichloroethylene (TCE)	10.9	5	5	2.4	1[b]	1[c]
Iodine-129	1.2	1	1	-	-	1
Technetium-99	1,442	900	900	-	-	900
Tritium	36,200	20,000	20,000	-	-	20,000

NOTES:

1. Units are "µg/L" for nonradionuclides and "pCi/L" for radionuclides.
2. Federal MCL values from 40 CFR 141, "National Primary Drinking Water Regulations," with iodine-129 and technetium-99 values from EPA's *Implementation Guidance for Radionuclides* (EPA 816-F-00-002).
3. State MCL values from WAC 246-290, "Public Water Supplies."

[a] There is no MCL specific to hexavalent chromium.

[b] The Model Toxics Control Act Method B cleanup levels for carbon tetrachloride and TCE are from Ecology's Cleanup Levels and Risk Calculations (CLARC) table current as of September 25, 2008.

[c] The DOE will clean up COCs for the 200-ZP-1 OU subject to WAC 173-340, "Model Toxics Control Act – Cleanup" (carbon tetrachloride and TCE), so the excess lifetime cancer risk does not exceed 1×10^{-5} at the conclusion of the remedy.

CFR = Code of Federal Regulations
COC = contaminant of concern
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
MCL = maximum contaminant level
NA = not applicable
OU = operable unit
WAC = Washington Administrative Code

Tables 12 and 13 present the estimated residual risks that are calculated to remain after remediation for the industrial, residential, and Tribal Nations exposure scenarios, when the final cleanup levels shown in Table 11 are achieved at exactly those values. The values shown in Table 12 and 13 were calculated using EPA's *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* (EPA 540/1-89/002). It is important to note that because carbon tetrachloride is widespread, dominates the risk, and controls the restoration timeframe, most of the other COCs (which will be effectively reduced by extraction and treatment) will have been reduced to levels well below their respective cleanup levels within the restoration timeframe required for carbon tetrachloride. Thus, it is conservative to assume that all COCs after remediation will be present at exactly their respective cleanup levels. The residual risk values presented in Tables 12 and 13, therefore, represent conservative estimates.

Table 12. Post-Cleanup Residual Excess Lifetime Cancer Risks Calculated Using EPA's Risk Assessment Guidance for Superfund.

Contaminant	Excess Lifetime Cancer Risk[a]		
	Industrial Drinking Water	Residential Drinking Water	Yakama Nation and CTUIR Scenarios[b]
Carbon tetrachloride	0.03 in 10,000	0.2 in 10,000	0.7 in 10,000
Trichloroethylene (TCE)	0.0009 in 10,000	0.007 in 10,000	0.03 in 10,000
Technetium-99	0.1 in 10,000	0.5 in 10,000	3 in 10,000
Iodine-129	0.008 in 10,000	0.03 in 10,000	0.2 in 10,000
Tritium	0.05 in 10,000	0.2 in 10,000	1 in 10,000

NOTE: This table summarizes the post-cleanup residual excess lifetime cancer risks estimated to remain when the final cleanup levels are reached.

[a] Risks shown in table above are calculated using the final cleanup levels shown in Table 11 and following EPA's *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* (EPA 540/1-89/002). Note that when risk values for carbon tetrachloride and TCE are calculated by MTCA Method B, they would each be 1×10^{-5} (i.e., 0.1 in 10,000) for the residential drinking water scenario, which represents the state's recognized beneficial use for groundwater.

[b] Exposure assumptions were provided by the Yakama Nation and the CTUIR. They are included at the request of the Tribal Nations.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation
EPA = U.S. Environmental Protection Agency
MTCA = *Model Toxics Control Act*

Table 13. Post-Cleanup Residual Hazard Quotients Calculated Using EPA's Risk Assessment Guidance for Superfund.

Contaminant	Hazard Quotient[a]			
	Industrial Drinking Water	Residential Drinking Water	Yakama Nation and CTUIR Scenarios[b]	
			Yakama	CTUIR
Carbon tetrachloride	0.05	0.4 (child) 0.1 (adult)	0.7 (child) 0.3 (adult)	0.5 (child) 0.3 (adult)
Trichloroethylene (TCE)	0.04	0.3 (child) 0.1 (adult)	0.5 (child) 0.2 (adult)	0.4 (child) 0.2 (adult)
Total chromium	0.001	0.005 (child) 0.002 (adult)	0.01 (child) 0.005 (adult)	0.008 (child) 0.005 (adult)
Hexavalent chromium	0.2	1 (child) 0.5 (adult)	3 (child) 1 (adult)	2 (child) 1 (adult)
Nitrate	0.06	0.4 (child) 0.1 (adult)	0.8 (child) 0.4 (adult)	0.6 (child) 0.4 (adult)

NOTE: This table summarizes the post-cleanup residual hazard quotients estimated to remain when the final cleanup levels are reached.

[a] Hazard quotients calculated using the final cleanup levels shown in Table 11 and following EPA's *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Interim Final* (EPA 540/1-89/002).

[b] Exposure assumptions were provided by the Yakama Nation and the CTUIR. They are included at the request of the Tribal Nations.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation
EPA = U.S. Environmental Protection Agency

13.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP Section 300.430(f)(5)(ii), the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, or contaminants as a principal element, and a bias against offsite disposal of untreated wastes.

CERCLA Section 121(c) also requires the use of 5-year reviews to determine if adequate protection of human health and the environment is being maintained in those instances where remedial actions result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure.

The preamble to the NCP states that when noncontiguous 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 noncontiguous facilities without having to obtain a permit. The 200-ZP-1 OU (addressed by this ROD) and ERDF are reasonably close to one another, and the wastes are compatible for

the selected disposal approach. Therefore, these two sites are considered to be a single site for response purposes.

The subsections below summarize the basis for determining the selected remedy for the 200-ZP-1 OU meets the statutory requirements.

13.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy for the restoration of the groundwater within the 200-ZP-1 OU will be protective of human health and the environment. The selected remedy is designed to return the 200-ZP-1 OU groundwater to beneficial use and will reduce existing contaminant concentration levels in the groundwater to achieve corresponding health-protective drinking-water MCLs (and state standards, where more stringent) as promulgated under the *Safe Drinking Water Act*. The selected remedy will also reduce CERCLA incremental lifetime cancer risks to within the acceptable health-protective 10^{-4} to 10^{-6} risk range for the domestic groundwater exposure pathway, and will achieve the threshold health-protective CERCLA hazard index of 1 for non-cancer health effects. The selected remedy will also protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU by removing the potential source of contamination.

During the time that the remedial action is taking place, institutional controls will be maintained on the Hanford Central Plateau to prevent access to the contaminated 200-ZP-1 OU groundwater. Alternate water supplies will also continue to be provided to current and future industrial users performing ongoing industrial land-use activities on Hanford's Central Plateau while cleanup is underway.

Following a demonstration and certification that cleanup levels are met, all areas of the 200-ZP-1 OU groundwater will have been restored to levels that allow for unrestricted use as a domestic drinking water supply. In the event that the groundwater cleanup levels specified in this ROD cannot be achieved in the future because of engineering limitations and a technical impracticability waiver is found to be necessary, alternate health and environmentally protective cleanup levels and engineering and other requirements would be established through an amendment to this ROD. As described in the NCP (40 CFR 300.430[f][1][ii][C]), a technical impracticability waiver can be sought when compliance with an ARAR requirement is found to be technically impracticable from an engineering perspective.

13.2 COMPLIANCE WITH ARARS

The NCP Sections 300.430(f)(5)(ii)(B) and (C) require that a ROD describe the Federal and state ARARs that the selected remedy will attain and any ARARs the remedy will not meet, the waiver invoked, and the justification for any waivers. All Federal and state ARARs will be met upon completion of the selected remedy, and no ARARs are being waived.

The ARARs are the substantive provisions of any promulgated Federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate for a CERCLA site or action. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements are requirements that, while not legally "applicable" to circumstances at a particular CERCLA site, address

problems or situations sufficiently similar to those encountered at the site that their use is well-suited. A definitive list of the ARARs that are to be attained by the selected remedy is provided in Appendix A, organized by Federal requirements (Table A-1) and Washington State requirements (Table A-2). Table A-3 describes "to be considered" criteria that were used in developing the remedy.

EPA OSWER Directive 9234.1-06, *Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26* (dated December 27, 1989), provides guidance on issues regarding whether land disposal restrictions apply to reinjection of groundwater. In general, this guidance states that EPA construes the provisions of RCRA Section 3020 to be applicable instead of land disposal restriction provisions contained in RCRA Sections 3004(f), (g), and (m), to reinjection of contaminated groundwater into an underground source of drinking water, which is part of a CERCLA response action.

13.3 COST EFFECTIVENESS

Alternative 2, the selected remedy, is cost effective because it has been determined to provide overall effectiveness proportional to its costs, the net present value being $174 million. While it is the highest cost alternative, the selected remedy results in the shortest estimated time (125 years) to achieve the required cleanup levels and provides the greatest certainty that the cleanup levels will be achieved. Alternative 1, which is considerably less expensive (net present value of $2.3 million) because it relies solely on natural remediation processes, would likely take centuries to achieve the cleanup levels. A minimum performance period of 250 years was used to represent an estimated cleanup time for Alternative 1 for cost-estimating purposes.

When the cost, remediation timeframe, and certainty of performance factors are considered together, Alternative 2 provides a better overall balance compared to Alternative 1. EPA and DOE have determined that the selected remedy (Alternative 2) will provide the best overall long-term effectiveness and permanence, as well as reduction in toxicity, mobility, and volume through treatment proportional to its costs and, therefore, is cost-effective in accordance with Section 300.430(f)(1)(ii)(D) of the NCP.

13.4 USE OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The EPA and DOE have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner for the 200-ZP-1 OU groundwater. Of the two alternatives that are protective of human health and the environment and comply with ARARs, EPA and DOE have determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element, bias against offsite treatment and disposal, and considering state and community acceptance. The selected remedy requires treatment that will achieve significant reduction in contaminant concentrations. The selected remedy does not present short-term risks different from the other alternatives. There are no special implementability issues that set the selected remedy apart from any of the other alternatives evaluated.

The selected remedy provides adequate short-term effectiveness and is technically implementable. The services and materials required to implement this remedy are readily available and use current technologies.

13.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The NCP states in 40 CFR 300.430(a)(iii)(A) and (B) that "EPA expects to use treatment to address the principal threats posed by the site…" and "…to use engineering controls, such as containment, for wastes that pose a relatively low long-term threat." There are no known contaminant source materials such as NAPLs in the 200-ZP-1 OU groundwater that would serve as a source of principal threat materials. The largest human health risk is exposure to contaminated groundwater containing dissolved contaminants at concentrations above health-based cleanup levels.

Groundwater treatment will be a significant element of the selected remedy for the 200-ZP-1 Groundwater OU. The extraction well and groundwater reinjection network will serve to efficiently capture, contain, and control the further migration of contaminated groundwater, and to remove contaminant mass from the affected portions of the aquifer to achieve mass-based removal requirements for the COCs. The extracted groundwater that is collected from the extraction well network will be treated to achieve health-protective cleanup levels prior to injection back into the aquifer. By using groundwater treatment as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.

13.6 FIVE-YEAR REVIEW REQUIREMENTS

A review (in accordance with 40 CFR 300.430[f][4][ii]) is required at a minimum every five years if a remedy is selected that results in hazardous substances, pollutants or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. However, because the selected remedy will not achieve levels that allow for unlimited use and unrestricted exposure within five years, DOE and EPA have agreed to conduct 5 year reviews in accordance with EPA policy until cleanup levels established in this ROD are attained. Reviews will begin 5 years after initiation of the remedial action to help ensure that the selected remedy is protective of human health and the environment.

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN

There were no significant changes to the selected remedy based on public comments.

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PART III: RESPONSIVENESS SUMMARY

1.0 INTRODUCTION

This responsiveness summary was prepared in accordance with the requirements of Section 117(b) of CERCLA, as amended. The purpose of this responsiveness summary is to summarize and respond to significant public comments on the Proposed Plan for remediation of the 200-ZP-1 Groundwater OU on the Hanford Site. The public comments were separated out and aggregated into general categories:

- Support for Alternative 2
- Proposed Plan Organization
- Community Participation
- ROD: Inclusion of 5-Year Review and Interim ROD Issues
- Implementation of Final Remedy and Future Performance Monitoring
- Sufficiency of Data to Support Remedy Selection
- OU Integration
- CERCLA/RCRA Integration
- ARAR Issues
- Other Comments on the Content of the Proposed Plan
- General Comments.

2.0 COMMUNITY INVOLVEMENT

A 30-day public comment period for the Proposed Plan (DOE/RL-2007-33) ran from July 21 through August 19, 2008. This comment period was publicized via a newspaper advertisement in the *Tri-City Herald* on July 21, 2008, and a fact sheet was mailed or sent electronically to more than 1,500 individuals on the Tri-Party Agreement mailing list. The Agencies also offered the opportunity for a public meeting if requested. No requests for a public meeting were received.

3.0 COMMENTS AND RESPONSES

Six commenters provided public comments. The name of the commenter, their comments, and the responses from the Tri Party Agencies are presented below.

- (b) (6) - *MM*
- Oregon Department of Energy - *ODOE*
- (b) (6) - *RS*
- Nez Perce Tribe - *NPT*

- (b) (6) - *AH*
- (b) (6) – *SH.*

SUPPORT FOR ALTERNATIVE 2

The following four comments express support for the preferred alternative (Pump-and-Treat, MNA, Flow-Path Control, and Institutional Controls) described in the Proposed Plan for the 200-ZP-1 OU.

Comment 1

I chose alternative # 2. *MM*

Comment 2

Oregon continues to agree that the ongoing active treatment (Alternative 2) is the correct choice for addressing the 200-ZP-1 contamination and DOE should move forward with the planned expansion of this system. *ODOE*

Comment 3

Of the alternatives selected for evaluation, Alternative 2 is clearly the better choice. *RS*

Comment 4

The Nez Perce ERWM appreciates the opportunity to review the *Proposed Plan for Remediation of the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2007-33, Rev. 0). We support the Tri-Parties selection of Alternative 2, which consists of Pump-and-Treat, Monitored Natural Attenuation, Flow-Path Control, and Institutional Controls. *NPT*

RESPONSE TO COMMENTS: The Tri Parties agree and have selected Alternative 2 as the remedy for the 200-ZP-1 OU.

PROPOSED PLAN ORGANIZATION

Comment 1

Editorially, the plan is fairly well written. We appreciate that the plan used an active writing style with a reduced amount of jargon, as well as several thoughtful editorial choices. These included the use of bolded text to refer readers to a glossary of technical terms in an appendix (rather than defining terms in text) and placement of appendices (such as the glossary and the table of abbreviations and acronyms) at the end rather than the beginning. These small elements make the plan more readable. We hope that these practices will be adopted more widely and not limited to documents issued for public comment. *ODOE*

Comment 2

These documents are far better in terms of organization and presentation than many earlier documents of this type. The alternatives and the conclusions are presented right up front, so the reader knows immediately what possibilities were considered and which one was chosen for remediation. The glossary is extensive and fairly complete. I commend DOE/RL for these improvements in their documents. *RS*

RESPONSE TO COMMENTS: The Tri-Parties appreciate these observations.

COMMUNITY PARTICIPATION

Comment 1

The proposed plan does not offer to extend the public comment period (July 21 through August 19). For this reason, I requested an extension to the public comment period on August 16. Considering the significance of the proposal which will lead to a final Record of Decision (ROD), 30 days is an insufficient public comment period. Typically, similar RCRA proposals provide a 45-day comment period. From the too-short public comment period, it could appear that this remediation decision is already made and on a fast track. From the comments provided, clearly inadequate information has been provided in the proposed plan and supporting documents to defensibly support a final ROD. It is recommended that the public comment period be extended to allow the public addition time to review the technical proposal. *AH*

RESPONSE TO COMMENT: EPA contacted the commenter and after discussion the request for an extension to the public comment period was withdrawn by the commenter. The comment on the adequacy of available information and supporting documents is addressed below in the Sufficiency of Data to Support Remedy Selection response.

ROD: INCLUSION OF 5-YEAR REVIEW AND INTERIM ROD ISSUES

Comment 1

Our first concern is that, except for the eventual target endpoint, the plan stops with remedy selection. The plan does not mention the legally required five year reviews or give interim contamination levels that DOE expects to find when those reviews occur, which are necessary to determine if (a) the conceptual site model is accurate, and (b) the remedy works as intended. Thus the plan needs an additional section describing how the progress will be monitored and assessed. This section should describe the five-year review requirement and the sampling that will be done to monitor progress. It should also estimate the interim contamination level projections that will be used to assess whether the remedy is succeeding (or whether a new or modified conceptual site model or cleanup approach is required). *ODOE*

Comment 2

The text describes the administrative decision-making process which led to this proposed plan and which will eventually lead to the ROD. Due to the numerous deficiencies associated with the interim action(s) (pump-and-treat system that only addressed the surface of the unconfined aquifer and only the most concentrated portion of the plume), remedial investigation (inadequate characterization of: potential carbon tetrachloride contamination sources, potential carbon tetrachloride contamination occurring in the vadose zone, and unconfined aquifer, semi-confined aquifer, and confined aquifer within the operable unit), and feasibility study (data evaluation that did not address deficiencies associated with data [i.e., data evaluation is not adequately conservative]), it is recommended that the eventual ROD that will be issued remain an “interim” ROD.

It is also recommended that the text clearly identify criteria upon which a final ROD will be based. It is this reviewer’s opinion that the defensibility of a final ROD based on this proposed is indefensible. *AH*

Comment 3

After the Interim Actions section, it is recommended that an additional section be added which describes the most recent 5-year ROD reviews that have been performed. Clearly, if the proposed plan were to acknowledge the most recent 5-year ROD review's deferral of a protectiveness determination associated with the carbon tetrachloride remediation, it would be concluded that insufficient contamination characterization information has been collected, modifications to existing effective remediations (i.e., soil vapor extraction) to increase efficiency have not been adequately evaluated and/or implemented, and existing characterization information has not been adequately evaluated to allow a protectiveness determination. Until a protectiveness determination is made as prescribed by the 5-year ROD review, it is respectfully submitted that the proposed actions should not precede a final ROD. *AH*

Comment 4

Due to the provision of a too-short public review and comment period (30 days), this reviewer was unable to complete the review of this complex and technical proposed plan. While this reviewer fully supports the proposed remediation actions, as the above comments communicate in various ways, characterization is inadequate and data interpretation/evaluation is not sufficiently conservative. Therefore, considering the many deficiencies, omissions, and concerns identified above, the ROD that this proposed plan is intended to support should not be final. *AH*

Comment 5

Alternative 2 is described as being recommended because it "uses a proven array of technologies." Although the technologies are "proven" does not mean they will achieve the stated remedial action goals. Furthermore, the proposed plan states: "The goal of the preferred alternative is to return the aquifer to its beneficial use, and the proposed cleanup levels for the 200-ZP-1 COCs have been identified accordingly." Due to the concerns regarding the COCs and the supporting document's failure to address concerns regarding the accuracy of measurement of groundwater contaminant concentrations, it is recommended that the text identify that this action will support the issuance of an interim ROD rather than a final ROD until such time that deficiencies associated with the basis are resolved. *AH*

Comment 6

After the Interim Actions section, it is recommended that an additional section be added which describes the most recent 5-year ROD reviews that have been performed. It is requested that the issue of there being less than adequate deep groundwater monitoring data downgradient of T Tank Farm to define the nature and extent of technetium-99 (Tc-99) groundwater plume near T Tank Farm be clearly identified. It is also requested that the proposed plan identify that a data quality objective process and sampling plan was generated but that the nature and extend of the Tc-99 has not been adequately characterized to support a final ROD. *AH*

Comment 7

The vertical distribution of contamination is poorly defined, and additional characterization is needed to better define the vertical distribution and movement of contamination within the aquifer. This characterization should facilitate a more cost-effective and timely remediation of the aquifer. *NPT*

Summary of Comments and Issues Raised Concerning the ROD:
Inclusion of 5-Year Review and Interim Record of Decision Issues

One commenter noted that the Proposed Plan does not address the legally required 5-year reviews and recommended adding information concerning this subject to the Proposed Plan. One comment expressed the need for interim action levels, assessment to ensure conceptual site model is accurate and remedy is working as intended.

One commenter expressed concerns that the ROD resulting from this Proposed Plan be classified as interim rather than final for a number of reasons:

- Due to numerous deficiencies associated with the existing interim action (primarily related to the concept that the existing interim action did not address a broad range of contaminants or encompass the vertical and horizontal dimensions of the contaminated regions of the aquifer).
- The Feasibility Study did not discuss what the commenter notes to be deficiencies in the data associated with the remedy evaluation.
- That a recent 5-year review of the interim action postponed a protectiveness determination associated with the remediation of carbon tetrachloride.
- That remedial investigation is not adequate. Characterization data is inadequate concerning vertical and lateral extent of contamination and the evaluation is not sufficiently conservative.
- That supporting documents fail to address the accuracy of measurement of groundwater contaminant concentrations.
- That technetium-99 in groundwater has not been adequately characterized in the vicinity of the T Tank Farm to support a final ROD.

RESPONSE TO COMMENTS:

Re: Proposed Plan not addressing 5-year reviews: The commenter is correct that 5-year reviews are required if a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. Because there are numerous documents associated with developing a remedial action under CERCLA, EPA has issued guidance on the content and detail that is to be provided in the various documents (EPA 1999). This guidance places the discussion of the 5-year review in the ROD (i.e., the document that follows the Proposed Plan in the CERCLA documentation sequence). EPA guidance for the content of proposed plans does not include information relative to 5-year reviews (EPA 1999). Since this action will span over a number of years in excess of 5 years, the DOE and EPA have agreed to conduct 5-year reviews in accordance with EPA policy. It should be noted that under the selected remedy, information will be collected across the lifecycle of the remedy and adjustments to the remedy can be made as appropriate. Additional data and information will be collected during the design, implementation, and operation of the remedial action. Please refer to the response in the section entitled “Implementation of Final Remedy and Future Performance Monitoring” for additional information that will be collected in the post-ROD phases of this remedy.

Re: Deficiencies as proposed by commenter in the existing interim action and data associated with the decision analysis for the 200-ZP-1 OU remedy: The Agencies do not agree that the 200-ZP-1 groundwater is not well characterized. Data have been collected as part of the ongoing interim action, as well as the characterization performed in the remedial investigation. A number of wells have been installed in the vicinity of the T Tank Farms to delineate the technetium-99 plume. Data exist on both the vertical and lateral extent of contamination and is sufficient for remedy selection.

The selected remedy requires that a groundwater monitoring plan be developed as part of the remedial design process and that it contain requirements to ascertain how well the remedy is performing. If needed, adjustments to the remedy can be made based on the data collected. The Agencies believe that information is sufficient for selection of a final remedy and to make a determination that the selected remedy is protective of human health and the environment.

IMPLEMENTATION OF FINAL REMEDY AND FUTURE PERFORMANCE MONITORING

Comment 1

After the Interim Actions section, it is recommended that an additional section be added which describes the most recent 5-year ROD reviews that have been performed. It is requested that the issue of the recent expansion of the 200-ZP-1 extraction well network near the TX-TY Tank Farm may result in Tc-99 contamination being pulled into the 200-ZP-1 treatment system. It is requested that the Proposed Plan clearly identify how the proposal addressed this issue. *AH*

Comment 2

After the Interim Actions section, it is recommended that an additional section be added which describes the most recent 5-year ROD reviews that have been performed. It is requested that the issue of increased efficiency and effectiveness of the 200-ZP-1 extraction well 299-W15-47 be addressed in the interim prior to the proposed expansion of the pump-and-treat system. *AH*

Comment 3

Statements are made throughout the documents to the effect that the pump-and-treat process would remove 95% of the mass of the COCs in 25 years, and that remaining 5% of the COCs would be remediated by NMA in 100 years. These statements are not supported very well by the analyses in the FS. The Figures ES-3 and D-51 in the FS show that 90% of the COCs removed after 25 years. The nature of the pump-and-treat removal process is such that the percent removed would asymptotically approach 100%. I suspect that the time to remove 95% of the COCs is likely to significantly exceed 30 years. I could not readily locate in the FS any analyses that demonstrated the ability of NMA to remove the remaining 5% of the COCs in 100 years after the pump-and-treat process has been terminated. If such analyses are present in the FS, their location should be given in the text at the first mention of the 100-year MNA period, so the reader can inspect those calculations. It is not clear in the FS what the rates are at which the various NMA processes listed would remove COCs from the groundwater. Creation of a curve or a family of curves showing COC species removal versus time for MNA would be very helpful to support the 100-year period assumption. As a result of the above uncertainties, the times experienced in the actual practice may be significantly longer than the times postulated in the cost analyses. *RS*

Comment 4

We are also concerned that the only mention of future monitoring in the plan is in the context of introducing the idea of a possible technical impracticability waiver. Given that the plan calls for more than two dozen extraction and injection wells to be operated for a quarter century, DOE must expect and plan to incorporate advances in cleanup and monitoring technology through time, not plan to seek a waiver if the proposed remedy provides disappointing results. The alternative to success with the Proposed Plan is finding more effective approaches, not declaring that cleanup is technically impractical. *ODOE*

Comment 5

We still have many of the concerns that we noted in our comments on the previous draft of this plan, which we provided by letter on November 13, 2007. We particularly stress the need for close monitoring of the cleanup progress with this plan and the need to use the monitoring results to refine and improve it, including the underlying conceptual site model and risk assessment. *ODOE*

Comment 6

The behavior of technetium-99 sources and plumes are not well understood, and the plan may have to be revised to address these. *ODOE*

Comment 7

There is a strong chance that a significant mass of the carbon tetrachloride is present as dense, nonaqueous phase liquid, or DNAPL. The plan supposes that little or no carbon tetrachloride is present as DNAPL. The key sign will be the response of the carbon tetrachloride levels in groundwater through time as the treatment progresses. As we suggested in our prior letter, DOE should pilot the use of additional treatments (electrical resistance heating and anaerobic bioremediation) to develop the ability to respond if the selected remedy is not performing as expected. *ODOE*

Summary of Comments and Issues Raised Concerning Implementation of the Proposed Remedy and Future Performance Monitoring

One commenter noted that a recent expansion of the 200-ZP-1 OU well network (conducted as part of the existing interim action) may result in technetium-99 being drawn into the treatment system and requested that the Proposed Plan describe how this circumstance will be addressed.

One commenter requested that an examination of the efficiency and effectiveness of a specific well be included in the Proposed Plan, as well as a summary of 5-year review results conducted for the existing interim action.

Another commenter noted that the behavior of technetium-99 sources and plumes are not well understood and suggested possible revisions to the Proposed Plan. One commenter noted that a strong chance may exist that a significant mass of carbon tetrachloride is present as a DNAPL, and that the current plan supposes that little or no carbon tetrachloride is present as DNAPL. Another commenter urges DOE to consider the use of treatment projects such as electrical resistivity heating and anaerobic bioremediation to address the presence of significant DNAPL should that condition be discovered.

One commenter noted that the removal rate of contaminants from the aquifer over time becomes asymptotic (i.e., with time it becomes more and more difficult to remove remaining contamination). One commenter also requested that discussion of the pump-and-treat and MNA components provided in the FS be called out more clearly to allow more careful inspection of the analyses. The commenter also made several suggestions as to additional detail that could be provided to show the analyses of contaminant removal with time and noted that due to uncertainties associated with such analyses, the actual remediation time may be significantly longer that postulated in the cost analyses.

One commenter expressed concern that the only future monitoring discussed is in the context of a possible technical impracticability waiver. The commenter then encouraged DOE to be reluctant to pursue a technical practicability waiver, but rather to focus on incorporating technological advances into the remedy in order to increase the effectiveness of the remedy with time. The same commenter noted the importance of monitoring of the cleanup progress to constantly improve the remedy.

RESPONSE TO COMMENTS:

Re: Continued definition and remediation of technetium-99 and potential carbon tetrachloride DNAPL in the 200-ZP-1 OU aquifer: Actions conducted under the existing interim action and those in the selected remedy directly address technetium-99, particularly with respect to the vicinity of the TX-TY Tank Farms. Technetium-99 is a COC and the selected remedy requires groundwater beneath these tank farms to be captured by the pump-and-treat system. Treatment tests already implemented as part of the interim action have demonstrated that technetium-99 can be effectively removed from the extracted groundwater.

To date, significant characterization activities have been conducted to search for the presence of carbon tetrachloride as DNAPL beneath the source areas most likely to generate DNAPL. However, while considerable quantities of carbon tetrachloride have been recovered from the vadose zone, evidence of significant DNAPL has not been discovered below the water table. The FS (Section 4.2 of DOE/RL-2007-28) examined both electrical resistivity heating and anaerobic bioremediation techniques, in part as an effort to preserve their viability as technologies that could be developed relatively quickly should evidence of significant DNAPL be discovered.

Several commenters correctly note that some uncertainty exists over elements of the remedy, such as the precise rate of contaminant removal, the duration of the remedy, and the overall cost of the remedy. These issues have continued to be recognized and addressed as part of the analyses conducted prior to the Proposed Plan. Execution of the CERCLA process does not require the analyses culminating in a FS and Proposed Plan to be free of uncertainty. Rather, the analyses are to be sufficient so as to select a remedy from the range of options available that satisfies CERCLA requirements. The selected remedy addresses the full vertical and horizontal extent of the 200-ZP-1 OU aquifer and encompasses the full range of contaminants that exceed cleanup levels developed under MTCA and Federal standards.

It is important to note that additional data collection and a program to improve the effectiveness of the remedy occur over the design and implementation lifecycle of the remedy. As this process matures, the degree of uncertainty diminishes and allows meaningful development and refinement of the analyses, including many of the recommendations made by the commenter's such as more detail of the removal rates over time for the COCs. The existing analyses on the

removal associated with the pump-and-treat technology and monitored natural attenuation can be found in Appendix D of the FS (DOE/RL-2007-28).

Re: Monitoring: Performance monitoring is required as part of the selected remedy. The discussion in the Proposed Plan was not meant to imply that the only monitoring that would be conducted would be in support of developing a case for a technical impracticability waiver, but rather would be integrated into a lifecycle approach for tracking the progress and effectiveness of the remedy across all components. Design and other system details will be determined during remedial design.

The DOE intends to continue to evaluate emerging or innovative technologies to enhance contaminant recovery from the aquifer and/or treatment of the groundwater over the life of the remedial action.

While monitoring information would be part of a potential technical impracticability waiver request, if one is found to be necessary at some point in the future, the inclusion of the technical impracticability discussion in the Proposed Plan was meant to alert the public that the possibility exists of seeking such a waiver in the future. The intent of the discussion was to provide background on the procedural mechanism of how such a waiver would occur in the future should it be necessary, and to reflect national experience with complex and large-scale groundwater cleanup remedies similar to that proposed for the 200-ZP-1 OU.

SUFFICIENCY OF DATA TO SUPPORT REMEDY SELECTION

Comment 1

The Proposed Plan identifies that the plan summarizes "…the findings of the RI report (*Remedial Investigation Report for the 200-ZP-1 Groundwater Operable Unit* [DOE/RL-2006-24]), the FS report (DOE/RL-2007-28), and the baseline risk assessment contained in the FS report." This reviewer has reviewed those reports and they do not address such issues as: filtering of groundwater prior to analysis for metals, the length of groundwater monitoring well screen length, the lack of depth-discrete monitoring, etc... Therefore, it is submitted that the ROD that this Proposed Plan (including the three above-referenced documents) is based on is insufficient to defensively support a final ROD. It is recommended that the ROD continue to be interim, rather than final. *AH*

Comment 2

[On] page 8, Current Extent of Contamination: It is recommended that the title of the section be changed to: "Current Extent of Characterized Contamination." Due to the lack of adequate vertical groundwater contamination characterization through the unconfined, semi-confined, and confined aquifers, the title and text should not imply that carbon tetrachloride and other contaminants have been characterized. *AH*

Comment 3

[On] page 8, Current Extent of Characterized Contamination: The text states: "The 107 wells were selected because their well depths were the most representative of those depths to which groundwater supply wells might be drilled…" RCRA and MTCA cleanup levels do not focus on "portions" of the aquifer to be remediated. The text should identify how this satisfies applicable RCRA and MTCA corrective action requirements. It is this reviewer's opinion that such statements only support why the eventual ROD should be interim and not final. *AH*

Comment 4

[On] page 8, Current Extent of Characterized Contamination: The text states: "The 107 wells were selected because their well depths were the most representative of those depths to which groundwater supply wells might be drilled…" Considering concerns associated with contaminant dilution due to long-length screens, it is requested that the text explain how this approach may not be conservative. It is this reviewer's opinion that such statements only support why the eventual ROD should be interim and not final. *AH*

Comment 5

[On] page 8, Current Extent of Characterized Contamination: The text states: "To establish the 25th, 50th, and 90th percentile concentration values, 5 years (2001-2005) of groundwater data from 107 wells within the 200-ZP-1 OU were used." The proposed plan should identify if contaminant concentrations in those 107 chosen wells were higher than concentrations measured in 2001-2005. In other words, there is a concern of inadequate characterization and inadequate conservatism. For example, information attached to DOE/RL-2007-28, Rev. 0 indicates that Tc-99 data from 10 to 20 meters, 30 to 40 meters, 40 to 50 meters, and >50 meters below the water table were used. It is requested that the proposed plan identify if this data set represents the highest concentrations of Tc-99 measured to date (not just from 2001-2005). In addition, it is requested that the Proposed Plan identify if this data set represents "the most representative of those depths to which groundwater supply wells might be drilled." Again, due to the concern that characterization is inadequate and data interpretation/evaluation is not sufficiently conservative support why the eventual ROD should be interim and not final. *AH*

Comment 6

[On] page 8, Current Extent of Characterized Contamination: The text states: "To establish the 25th, 50th, and 90th percentile concentration values, 5 years (2001-2005) of groundwater data from 107 wells within the 200-ZP-1 OU were used." Information attached to DOE/RL-2007-28, Rev. 0 indicates that carbon tetrachloride data from 10 to 20 meters, 30 to 40 meters, 40 to 50 meters, and >50 meters below the water table were used. It is requested that the Proposed Plan identify if this data set represents the highest concentrations of carbon tetrachloride measured to date (not just from 2001-2005). In addition, it is requested that the Proposed Plan identify if this data set represents "the most representative of those depths to which groundwater supply wells might be drilled." Again, due to the concern that characterization is inadequate and data interpretation/evaluation is not sufficiently conservative support why the eventual ROD should be interim and not final. *AH*

Comment 7

[On] page 8, Current Extent of Characterized Contamination: The text states: "To establish the 25th, 50th, and 90th percentile concentration values, 5 years (2001-2005) of groundwater data from 107 wells within the 200-ZP-1 OU were used." Information attached to DOE/RL-2007-28, Rev. 0 indicates that trichloroethylene data from 10 to 20 meters, 30 to 40 meters, 40 to 50 meters, and >50 meters below the water table were used. It is requested that the Proposed Plan identify if this data set represents the highest concentrations of trichloroethylene measured to date (not just from 2001-2005). In addition, it is requested that the Proposed Plan identify if this data set represents "the most representative of those depths to which groundwater supply wells might be drilled." Again, due to the concern that characterization is inadequate and data interpretation/evaluation is not sufficiently conservative support why the eventual ROD should be interim and not final. *AH*

Comment 8

[On] page 8, Current Extent of Characterized Contamination: The text states: "To establish the 25th, 50th, and 90th percentile concentration values, 5 years (2001-2005) of groundwater data from 107 wells within the 200-ZP-1 OU were used." Information attached to DOE/RL-2007-28, Rev. 0 indicates that data from the shallowest portion of the aquifer for iodine-129, methylene chloride, nitrate, tetrachloroethylene, tritium, and uranium was used. It is requested that the Proposed Plan identify if this data set represents the highest concentrations of trichloroethylene measured to date (not just from 2001-2005). It is also requested that the Proposed Plan identify if vertical characterization for these contaminants exists. Lastly, it is requested that the proposed plan identify which depth is believed to be the most representative in which groundwater supply wells might be drilled. Again, due to the concern that characterization is inadequate and data interpretation/evaluation is not sufficiently conservative support why the eventual ROD should be interim and not final. *AH*

Comment 9

[On] page 8, Current Extent of Characterized Contamination: The text states: "To establish the 25th, 50th, and 90th percentile concentration values, 5 years (2001-2005) of groundwater data from 107 wells within the 200-ZP-1 OU were used." The text explains the 90th percentile value by: "The 90th percentile value is useful for aquifer settings where multiple groundwater contaminants are present in overlapping plumes and the highest concentrations have different locations within the plumes (such as occurs in the 200-ZP-1 OU)." It is respectfully submitted that the contamination plumes emanating from the T Tank Farm are not co-mingled with those emanating from the 216-A-8, 216-Z-1A, 216-Z-8, 216-Z-9, and 216-Z-10 units as implied. It is requested that the contaminants emanating from the T Tank Farm (which are different from those emanating from the 216-A-8, 216-Z-1A, 216-Z-8, 216-Z-9, and 216-Z-10 units), be evaluated at the 90th, 95th, and 99th percentile concentration values for a comparison of conservatism to the 200-ZP-1 "OU-wide" 90th percentile concentration values. Likewise, it is requested that the contaminants emanating from the TX-TY Tank Farm (which are different from those emanating from the 216-A-8, 216-Z-1A, 216-Z-8, 216-Z-9, and 216-Z-10 units), be evaluated at the 90th, 95th, and 99th percentile concentration values for a comparison of conservatism to the 200-ZP-1 "OU-wide" 90th percentile concentration values. *AH*

Comment 10

[On] page 8, Current Extent of Characterized Contamination: The text states: "To establish the 25th, 50th, and 90th percentile concentration values, 5 years (2001-2005) of groundwater data from 107 wells within the 200-ZP-1 OU were used." It is requested that all unit-specific (i.e., 216-A-8, 216-Z-1A, 216-Z-8, 216-Z-9, and 216-Z-10, T Tank Farm, TX-TY Tank Farm, etc.) data from 2001-2007 be evaluated to establish the 90th, 95th, and 99th percentile concentration values for the following contaminants: carbon tetrachloride, chloroform, chromium (total), hexavalent chromium, methylene chloride, nitrate, PCE, TCE, uranium, iodine-129, technetium-99, tritium, 1,2-dichloroethane, antimony, iron, fluoride, arsenic, manganese, methylene chloride, and radioisotopic daughter products (e.g., neptunium-237). Again, due to the concern that characterization is inadequate and data interpretation/evaluation is not sufficiently conservative support why the eventual ROD should be interim and not final. *AH*

Comment 11

[On] page 8, Current Extent of Characterized Contamination: The text states: "Based on EPA's use of the 90th percentile value in its regulatory compliance programs for drinking water, this value represents a reasonable approach for presenting the contamination levels in the aquifer and for purposes of evaluating the risks associated with exposure to the contamination." Considering concerns regarding well screen lengths, filtering of water for metals analysis, inadequate vertical aquifer characterization, etc. the use of the 90th percentile value may not represent a "reasonable approach for….evaluating the risks associated with exposure to the contamination." Until all such concerns are addressed the eventual ROD should be interim and not final. *AH*

Comment 12

[On] page 10, Figure 4: The depiction of the trichloroethylene groundwater contamination could easily indicate two different trichloroethylene plumes. It is requested that the basis for performing a risk assessment using 107 groundwater monitoring wells (some at different depths yielding different contaminant concentrations) within a "dispersed" plume (that may be the result of inadequate treatment and re-injection) and evaluating the 90th percentile concentration values be provided. Some of the contaminants being addressed by this action are very likely from different sources. It is requested that the Proposed Plan identify if this approach is consistent with MTCA cleanup requirements and the MTCA requirement to establish a point of compliance. In other words, it would appear that the outer perimeter depicted as <5 µg/L concentration of trichloroethylene also would represent the point of compliance for this contaminant. As such, the inclusion of wells where the contaminant is not observed dilutes the average and allows the risk to be lower. In other words, by moving the point of compliance well beyond the plume's leading edge, the statistics dilute the risk. It is requested that the proposed plan explain the basis for what appears to be a far-field point of compliance that allows risk to be diluted. *AH*

Comment 13

[On] page 11, Figure 5: The depiction of the total chromium groundwater contamination could easily indicate four to six different plumes. It is requested that the basis for performing a risk assessment using 107 groundwater monitoring wells (some at different depths yielding different contaminant concentrations and some concentrations resulting from filtration prior to analysis) within a "dispersed" plume (that may be the result of inadequate treatment and re-injection or multiple unidentified and uncharacterized sources) and evaluating the 90th percentile concentration values be provided. Some of the contaminants being addressed by this action are very clearly from different sources (some of those sources which have not been evaluated by the supporting risk assessment [i.e., T and TX-TY Tank Farms]). It is requested that the Proposed Plan identify if this approach is consistent with MTCA cleanup requirements and the MTCA requirement to establish a point of compliance. In other words, it would appear that the outer perimeter depicted as 6 to 39 µg/L concentration of total chromium also would represent the point of compliance for this contaminant. As such, the inclusion of wells where the contaminant is not observed dilutes the average and allows the risk to be lower. In other words, by moving the point of compliance well beyond the plume's leading edge, the statistics dilute the risk. It is requested that the proposed plan explain the basis for what appears to be a far-field point of compliance that allows risk to be diluted. *AH*

Comment 14

Due to this reviewer's concern regarding the adequacy of the COPC and COC lists, it is requested that the Proposed Plan identify that a large percentage of groundwater monitoring results for metals that the RI/FS used were filtered. It is also requested that the Proposed Plan explain how the RI/FS evaluated the conservatism associated with using filtered metals sample results in the risk assessment. Note: This reviewer's review of the referenced documents did not identify where this issue was addressed. *AH*

Comment 15

Due to this reviewer's concern regarding the adequacy of the COPC and COC lists, it is requested that the Proposed Plan identify if the accuracy of the contaminant concentrations were evaluated in consideration of the screen lengths of the groundwater monitoring wells. In particular, typically, groundwater monitoring well screen lengths are 15 feet in length. At the Hanford Site, screen lengths are typically much longer (30 feet). Considering the additional screen length and the Hanford Site's sampling methods (non-discrete-depth sampling), there is a valid concern that measured contaminant concentrations may be inaccurate (i.e., diluted). It is also requested that the Proposed Plan explain how the RI/FS evaluated the conservatism associated with use of long screen lengths. Note: This reviewer's review of the referenced documents did not identify where this issue was addressed. *AH*

Comment 16

Due to the insufficient characterization of the entire aquifer, the statement that the pump-and-treat remediation will capture all but 5% of the carbon tetrachloride's mass may not be accurate and is without a technical defensible basis. Therefore, until such time that adequate characterization of the entire unconfined, semi-confined, and confined aquifers beneath the operable unit is achieved, the Proposed Plan and supporting documents should not claim that all carbon tetrachloride mass will be captured except 5%. *AH*

Comment 17

Because the vertical extent of groundwater (unconfined, semi-confined, and confined) contamination has not been characterized, the ROD should not be final. Similar to the 300-FF-5 groundwater OU that selected MNA as a remedy, the 200-ZP-1 OU ROD should not be final. *AH*

Summary of Comments Concerning Sufficiency of Data to Support Remedy Selection

One commenter provided comments indicating dissatisfaction with the sufficiency of elements of the data used to develop the preferred remedy described in the Proposed Plan. The commenter noted the following insufficiencies:

- Filtering of groundwater prior to analyses
- Length of monitoring well screens (contaminant "dilution" due to long screen lengths)
- Lack of depth-discrete monitoring
- Inadequate vertical characterization of the contamination within the aquifer
- Whether data sets used portrayed the highest concentrations of technetium-99, carbon tetrachloride, and trichloroethylene measured to date.

The commenter noted that a number of smaller scale "plumes" may be present, for instance for trichloroethylene and for chromium, and that portraying the contamination as more broadly distributed could cause the "points of compliance" to be so remote from the contamination as to "dilute" the concentration used for the analysis. ("*In other words, by moving the points of compliance well beyond the plume's leading edge, the statistics dilute the risk.*" – excerpt from Comments 12, 13, and 14 in this section.) The commenter also states that RCRA and MTCA cleanup levels do not focus on "portions" of the aquifer to be remediated. The commenter also requested that a broader range of constituents be evaluated at the 90th, 95th, and 99th percentile concentrations for more discrete areas such as the T Tank Farm. The commenter asks whether this approach is consistent with MTCA cleanup requirements and the MTCA requirement to establish a point of compliance.

The commenter notes that because of the inadequacies described above, the ROD should be interim rather than final.

One commenter suggests using 107 wells to represent the groundwater contamination may not be appropriate because RCRA and MTCA cleanup levels do not focus on "portions" of the aquifer to be remediated. The commenter also notes that some of the 107 wells may not provide conservative enough information on which a cleanup decision can be based because they may have relatively long screen intervals.

RESPONSE TO COMMENTS:

There are many objectives for which data are collected. The data from the 107 wells were not used to demonstrate those zones where compliance might be measured. Rather, in addition to being located in zones that represented potential for future groundwater use, they were biased toward the higher contaminant concentration areas to assure that a conservative set of data that did not dilute the concentration was used to assess risk to potential groundwater users. The data collected from the wells in question clearly demonstrated a need to take action. The cleanup objective of this ROD is to return the aquifer to beneficial use. The State of Washington defines beneficial use (WAC 173-340-720[1] and [2]) as domestic water use. Development of a remedial action for this OU must address a wide range of contamination that is transient over the life of the remedy and consider technologies and actions that may be used to address that contamination. Because groundwater conditions are transient and because estimated exposures by receptors could only take place over time from current conditions forward, it is most appropriate to use the most recent data set available.

The 90th percentile value for these wells represents a conservative estimate of the contamination likely to be encountered within the aquifer. Furthermore, the 25th, 50th, and 90th percentile values provide data representative of the integrated contamination within the unconfined aquifer. (*Note: The 25th and 50th percentile values were not intended to be used to establish risk thresholds but to provide a sense of the variability of the contamination within the aquifer.*) This is most appropriate and representative because any groundwater well installed into the aquifer would "integrate" water from the aquifer by drawing in water over time from zones within the area affected by its pumping action. The screen lengths and sampling intervals that have been implemented are appropriate for evaluating whether the potential use of this aquifer as a domestic supply has been impaired.

The action addresses the entire area encompassed by these wells by extracting and treating the groundwater throughout the aquifer thickness in this area. It is difficult to envision how additional or different data sets would have changed this outcome. Portrayals of contamination

at single wells and at single instances in time would lead to a fragmented remedy that does not adequately consider the temporal and spatial scales required for a comprehensive robust remedy. The approach taken for this analysis considers transience and acknowledges the fact that such a widespread and complex distribution of contaminants requires a response that addresses this heterogeneity and complexity. The spatial and temporal characteristics of the data used were aimed at developing the most appropriate remedy. A comprehensive, fully three-dimensional remedy, spanning realistic cleanup timeframes was the result of this analysis.

Furthermore, the existing data and information is sufficient to make this remedy decision.

OPERABLE UNIT INTEGRATION

Comment 1

After the Interim Actions section, it is recommended that an additional section be added which describes the most recent 5-year ROD reviews that have been performed. It is requested that the issue of increasing the efficiency of the carbon tetrachloride remediation by increasing the use of the vapor extraction system [sic]. As the soil-vapor extraction system is in limited operation, expansion of the system would increase efficiency of the carbon tetrachloride remediation. It is understood that an evaluation of soil vapor extraction operations was conducted and it was agreed that the system could be expanded. It is also understood that additional wells will be added to the soil vapor extraction system. *AH*

Comment 2

The DOE/RL-2007[-28], Rev. 0 document states: "The soil sites evaluated in this assessment include 216-A-8, 216-Z-1A, 216-Z-8, 216-Z-9, and 216-Z-10. These soil sites were identified in the *Remedial Investigation Report for the Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units* (DOE/RL-2006-51) as representative or unique of the 17 individual waste sites in these three OUs. This risk assessment will be used to evaluate the need for remedial action in soil in these OUs and to evaluate the protectiveness of certain remedies for soil and groundwater based on current and potential future uses of the land. All the evaluated waste sites are located in the 200 West Area, with the exception of 216-A-8, which is located in the 200 East Area." It is respectfully submitted that the contaminants and contaminant concentrations emanating from the T and TX-TY Tank Farms are not the same as those emanating from the 216-A-8, 216-Z-1A, 216-Z-8, 216-Z-9, and 216-Z-10 units. Therefore, the risk assessment on which this proposed plan is based is inadequate and should not be used to support a final ROD. *AH*

Comment 3

The DOE/RL-2007[-28], Rev. 0 document indicates the exposure and risk assessment results are based on evaluation of the following soil sites: 216-A-8, 216-Z-1A, 216-Z-8, 216-Z-9, and 216-Z-10. Such an evaluation does not address other units located above the groundwater OU. Exposure and risk assessment results from T and TX-TY Tank Farms could be significantly different from those obtained from evaluating the identified soil units. Therefore, until such time that exposure and risk assessment results are available from T and TX-TY Tank Farms, a final ROD should not be issued. *AH*

Comment 4

These documents clearly show the lack of coordination between vadose zone and groundwater remediation planning efforts during the period of preparation. This entire analysis appears to be driven by the existing inventory of COCs in the groundwater of this OU. It is not obvious that any attempt was made in these analyses to handle the problem of variable rates of vadose zone transport of COCs into the underlying groundwater over time. There are statements in the FS to the effect that the vadose zone transport problem will be handled by the vadose zone remediation projects. Unfortunately, this approach clearly results in an underestimate of the quantity of COCs that will have to be removed over time in order to meet existing groundwater MCLs. The reader is left with the idea that we know how much and how long the remediation process for the existing COCs in the groundwater will require, but we have no clue as to the impact of vadose zone transport of COCs or the time and effort required to meet groundwater MCLs over time. *RS*

Comment 5

It would be interesting to see the analysis results from another alternative not studied (i.e., Alternative 2 plus soil flushing with water). Soil flushing might be beneficial for more rapid removal of the highly mobile species, such as technetium-99, and possibly some of the other COCs as well. I am not aware of any actual analyses to date that have looked at the soil flushing possibility, but such an analysis could show the possible benefits (or lack of benefits) of this approach for vadose zone remediation, and for groundwater remediation. *RS*

Comment 6

Remediation of vadose zone contamination is a key component of groundwater remediation. This proposed plan only discusses the waste sites in the 200-PW-1 Source Unit. Other source units such as the tank farms, 200-SW-2, 200-TW-1&2, 200-LW 1&2, and 200-CW-5 source units should be integrated into the groundwater remediation. *NPT*

Comment 7

The remediation of the 200-ZP-1 Groundwater OU will need to be to be closely coordinated with the remediation of 200-UP-1 Groundwater OU. *NPT*

Comment 8

The relationship of this groundwater unit to the source units and the vadose zone above, particularly the 200-PW-1 unit is critical. The plan notes that the Tri-Parties agreed to perform the risk assessment and feasibility studies for ZP-1 and PW-1 in parallel; however, the projects are no longer proceeding in parallel. DOE is submitting a proposed plan for ZP-1 before the plan for PW-1, which is turning out to be a complex and difficult challenge. Thus, even if approved, this plan must be considered conditional. DOE must expect and plan to reopen the conceptual site model and the risk assessment for ZP-1 as new information is gained about contaminant fate and transport through the vadose zone. *ODOE*

Summary of Comments and Issues Raised Concerning OU Integration

One commenter requested a section to be added to the Proposed Plan that discusses expanding the existing soil vapor extraction system to remove additional carbon tetrachloride in the vadose zone. The same commenter also noted that until all sources of carbon tetrachloride requiring remediation are identified, the 200-ZP-1 OU ROD should be considered interim. In a separate

comment, the commenter noted that contaminants in the T and TX-TY Tank Farms are not the same as the contaminants in the 200-PW-1/3/6 waste sites. (*Note: The 200-PW-1/3/6 waste sites are in the vadose zone above the 200-ZP-1 OU aquifer. EPA initially established identical schedules for the development of the baseline risk assessment and FS for the 200-PW-1/3/6 OUs with the schedule for the 200-ZP-1 OU schedule. Therefore, the risk assessment for the two sets of OUs was performed as a single risk assessment.*) Because of the differences, the commenter suggests the risk assessment is inadequate and should not be used to support the final ROD [for the 200-ZP-1 OU]. Another commenter noted that other source units should also be integrated into the groundwater remediation.

Another commenter notes that the 200-ZP-1 OU schedule and 200-PW-1/3/6 schedule are no longer proceeding in parallel and suggests that this will cause a need to reopen the conceptual site model and risk assessment as new information is gained. The commenter notes that this should require the decision to be conditional.

Another commenter said there was a lack of coordination between vadose zone and groundwater remediation and that the analysis is driven by the contaminant inventory currently in the groundwater. The commenter did not find any obvious attempt to handle the problem of variable rates of vadose zone transport of COCs into the groundwater over time. Rather, the commenter stated the FS for the 200-ZP-1 OU deferred those analyses to the CERCLA decision analyses being conducted for the vadose zone operable units. The commenter notes that this will result in an underestimate of the quantity of contaminants that will have to be removed over time in order to meet cleanup levels and this unknown creates significant uncertainty about the time required to meet final cleanup objectives. The same commenter recommended consideration of a technique to flush highly mobile contaminants such as technetium-99 [from the vadose zone into the groundwater] as a viable potential approach for remediating the vadose zone in some locations.

One commenter noted that the remediation of the 200-ZP-1 OU groundwater must be closely coordinated with remediation of the 200-UP-1 OU.

RESPONSE TO COMMENTS:

In a cleanup as complex as the Hanford Site, integration between all the source areas is difficult. The analysis supporting the selection of this remedy has been able to account for much of the source term that may eventually impact groundwater. An extensive carbon tetrachloride characterization effort was conducted in the vadose zone as part of the 200-PW-1 OU, and this information showed that the carbon tetrachloride remaining in the vadose zone is not expected to impact groundwater in the future provided the vapor extraction system that is currently operating continues.

The other major vadose zone source term that is of concern is the technetium 99 located in the T and TX-TY Tank Farms. This contamination is being characterized as part of the corrective measures study for this area. In addition, the Agencies are conducting a treatability test in the 200 B/C Cribs area testing technology that may be effective in dealing with technetium-99 sources in the vadose zone.

During historical production operations at this site, billions of gallons of water containing contamination were discharged over the course of several decades into the vadose zone from whence they migrated to the groundwater. The single most important variable in the migration of contaminants through the vadose zone to groundwater is the flux rate of water. There are no credible circumstances under which future fluxes could approach the magnitude and duration of

those historical fluxes. In regard to evaluating the use of soil flushing, the selected action is limited to groundwater. Alternatives for vadose zone remediation will be developed as part of the soil operable units or RCRA corrective measures studies.

This remedy will be able to capture fluxes from the vadose zone since the active treatment system will be operating below these potential sources. To a significant degree, this function serves to mitigate many of the consequences associated with the uncertainties that exist about contamination in the vadose zone wherever it occurs above the 200-ZP-1 OU aquifer.

Re: Uncertainty about time frames to complete the remedy: This uncertainty was discussed in the FS. The FSs are not meant to provide high degrees of accuracy with regards to quantities like cost and duration of remedies. Rather, they are designed to provide comparative "order-of-magnitude" estimates that allow various alternative approaches to be compared fairly and relatively to each other. The remedy requires the treatment system be designed to achieve a timeframe of 25 years for active treatment.

Re: Use of risk assessment to support the ROD: The risk assessments performed in support of this remedy clearly demonstrate a need for action. In addition, it should be noted that the basis for taking action in this aquifer is predicated primarily on the fact that drinking water standards are exceeded.

Re: Expansion of the soil vapor extraction system to remove carbon tetrachloride: Even prior to the implementation of the 200-ZP-1 OU ROD, the soil vapor extraction system is being expanded, renovated, and upgraded. This is a continuing process being conducted under the 200-PW-1/3/6 OU decision making.

Re: Need to coordinate with remedy development for 200-UP-1: The Tri-Parties are aware that this is an important need. Although not part of this decision, DOE is considering sizing the treatment facility such that it can treat water from the 200-UP-1 OU. That decision will be made as part of the 200-UP-1 decision.

CERCLA/RCRA INTEGRATION

Comment 1

It is recommended that additional sections be added which address: 6) identification of all impacts to the hydrogeologic settings of RCRA groundwater monitoring networks, 7) description of RCRA and/or MTCA administrative actions made necessary as a result of the proposed CERCLA action (i.e., RCRA regulated unit groundwater monitoring network revisions, RCRA unit permit modifications to address changing groundwater conditions, RCRA/MTCA corrective action due to applicable standards not being addressed by the proposed CERCLA action, etc.), 8) status of the 5 year ROD review actions, and 9) identification of all "applicable" ARARs. *AH*

Comment 2

It is recommended that a new section be added to the Proposed Plan that describes how the RCRA TSD regulated units (located above this groundwater OU) will be affected by the proposed actions. In particular, each RCRA TSD regulated unit groundwater monitoring network has a point of compliance (defined by WAC 173-303-645) and it is anticipated that the proposed pump-and-treat action will affect the owner's/operator's ability to comply with RCRA groundwater protection standards. Specifically, it is requested that the Proposed Plan clearly identify the RCRA regulated units located above this groundwater operable unit (T Tank Farm,

TX-TY Tank Farm, Low Level Waste Management Area (LLWMA) 3, and LLWMA 4) and clearly identify how the groundwater monitoring networks and programs will be affected. For example, if the proposed actions will actually change the direction of groundwater flow beneath a RCRA TSD regulated unit, the proposed plan should clearly identify this. Another example, if the proposed actions are anticipated to cause RCRA TSD regulated units to be non-compliant (i.e., groundwater direction change, dry wells, etc.) the Proposed Plan should clearly identify this. Another example, if the proposed actions are anticipated to cause RCRA TSD regulated units to be non-compliant, the proposed plan should clearly identify the administrative mechanism for these affected units to become compliant. Another example, if the proposed actions are anticipated to cause RCRA TSD regulated units to be non-compliant, the Proposed Plan should identify the responsible agency's approval with the anticipated state of non-compliance. Another example, if the proposed actions are anticipated to affect RCRA TSD regulated unit corrective action decisions (i.e., T Farm and TX-TY Farm), the Proposed Plan should clearly identify how groundwater protection standards of WAC 173-303-645 will be satisfied at the point of compliance for those RCRA units. Clearly, there are many unanswered questions as to how the proposed actions will affect RCRA regulated units and how the applicable groundwater protection standards of WAC 173-303-645 will be satisfied at the point of compliance for these regulated TSD units. *AH*

RESPONSE TO COMMENTS:

The Proposed Plan is a summary-level document, and we chose not to include an extensive discussion of the TSD units as they are not part of the 200-ZP-1 OU. It is recognized that selected remedy may impact required groundwater monitoring for the TSD units, which is not being addressed under the 200-ZP-1 ROD. Ecology does intend to address these requirements.

With respect to corrective action requirements, in concurring on the selected remedy, Ecology has indicated that:

> … *Under the Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion (Site-wide Permit), issued under the HWMA, Ecology allows for work under other cleanup authorities or programs to be used to satisfy corrective action requirements, provided such work protects human health and the environment:* Sitewide Permit Condition II.Y.2. *Ecology specifically accepts work under the Hanford Federal Facility Agreement and Consent Order (HFFACO) and the CERCLA program as satisfying corrective action requirements, subject to certain reservations.* Sitewide Permit Condition II.Y.2.a. *These reservations include a qualification that "a final decision about satisfaction of corrective action requirements will be made in the context of issuance of a final ROD."* Sitewide Permit Condition II.Y.2.a.ii.

Ecology also states that:

> … *in addition to jurisdiction asserted under the permit, certain HWMA corrective action requirements are "applicable or relevant and appropriate requirements" (ARARs) under CERCLA….Compliance monitoring must be addressed in corrective action, and Ecology notes that the ROD requires development of a monitoring plan for the CERCLA action.*

Finally, with respect to groundwater compliance for TSD units, Ecology states:

> *In addition, independent of any corrective action requirements, Ecology must regulate groundwater compliance and closure/post-closure for TSD Units. The remedy intends to remediate past and potential future contaminants coming into groundwater from the Single Shell Tank Farms (T, TX, TY) or the Low Level Waste Management Area 3 and 4. These units are geographically located above the 200-ZP-1 OU. Ecology will review any monitoring plan required by this ROD. Ecology will either determine that the monitoring plan meets HWMA requirements for regulated units as alternative requirements under WAC 173-303-645(1)(e) and are satisfactory to serve as monitoring for other TSD units, or Ecology will impose required unit monitoring through conditions in the Site-wide Permit."*

ARAR ISSUES

Comment 1

It is indicated that "following extraction, the groundwater COCs will be treated to achieve the cleanup levels (presented later in Table 4) and then returned to the aquifer through injection wells." Due to the COPC and COC concerns previously identified, it is requested that the text identify that the non-endangerment standard of WAC 173-218-080 will be met. *AH*

Comment 2

[On] page 6, Site Background: the text states: "Collectively, the four OUs and their RODs will define the necessary groundwater cleanup actions across the Central Plateau." It is recommended that the statement either insert "CERCLA" between the words "necessary" and "groundwater" or identify that because this proposed plan does not address RCRA/MTCA groundwater protection standards specifically applicable to RCRA TSD regulated units and certain solid waste management units, that RCRA permit conditions will be necessary to augment the CERCLA action to define and remediate the necessary groundwater cleanup actions associated with specific TSD and corrective action solid waste management units. *AH*

Comment 3

[On] page 9, Land Use and CERCLA Expectations for Groundwater Cleanup: The proposed plan identifies the requirement to "meet ARARs (or satisfy criteria for an ARAR to be waived)". Because "applicable" requirements are different from "relevant" or "appropriate" requirements, it is requested that all applicable requirements that will be met (i.e., not waived) during this action be clearly identified in this proposed plan. In addition, it is requested that the standard that will be met also be identified. The public deserves to know which regulations will be followed and which standards will be met. For example, and because the nonendangerment injection standard is so important, the following applicable Underground Injection Control (UIC) regulations should be identified as being applicable with a nonendangerment injection standard to be met: WAC 173-218-040, -060, -070, -080, -090, and -120. The Proposed Plan should clearly identify all applicable regulations and all standards that will be met. *AH*

RESPONSE TO COMMENTS:

The laws and regulations that are applicable or relevant and appropriate (ARARs) to this decision were established by the Tri-Party agencies using the CERCLA process and the Tri-Party Agreement protocol. The FS describes potentially applicable or relevant and appropriate laws

and regulations. The key ARARs were summarized in the Proposed Plan. The ROD documents the ARARs identified in accordance with CERCLA and required for this remedy and includes WAC 173-218-040-080 and -120 as ARARs. WAC 173-218-040, -060, -070, and -090 are not ARARs because they are either do not impose substantive requirements, criteria, or limitations , or they are not applicable and do not address problems or situations sufficiently similar to those encountered at 200-ZP-1 such that their use is well suited to 200-ZP-1. Appendix A to the ROD identifies the ARARs that the selected remedy must meet, and Appendix A includes a discussion of each of the ARAR requirements and the rationale for use.

OTHER COMMENTS ON THE CONTENT OF THE PROPOSED PLAN

Comment 1

The *Feasibility Study Report for the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2007-28, Revision 0) [lists] the following 15 COPCs: carbon tetrachloride, chloroform, chromium (total), hexavalent chromium, methylene chloride, nitrate, PCE, TCE, uranium, iodine-129, technetium-99, tritium, 1,2-dichloroethane, antimony, and iron. It is requested that the Proposed Plan identify if the following additional contaminants were evaluated as COPCs: fluoride, arsenic, manganese, methylene chloride, and radioisotopic daughter products (e.g., neptunium-237). *AH*

Comment 2

[On] page 3, Scope of the 200-ZP-1 Groundwater Operable Unit Decision: The text states: "In addition to carbon tetrachloride, the other contaminants of concern (COCs) identified during the RI/FS process for the 200-ZP-1 groundwater are trichloroethylene (TCE), total and hexavalent chromium, nitrate, technetium-99, iodine-129, and tritium." It is requested that all RI/FS contaminants of potential concern (COPCs) be identified in this section. Considering the significant groundwater contamination in this operable unit, it is reasonable for the public to clearly understand how the COC list was developed. *AH*

Comment 3

It is requested that the Proposed Plan identify if the laboratory analytical method-based approach for identifying COPCs was utilized. If not, it is requested that the proposed plan include an explanation of how the COPC list was developed. *AH*

Comment 4

Due to this reviewer's concern regarding the adequacy of the COPC and COC lists, it is requested that the Proposed Plan included an identification and description of all groundwater observations of contaminant concentrations exceeding MCLs. For example, arsenic was detected at levels above the 10-µg/L drinking water standard in well 299-W10-4 during FY 2007. Note: this reviewer's review of the referenced documents did not identify where this issue was addressed. *AH*

Comment 5

On page 5, under groundwater extraction and treatment ("pump-and-treat") component: the sentence beginning with "Except for nitrate" should be re-written to clearly indicate that nitrate concentrations re-injected back into the aquifer will satisfy the cleanup level as is described later on page 5. *AH*

Comment 6

The text is silent about the role of waste management in contributing to groundwater contamination. Specifically, the tanks farms and cribs, ponds, lagoons, ditches, etc. were very likely more responsible for contaminating the 200-ZP-1 OU groundwater than the waste production facilities. If this proposed plan and eventual ROD (which should be interim) will not address contamination, remediation, and applicable requirements associated with land-based units (both TSDs and solid waste management units), the text should clearly identify that those units (which are more important to contributing to groundwater contamination than the waste production facilities) and the contamination from those units that contributed to the groundwater contamination are not being addressed by this Proposed Plan or eventual ROD (which should be interim) and will be addressed by RCRA/MTCA corrective actions via the RCRA Hanford Site permit. *AH*

Comment 7

It is recommended that this section identify RCRA TSD units within the source OU. Specifically, this section should describe the following TSD units: T Tank Farm, TX-TY Tank Farm, Low Level Waste Management Area (LLWMA) 3, and LLWMA 4. *AH*

Comment 8

[On] page 6, Site Background: it is recommended that this section describe the State-Approved Land Disposal [SALD] unit's association with this OU. *AH*

Comment 9

[On] page 6, Site Background: it is recommended that this section identify RCRA past practice and CERCLA past practice units which may have contributed to or are considered potential "contributors" to the groundwater contamination addressed by this Proposed Plan. *AH*

Comment 10

[On] page 6, Interim Actions: the text states: "This remediation system extracts groundwater downgradient from the former disposal sites where carbon tetrachloride contamination impacted the groundwater." Because all sources of carbon tetrachloride groundwater contamination may not have been identified (i.e., characterization associated with the 200-SW-1/2 OU and the 200-IS-1 OU are only in the initial phases), it is recommended that the word "identified" be inserted between the words "the" and "former" to read: "…downgradient from the identified former disposal sites where…" *AH*

Comment 11

[On] page 6, Interim Actions: It is requested that the description of the interim actions include an identification of the most recent estimates of carbon tetrachloride inventories (DOE/RL-2006-58) as between 570,000 and 920,000 kilograms of carbon tetrachloride discharged to three waste sites (216-Z-9, 216-Z-1A, and 216-Z-18). *AH*

Comment 12

[On] page 6, under Interim Actions: It is requested that the description of the interim actions include an identification of source term carbon tetrachloride inventories (DOE/RL-2007-22) which estimate carbon tetrachloride in the unconfined aquifer. Specifically, dissolved carbon tetrachloride is estimated to be 55,900 to 64,500 kilograms with 44,500 to 51,400 kilograms sorbed to the aquifer sediments. *AH*

Comment 13

It is requested that the description of the interim actions include an identification of source term carbon tetrachloride inventories (DOE/RL-2007-22) which estimate 13,700 to 15,800 kilograms of carbon tetrachloride has degraded to chloroform below the water table. *AH*

Comment 14

[On] page 7, Interim Actions: the text states: "The interim 200-ZP-1 groundwater extraction and treatment system will therefore continue to operate until the final remedy is in place and is operational as a result of the decisions under this Proposed Plan." It is recommended that the text be re-written to indicate that the extraction and treatment system will continue to operate after the modification of the interim action (as described in this Proposed Plan) is in place and portions will be evaluated for shut-down if it is concluded that the soil extraction treatment system should not be expanded and/or would no longer be effective with expansion to augment the expanded groundwater pump-and-treat remediation. In the "Integration of Cleanup for Soil and Groundwater" section of this Proposed Plan, it is indicated that the two OUs are integrated. With statements of shutting down the existing pump-and-treat remedy without evaluating the effects associated with the soil remediation, it does not appear the two remediation's are as integrated as suggested. In addition, there is concern that with the operation of the massive pump-and-treat system, additional unsaturated zone will be made available for treatment for which "focused" pump-and-treat (which currently is being performed) may be effective or may effectively augment the soil remediation. It is requested that the option to continue and/or expand the current pump-and-treat system be included in this Proposed Plan. From the description of the current pump-and-treat system included in the Proposed Plan, it can be concluded that the remediation has proven to be effective in removing 12 tons of carbon tetrachloride. Therefore, after the expanded groundwater pump-and-treat system is operational, at the very most, the "focused" pump-and-treat system should be shut down only to perform a rebound study with the option to re-start and/or expand the "focused" system if determined necessary for or effective at removing carbon tetrachloride. *AH*

Comment 15

After the Interim Actions section, it is recommended that an additional section be added which describes the most recent 5-year ROD review that have been performed. It is recommended that an excellent status of the 5-year review action items is provided in the annual groundwater monitoring report (DOE/RL-2008-01, Rev. 0). *AH*

Comment 16

After the Interim Actions section, it is recommended that an additional section be added which describes the most recent 5-year ROD reviews that have been performed. It is recommended that the text clearly identify that a protectiveness determination for the pump-and-treat interim remedy was deferred until a "final remedy" was selected through this process. It is requested that the text clearly identify that insufficient information existed at the time to make the protectiveness determination for the pump-and-treat interim remedy and as such, the determination should have clearly been that there was insufficient information to make the protectiveness determination. Clearly, the purpose of the 5-year ROD reviews is to make such determinations, not to defer the determination. Such lack of determination can be concluded to represent a significant deficiency associated with the characterization information that would have allowed the determination of which the 5-year ROD review intended. *AH*

Comment 17

For Figures 5 and 6 (page 11), Figure 8 (page 12), and Figure 9 (page 13): It is requested that all figures identify the depth below the water table that the contamination plume is being depicted. *AH*

Comment 18

In the plan, there are three statements made describing the pump-and-treat process that are clearly in error. They state that the treated COCs are re-injected into the groundwater. Page 5, 1st bullet, 2nd paragraph, line 3: the revised statements should read: Following extraction, the groundwater will be treated to achieve the proposed cleanup levels for COCs (shown in Table 4). The treated water is then returned to the aquifer through injection wells. Page 20, 2nd column, 2nd paragraph: same correction as above. Page 20, 2nd column, 4th paragraph, line 5: the revised statements should read: as with the other COCs, the water captured by pumping will be treated to meet the proposed cleanup levels for nitrate (shown in Table 4). The treated water is then returned to the aquifer through injection wells. *RS*

Comment 19

One editorial choice not made that would have helped the readers and reviewers very much is the use of pinpoint citations (telling the reader which sections or pages of other documents that the writer is specifically referring to, rather than simply listing entire documents). An appendix of references consisting entirely of an alphabetical list of thirty-three documents – many book length – does nothing to help a reviewer understand the plan or its technical basis. Pinpoint citations let reviewers follow the logic of the analyses presented and, therefore, offer more useful comments and questions. Along those lines, the plan should explain what "supporting documents" are and their relationship to the references. *ODOE*

Summary of Comments and Issues Raised Concerning the Content of the Proposed Plan

Comments 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 15, and 16 request additional detail to be added to the Proposed Plan in the following subject areas:

- Identification and discussion of specific COPCs identified throughout the RI/FS process and the protocol used to arrive at the list of COCs.
- Discussion as to whether the "laboratory analytical method-based approach" for identifying COPCs was used.
- Identification and description of all groundwater contaminant concentrations exceeding MCLs.
- Role of the tanks, cribs, ponds, lagoons, ditches, etc. in contributing contamination to the 200-ZP-1 OU groundwater.
- The association of the SALDS association with the 200-ZP-1 OU.
- Identification and description of RCRA TSD units and a discussion of documented or potential contributors of contamination to groundwater organized by whether the unit is a RCRA past-practice unit or a CERCLA past-practice unit.
- Additional information relative to sources of carbon tetrachloride.

- Identification of the most recent estimates of carbon tetrachloride inventories discharged to waste sites and resident in the groundwater as well as estimate of chloroform inventory in groundwater.
- Description and details of the most recent 5-year ROD review conducted for the existing interim action, including rationale for deferring protectiveness determination at that time.
- Depict the depth the contamination plumes are below the water table for Figures 5, 6, 7, and 8.

Comments 5, 14, 17, 18, and 19 reflect requests for general revisions.

RESPONSE TO COMMENTS:

The development of the documents for the 200-ZP-1 OU (i.e., remedial investigation, FS/baseline risk assessment, and Proposed Plan) followed the National Contingency Plan and EPA guidance (EPA 1999) in terms of style and content. The Proposed Plan is required to briefly describe the remedial alternatives analyzed, propose a preferred alternative, and summarize the information relied upon to select the preferred alternative. However, the CERCLA process provides detailed support information, including in the remedial investigation report, FS, and other supporting documents. CERCLA also requires that these supporting documents be available to the public in the administrative record for the site. In this way, anyone interested in additional detail can refer to the supporting documents required as part of the CERCLA process.

The information requested to be included in the Proposed Plan in comments 1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 15, and 16 is available in the 200-ZP-1 Administrative Record. Details requested on COPCs, COCs, and the analytical methods used are provided in the remedial investigation report (Section 1.4 of DOE/RL-2006-24, and Appendices A and C of DOE/RL-2003-55) and the baseline risk assessment (Appendix A of the FS [DOE/RL-2007-28]). Although, refinement of the COPC list occurs through the FS and some additional content is provided there.

Detailed descriptions of the sources of contamination, waste disposal practices, and potential secondary sources of contamination including a discussion of the production facilities, cribs, ponds, trenches and TSD units: T Tank Farm, TX-TY Tank Farm, Low-Level Waste Management Area (LLWMA) 3, and LLWMA-4 and the SALDS, are provided in the remedial investigation report (Sections 3.2 and 3.4 of DOE/RL-2006-24), and summary descriptions are provided in the FS (Section 2.4 of DOE/RL-2007-28).

Information pertinent to carbon tetrachloride inventories are provided in the remedial investigation report (Table 1-9 of DOE/RL-2006-24) and the FS (pages 2-14 and 2-16 of DOE/RL-2007-28). Degradation of carbon tetrachloride to chloroform and other compounds is discussed in the remedial investigation report (pages 4-15 to 4-19 of DOE/RL-2006-24).

As noted by the commenter, "…an excellent status of the 5-year review action items is provided in the annual groundwater monitoring report (Section 1.6 of DOE/RL-2008-01, Rev. 0)." For discussion surrounding the 5-year review, see the "ROD: Inclusion of 5-Year Review and Interim ROD Issues" response section.

If there are significant changes to the remedy that arise out of comments to the Proposed Plan, those changes are discussed as part of the ROD and other appropriate post-ROD CERCLA documents where necessary. Proposed plans are not typically revised and reissued, therefore, comments on this Proposed Plan requesting clarifications are addressed via the response process.

Re: Treatment of nitrate in extracted groundwater prior to injection: As noted above, the Proposed Plan will not be revised. However, the selected remedy requires that nitrate in the extracted groundwater be treated to the cleanup level (or lower before returning the water to the aquifer via injection.

Re: Role and operation of the existing Interim Action with respect to implementation of the proposed action: As noted above, the Proposed Plan will not be revised. The extraction and treatment system may be incorporated into the significantly expanded system. The entire system, both existing and planned expansion, will be designed to effectively capture and treat the contamination throughout the 200-ZP-1 OU aquifer.

Re: Identifying the depth below the water table for Figures 5, 6. 7, and 8: Figures 5, 6, 7, and 8 of the Proposed Plan reflect non-depth discrete results for groundwater from all wells monitored within the 200-ZP-1 OU. Generally the wells are screened in the upper one-third of one-half of the aquifer.

Re: Correct text to reflect that treated water is re-injected into the groundwater: The Proposed Plan will not be revised. The ROD does describe that the groundwater will be reinjected in to the aquifer at or below the levels show in Table 11of this ROD.

Re: Use of pinpoint citations: Thank you for the suggestion. We tried to convey the extensive reference list in the most direct manner, and used the pinpoint citations in our responses to ensure the information cited in reference materials were easier to access.

GENERAL COMMENTS

Comment 1

[On] pages 10-13, Figures 3-9: It is requested that the MTCA point of compliance be shown on each figure. If the point of compliance is the outer boundary of the operable unit, it is also requested that an identification of the MTCA decision-making process for that point of compliance be included in the Proposed Plan. If the point of compliance is the outer boundary of the OU, it is also requested that an identification of the lack of conservatism associated with the risk assessment be included in the Proposed Plan. *AH*

RESPONSE TO COMMENT:

The ROD requires actions to return the 200-ZP-1 groundwater to beneficial use; thus, at the conclusion of the remedy, the point of compliance will be throughout the plume.

Comment 2

It is my opinion that there should be no re-negotiation of any cleanup deadline. The cleanup budget needs to be increased to meet currently scheduled mileposts. *SH*

RESPONSE TO COMMENT:

Thank you for your interest in the cleanup of Hanford. This comment addresses a larger issue than this specific action and will be considered in the broader cleanup context.

Comment 3

We believe that the projected cost ($174 million) and time frame for completion of the remediation (125 years) are overly conservative. *NPT*

RESPONSE TO COMMENT:

As discussed in earlier responses, the projected costs and timeframes are an estimate for comparative purposes. The Tri-Parties believe the money and timeframes are appropriate given our understanding of the needed action as system will be designed to meet the ROD requirement of reducing the mass by 95% within a 25-year timeframe.

Comment 4

ERWM would appreciate timely participation in the further development of the remediation approach for the groundwater in the 200 West Area. *NPT*

RESPONSE TO COMMENT:

The Tri-Parties welcome the Nez Perce Tribes participation as we move forward with implementation of this remedy.

Comment 5

On page 2, under Agency Involvement in This Proposed Plan: the text includes the statement: "Ecology has concurred with the preferred alternative." It is requested that a reference be included which directs the reader to the documentation of Ecology's concurrence. *AH*

RESPONSE TO COMMENT:

See the State acceptance language located in Section 10.8 of this ROD.

Comment 6

Currently, it appears to us that DOE is underestimating the potential for actinide mobility in the vadose zone and the potential impact of actinide migration to groundwater. *NPT*

RESPONSE TO COMMENT:

Monitoring data indicate that the actinides are not moving in the vadose zone. As described in an earlier response, billions of gallons of water mixed with contaminants were disposed to the soil. The large volume of water moved contamination deeper in to the vadose zone during active plant operation. Water discharges have ceased and there is no longer a driving force to move the actinides through the soil column. The actinides include plutonium and americium, and they each bind tightly to soil.

REFERENCES

DOE/RL-2003-55, 2004, *Remedial Investigation/Feasibility Study Work Plan for the 200-ZP-1 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2006-24, 2006, *Remedial Investigation Report for the 200-ZP-1 Groundwater Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA FOR THE 200-ZP-1 OPERABLE UNIT

The selected final remedy shall attain all Federal and State ARARs, as required by 40 CFR 300.430(f)(5)(ii)(B) and (C). No ARARs were waived for this action.

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Table A-1. Identification of Federal Applicable or Relevant and Appropriate Requirements. (2 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
"National Primary Drinking Water Regulations," 40 CFR 141			
"Maximum Contaminant Levels for Organic Contaminants," 40 CFR 141.61	ARAR	Establishes MCLs for drinking water that are designed to protect human health from the potential adverse effects of organic contaminants in drinking water.	The groundwater in the 200-ZP-1 Groundwater OU is not currently used for drinking water. However, Central Plateau groundwater is considered a potential drinking water source and, because the groundwater discharges to the Columbia River (which is used for drinking water), the substantive requirements in 40 CFR 141.61 for organic constituents are applicable. This requirement is chemical-specific.
"Maximum Contaminant Levels for Inorganic Contaminants," 40 CFR 141.62	ARAR	Establishes MCLs for drinking water that are designed to protect human health from the potential adverse effects of inorganic contaminants in drinking water.	The groundwater in the 200-ZP-1 Groundwater OU is not currently used for drinking water. However, Central Plateau groundwater is considered a potential drinking water source and, because the groundwater discharges to the Columbia River (which is used for drinking water), the substantive requirements in 40 CFR 141.62 for inorganic constituents are applicable. This requirement is chemical-specific.
"Maximum Contaminant Levels for Radionuclides," 40 CFR 141.66	ARAR	Establishes MCLs for drinking water that are designed to protect human health from the potential adverse effects of radionuclides in drinking water.	The groundwater in the 200-ZP-1 Groundwater OU is not currently used for drinking water. However, Central Plateau groundwater is considered a potential drinking water source and because the groundwater discharges to the Columbia River (which is used for drinking water), the substantive requirements in 40 CFR 141.66 for radionuclides are applicable. This requirement is chemical-specific.
Other Federal ARARs			
Archeological and Historic Preservation Act, 16 U.S.C. 469aa-mm, et seq.	ARAR	Requires that remedial actions at the 200-ZP-1 Groundwater OU do not cause the loss of any archaeological or historic data. This act mandates preservation of the data and does not require protection of the actual historical sites.	Archeological and historic sites have been identified within the 200 Areas; therefore, the substantive requirements of this act are applicable to actions that might disturb these sites. This requirement is action-specific.
National Historic Preservation Act of 1966, 16 U.S.C. 470, Section 106, et seq.	ARAR	Requires Federal agencies to consider the impacts of their undertaking on cultural properties through identification, evaluation and mitigation processes.	Cultural and historic sites have been identified within the 200 Areas; therefore, the substantive requirements of this act are applicable to actions that might disturb these types of sites. This requirement is location-specific.

Table A-1. Identification of Federal Applicable or Relevant and Appropriate Requirements. (2 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
Native American Graves Protection and Repatriation Act, 25 U.S.C. 3001, et seq.	ARAR	Establishes Federal agency responsibility for discovery of human remains, associated and unassociated funerary objects, sacred objects, and items of cultural patrimony.	Substantive requirements of this act are applicable if remains and sacred objects are found during remediation. This is a location-specific requirement.
Endangered Species Act of 1973, 16 U.S.C. 1531, et seq., subsection 16 USC 1536(c)	ARAR	Establishes requirements for actions by Federal agencies that are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. If remediation is within critical habitat or buffer zones surrounding threatened or endangered species, mitigation measures must be taken to protect the resource.	Substantive requirements of this act are applicable if threatened or endangered species are identified in areas where remedial actions will occur. This is a location-specific requirement.
Interim Control of Hazardous Waste Injection 42 U.S.C. 6939b sec. 3020(b)	ARAR	Establishes requirements to allow injection of groundwater that contains hazardous waste back into the aquifer during implementation of the CERCLA remedy.	Substantive requirements of the section are applicable to the injection of contaminated groundwater to the aquifer during the remedy. The injection standards for this remedy are specified in Table 11 of this ROD.
40 CFR 61, Subpart H	ARAR	Radionuclide airborne emissions from the facility shall be controlled so as not to exceed amounts that would cause an exposure to any member of the public of greater than 10 mrem/yr effective dose equivalent.	Substantive requirements of this standard are applicable because this remedial action may provide airborne emissions of radioactive particulates to unrestricted areas. As a result, requirements limiting emissions apply. This is a risk-based standard for the purposes of protecting human health and the environment. This requirement is action-specific.

ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
MCL = maximum contaminant level
OU = operable unit
USC = United States Code
WAC = *Washington Administrative Code*

Table A-2. Identification of State Applicable and Relevant or Appropriate Requirements. (7 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
"Model Toxics Control Act," WAC 173-340			
"Standard Method B Potable Ground Water Cleanup Levels," WAC 173-340-720(4)(b)(iii)(A) and (B)	ARAR	Use of Method B equations 720-1 and 720-2 to calculate groundwater cleanup levels for noncarcinogens and carcinogens, respectively.	The groundwater in the 200-ZP-1 Groundwater OU is not currently used for drinking water. However, the ARAR requires that the groundwater cleanup levels shall be based on the highest beneficial use both current and potential future site use. The Central Plateau and the 200-ZP-1 OU groundwater is considered potable under WAC 173-340-720. The substantive requirements are WAC 173-340-720(4)(b)(iii)(A) and (B). This requirement is chemical-specific.
"Adjustments to Cleanup Levels," WAC 173-340-720(7)(b)	ARAR	Requires an adjustment downward of Method B groundwater cleanup levels based on an existing state or Federal cleanup standard so that the total excess cancer risk does not exceed 1×10^{-5} and the hazard index does not exceed 1.	The groundwater in the 200-ZP-1 Groundwater OU is not currently used for drinking water. However, the ARAR requires that the groundwater cleanup levels shall be based on the highest beneficial use both current and potential future site use. The Central Plateau and the 200-ZP-1 OU groundwater is considered potable under WAC 173-340-720. The substantive requirement is WAC 173-340-720(7)(b). This requirement is chemical-specific.
"Dangerous Waste Regulations," WAC 173-303			
"Identifying Solid Waste," WAC 173-303-016	ARAR	Identifies those materials that are and are not solid wastes.	Substantive requirements of these regulations are applicable because they define which materials are subject to the designation regulations. Specifically, materials that are generated during the remedial action would, if a solid waste, be subject to the requirements for solid wastes. This requirement is action-specific.
"Recycling Processes Involving Solid Waste," WAC 173-303-017	ARAR	Identifies materials that are and are not solid wastes when recycled.	Substantive requirements of these regulations are applicable because they define which materials are subject to the designation regulations. Specifically, materials that are generated during the remedial action would if a solid waste be subject to the requirements for solid wastes. This requirement is action-specific.
"Designation of Dangerous Waste," WAC 173-303-070(3)	ARAR	Establishes whether a solid waste is, or is not, a dangerous waste or an extremely hazardous waste.	Substantive requirements of these regulations are applicable to materials generated during the remedial action. Specifically, solid waste that is generated during this remedial action would if a dangerous waste be subject to the dangerous waste requirements. This requirement is action-specific.

Table A-2. Identification of State Applicable and Relevant or Appropriate Requirements. (7 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
"Excluded Categories of Waste," WAC 173-303-071	ARAR	Describes those categories of wastes that are excluded from the requirements of WAC 173-303 (excluding WAC 173-303-050).	This regulation is applicable to remedial actions in the 200-ZP-1 Groundwater OU should wastes identified in WAC 173-303-071 be generated. This requirement is action-specific.
"Conditional Exclusion of Special Wastes," WAC 173-303-073	ARAR	Establishes the conditional exclusion and the management requirements of special wastes, as defined in WAC 173-303-040.	Substantive requirements of these regulations are applicable to special wastes generated during the remedial action. Specifically, the substantive standards for management of special waste are relevant and appropriate to the management of special waste that will be generated during the remedial action. This requirement is action-specific.
"Requirements for Universal Waste," WAC 173-303-077	ARAR	Identifies those wastes exempted from regulation under WAC 173-303-140 and WAC 173-303-170 through 173-303-9906 (excluding WAC 173-303-960). These wastes are subject to regulation under WAC 173-303-573.	Substantive requirements of these regulations are applicable to universal waste generated during the remedial action. Specifically, the substantive standards for management of universal waste are relevant and appropriate to the management of universal waste that will be generated during the remedial action. This requirement is action-specific.
"Recycled, Reclaimed, and Recovered Wastes," WAC 173-303-120 Specific subsections: WAC 173-303-120(3) WAC 173-303-120(5)	ARAR	These regulations define the requirements for recycling materials that are solid and dangerous waste. Specifically, WAC 173-303-120(3) provides for the management of certain recyclable materials, including spent refrigerants, antifreeze, and lead-acid batteries. WAC 173-303-120(5) provides for the recycling of used oil.	Substantive requirements of these regulations are applicable to certain materials that might be generated during the remedial action. Eligible recyclable materials can be recycled and/or conditionally excluded from certain dangerous waste requirements. This requirement is action-specific.
"Land Disposal Restrictions," WAC 173-303-140(4)	ARAR	This regulation establishes state standards for land disposal of dangerous waste and incorporates, by reference, Federal land-disposal restrictions of 40 CFR 268 that are relevant and appropriate to solid waste that is designated as dangerous or mixed waste in accordance with WAC 173-303-070(3).	The substantive requirements of this regulation are applicable to materials generated during the remedial action. Specifically, dangerous/mixed waste that is generated during the remedial action would be subject to the relevant and appropriate substantive land-disposal restrictions. The offsite treatment, disposal or management of such waste would be subject to all applicable substantive and procedural laws and regulations, including LDR requirements. This requirement is action-specific.

Table A-2. Identification of State Applicable and Relevant or Appropriate Requirements. (7 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
"Requirements for Generators of Dangerous Waste," WAC 173-303-170	ARAR	Establishes the requirements for dangerous waste generators.	Substantive requirements of these regulations are applicable to materials generated during the remedial action. Specifically, the substantive standards for management of dangerous/mixed waste are relevant and appropriate to the management of dangerous waste that will be generated during the remedial action. For purposes of this remedial action, WAC 173-303-170(3) includes the substantive provisions of WAC 173-303-200 by reference. WAC 173-303-200 further includes certain substantive standards from WAC 173-303-630 and -640 by reference. This requirement is action-specific.
"Corrective Action Dangerous Waste Regulation Requirements," WAC 173-303-64620(4)	ARAR	Requires Corrective Action to be "consistent with" specified section in WAC 173-340.	The substantive portions of this regulation establish minimum requirements for HWMA corrective action.
"Minimum Functional Standards for Solid Waste Handling," WAC 173-304 and "Solid Waste Management — Reduction and Recycling," RCW 70.95			
"Minimum Functional Standards for Solid Waste Handling" WAC 173-304 Specific subsections: WAC 173-304-190, WAC 173-304-200(2) WAC 173-304-460 "Solid Waste Management — Reduction and Recycling," RCW 70.95	ARAR	Establishes the requirements for the onsite storage of solid wastes that are not radioactive or dangerous wastes.	Substantive requirements of these regulations are applicable to materials generated during the remedial action. Specifically, nondangerous, nonradioactive solid wastes (i.e., hazardous substances that are only regulated as solid waste) that will be containerized for removal from the CERCLA site would be managed onsite according to the substantive requirements of this standard. This requirement is action-specific.

Table A-2. Identification of State Applicable and Relevant or Appropriate Requirements. (7 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
"Solid Waste Handling Standards," WAC 173-350			
"On-Site Storage, Collection and Transportation Standards," WAC 173-350-300	ARAR	Establishes the requirements for the temporary storage of solid waste in a container onsite and the collecting and transporting of the solid waste.	The substantive requirements of this newly promulgated rule are applicable to the onsite collection and temporary storage of solid wastes for the 200-ZP-1 Groundwater OU remediation activities. Compliance with this regulation is being implemented in phases for existing facilities. These requirements are location specific.
"Minimum Standards for Construction and Maintenance of Wells," WAC 173-160			
WAC 173-160-161	ARAR	Identifies well planning and construction requirements.	The substantive requirements of these regulations are ARAR to actions that include construction of wells used for groundwater extraction, monitoring, or injection of treated groundwater or wastes. The substantive requirements of WAC 173-160-161, 173-160-171, 173-160-181, 173-160-400, 173-160-420, 173-303-430, 173-160-440, 173-160-450, and 173-160-460 are relevant and appropriate to groundwater well construction, monitoring, or injection of treated groundwater or wastes in the 200-ZP-1 Groundwater OU. These requirements are action-specific.
WAC 173-160-171	ARAR	Identifies the requirements for locating a well.	
WAC 173-160-181	ARAR	Identifies the requirements for preserving natural barriers to groundwater movement between aquifers.	
WAC 173-160-400	ARAR	Identifies the minimum standards for resource protection wells and geotechnical soil borings.	
WAC 173-160-420	ARAR	Identifies the general construction requirements for resource protection wells.	
WAC 173-160-430	ARAR	Identifies the minimum casing standards.	
WAC 173-160-440	ARAR	Identifies the equipment cleaning standards.	
WAC 173-160-450	ARAR	Identifies the well sealing requirements.	
WAC 173-160-460	ARAR	Identifies the decommissioning process for resource protection wells.	

Table A-2. Identification of State Applicable and Relevant or Appropriate Requirements. (7 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
"Underground Injection Control," WAC 173-218			
WAC 173-218-040	ARAR	Identifies what an injection well is and types of prohibited wells.	The substantive requirements of these regulations are ARAR to actions that discharge liquid effluents to injection wells. WAC 173-218-040(4) allows for injection of treated groundwater into the same formation from where it was drawn as part of a removal or remedial action approved by EPA in accordance with CERCLA. This requirement is action-specific.
WAC 173-218-120	ARAR	Identifies the requirements for decommissioning a UIC well.	Periodically, over the course of the remedy injection wells will need to be removed from service and decommissioned. In the event of injection well decommissioning, WAC 173-218-120 is ARAR. This requirement is action-specific.
"General Regulations for Air Pollution Sources," WAC 173-400			
"General Standards for Maximum Emissions," WAC 173-400-040 WAC 173-400-113	ARAR	Requires all sources of air contaminants to meet emission standards for visible, particulate, fugitive, odors, and hazardous air emissions. Requires use of reasonably available control technology. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	Substantive requirements of these standards are ARAR to this remedial action because there may be visible, particulate, fugitive, and hazardous air emissions and odors resulting from remedial activities. As a result, standards established for the control and prevention of air pollution are relevant and appropriate. This requirement is action-specific.
"Controls for New Sources of Toxic Air Pollutants," WAC 173-460			
"Controls for New Sources of Toxic Air Pollutants," WAC 173-460 Specific subsections: WAC 173-460-030 WAC 173-460-060	ARAR	Requires that new sources of air emissions meet emission requirements identified in this regulation. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	Substantive requirements of these standards are ARAR to this remedial action because there is the potential for toxic air pollutants to become airborne as a result of remedial activities. As a result, standards established for the control of toxic air contaminants are relevant and appropriate. This requirement is action-specific.

Table A-2. Identification of State Applicable and Relevant or Appropriate Requirements. (7 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
"Ambient Impact Requirement," WAC 173-460-070	ARAR	The owner/operator of a new toxic air pollutant source that is likely to increase toxic air pollutant emissions shall demonstrate that emissions from the source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	The substantive requirements of this standard are ARAR to remedial actions in the 200-ZP-1 Groundwater OU, should the remedial action result in the treatment of the soil or debris that contains contaminants of concern identified in the regulation as a toxic air pollutant. This requirement is action-specific.
"Ambient Air Quality Standards and Emission Limits for Radionuclides," WAC 173-480			
"General Standards for Maximum Permissible Emissions," WAC 173-480-050(1)	ARAR	Determine compliance with the public dose standard by calculating exposure at the point of maximum annual air concentration in an unrestricted area where any member of the public may be. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	Substantive requirements are ARAR when fugitive and diffuse emissions resulting from excavation occur and related activities will require assessment and reporting. This requirement is action-specific.
"Compliance," WAC 173-480-070(2)	ARAR	Requires that radionuclide emissions compliance shall be determined by calculating the dose to members of the public at the point of maximum annual air concentration in an unrestricted area where any member of the public may be. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	The substantive requirements of this standard are ARAR to remedial actions involving disturbance or ventilation of radioactively contaminated areas or structures, because airborne radionuclides may be emitted to unrestricted areas where any member of the public may be. This requirement is action-specific.
"Radiation Protection -- Air Emissions," WAC 246-247			
"National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," WAC 246-247-035(1)(a)(ii)	ARAR	This regulation incorporates requirements of 40 CFR 61, Subpart H by reference. Radionuclide airborne emissions from the facility shall be controlled so as not to exceed amounts that would cause an exposure to any member of the public of greater than 10 mrem/yr effective dose equivalent. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	Substantive requirements of this standard are ARAR because this remedial action may provide airborne emissions of radioactive particulates to unrestricted areas. As a result, requirements limiting emissions apply. This is a risk-based standard for the purposes of protecting human health and the environment. This requirement is action-specific.

Table A-2. Identification of State Applicable and Relevant or Appropriate Requirements. (7 sheets)

ARAR Citation	ARAR	Requirement	Rationale for Use
"General Standards," WAC 246-247-040(3), WAC 246-247-040(4)	ARAR	Emissions shall be controlled to ensure that emission standards are not exceeded. Actions creating new sources or significantly modified sources shall apply best available controls. All other actions shall apply reasonably achievable controls. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	Substantive requirements of this standard are ARAR because fugitive, diffuse and point source emissions of radionuclides to the ambient air may result from remedial activities, such as excavation of contaminated soils and operation of exhauster and vacuums, performed during the remedial action. This standard exists to ensure compliance with emission standards. This requirement is action-specific.
"Monitoring, Testing, and Quality Assurance," WAC 246-247-075(1), (2), (3), and (4)	ARAR	Emissions from non-point and fugitive sources of airborne radioactive material shall be measured. Measurement techniques may include, but are not limited to, sampling, calculation, smears, or other reasonable method for identifying emissions as determined by the lead agency. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	Substantive requirements of this standard are ARAR when fugitive and non-point source emissions of radionuclides to the ambient air may result from activities, such as operation of exhauster and vacuums, performed during a remedial action. This standard exists to ensure compliance with emission standards. This requirement is action-specific.
"Monitoring, Testing, and Quality Assurance," WAC 246-247-075(8)	ARAR	Facility (site) emissions resulting from non-point and fugitive sources of airborne radioactive material shall be measured. Measurement techniques may include ambient air measurements, or in-line radiation detector or withdrawal of representative samples from the effluent stream, or other methods as determined by the lead agency. This state regulation is as (or more) stringent than the equivalent Federal program requirement.	Substantive requirements are ARAR when fugitive and diffuse emissions of airborne radioactive material due to excavation and related activities occur and will require measurement. This requirement is action-specific.

ARAR = applicable or relevant and appropriate requirement
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR = *Code of Federal Regulations*
HWMA = *Hazardous Waste Management Act of 1976*
LDR = land disposal restrictions
OU = operable unit
UIC = Underground Injection Control (Program)
WAC = *Washington Administrative Code*

Table A-3. Identification of To Be Considered Criteria

Criteria To Be Considered	Rationale for Use
Criteria To Be Considered	
Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (DOE/EIS-0222F, 1999).	Established the future land-use projections for the Central Plateau.
OSWER Directive 9200.4-17P, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*	Provided the framework and appropriateness for using the MNA as a remedy component for organic and inorganic contaminants.
Response to HAB Advice #132, Exposure Scenarios Task Force on the 200 Area (Klein et al. 2002)	Provided the basis for the reasonableness of the estimated cleanup time for the selected remedy.
OSWER Directive 9234.1, *Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26*	Provided the basis for the acceptability of reinjection of treated groundwater containing listed dangerous wastes under RCRA.

HAB = Hanford Advisory Board
MNA = monitored natural attenuation
OSWER = Office of Solid Waste and Emergency Response
RCRA = *Resource Conservation and Recovery Act of 1976*

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- 40 CFR 61 Subpart H, "National Emission Standards of Radionuclides Other Than Radon from Department of Energy Facilities"

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- 40 CFR 141.61, "Maximum Contaminant Levels for Organic Constituents"
- 40 CFR 141.62, "Maximum Contaminant Levels for Inorganic Constituents"
- 40 CFR 141.66, "Maximum Contaminant Levels for Radionuclides"

40 CFR 268, "Land Disposal Restrictions", *Code of Federal Regulations*.

40 CFR 300.430, "Remedial Investigation/Feasibility Study and Selection of Remedy" *Code of Federal Regulations*.

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Klein et al, 2002, Response to HAB Advice #132, *Consensus Advice #132: Exposure Scenarios Task Force on the 200-Area*, letter dated July 2002, U.S. Department of Energy, Richland, Washington.

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OSWER Directive 9234.1, 1989, *Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

RCW 70.95, "Solid Waste Management - Reduction and Recycling," *Revised Code of Washington*.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901, et seq.

- 42 U.S.C. 6939b Sec. 3020(b), "Interim Control of Hazardous Waste Injection."

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Toxic Substances Control Act of 1976, 15 U.S.C. 2601, et seq.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*.

- 173-160-161, "How Shall Each Water Well be Planned and Constructed?"
- 173-160-171, "What are the Requirements for the Location of the Well Site and Access to the Well?"
- 173-160-181, "What are the Requirements for Preserving the Natural Barriers to Ground Water Movement Between Aquifers?"
- 173-160-400, "What are the Minimum Standards for Resource Protection Wells and Geotechnical Soil Borings?"
- 173-160-420, "What are the General Construction Requirements for Resource Protection Wells?"
- 173-160-430, "What are the Minimum Casing Standards?"
- 173-160-440, "What are the Equipment Cleaning Standards?"
- 173-160-450, "What are the Well Sealing Requirements?"
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- 173-218-040, "UIC Well Classification Including Allowed and Prohibited Wells"
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- 173-303-016, "Identifying Solid Waste"
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- 246-247-035(1)(a)(ii), "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities"
- 246-247-040, "General Standards"
- 246-247-075, "Monitoring, Testing, and Quality Assurance"