RECORD OF DECISION
For Interim Remedial Action

HANFORD 200 AREA
SUPERFUND SITE
200-UP-1 OPERABLE UNIT

September 2012

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Acronyms

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BRA	baseline risk assessment
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CLARC	Cleanup Levels and Risk Calculations
COC	contaminant of concern
COPC	contaminant of potential concern
Cs-137	cesium-137
CSM	conceptual site model
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DST	double-shell tank
DWS	drinking water standard
Ecology	Washington State Department of Ecology
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERDF	Environmental Restoration Disposal Facility
ESD	explanation of significant difference
FS	feasibility study
FY	fiscal year
HCP-EIS	Hanford Comprehensive Land Use Plan-Environmental Impact Statement
HEAST	Health Effects Assessment Summary Tables
HEIS	Hanford Environmental Information System
HI	hazard index
HQ	hazard quotient
HSU	hydrostratigraphic unit
HWMA	Washington State *Hazardous Waste Management Act of 1976*
I-129	iodine-129
IRA	interim response action

IRIS	Integrated Risk Information System
K_d	distribution coefficient
MCL	maximum contaminant level
MIBK	methyl isobutyl ketone
MNA	monitored natural attenuation
MTCA	*Model Toxics Control Act*
N/A	not applicable *or* not analyzed
NBS	National Bureau of Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	*National Environmental Policy Act of 1969*
NPL	National Priorities List
NPV	net present value
O&M	operations and maintenance
OU	operable unit
P&T	pump-and-treat
PCE	tetrachloroethene
PFP	Plutonium Finishing Plant
PRG	preliminary remediation goal
PUREX	Plutonium-Uranium Extraction (Plant or process)
Ra	radium
RAD	radionuclide
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	*Revised Code of Washington*
RD/RA	Remedial Design/Remedial Action
REDOX	Reduction-oxidation (Plant or process)
RfD	reference dose
RI	remedial investigation
RL	DOE Richland Operations Office
ROD	record of decision
SAP	sampling and analysis plan
Sr-90	strontium-90
SST	single-shell tank
SVE	soil vapor extraction

SVOC	semivolatile organic compound
Tc-99	technetium-99
TCE	trichloroethene
TPA	Tri-Party Agreement (*Hanford Federal Facility Agreement and Consent Order)*
UCL	upper confidence limit
UIC	underground injection control
USACE	U.S. Army Corps of Engineers
USC	United States Code
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WMA	waste management area

PART I: DECLARATION OF THE RECORD OF DECISION

1.0 Site Name and Location

USDOE Hanford 200 Area
200-UP-1 Operable Unit
Benton County, Washington
CERCLIS ID: #WA 1890090078

2.0 Statement of Basis and Purpose

This decision document presents the Selected Interim Remedial Action for the 200-UP-1 Operable Unit (OU), which is part of the Hanford Site, 200 Area, in Benton County, Washington. This Record of Decision **(**ROD) supersedes the previous 200-UP-1 OU remedy decisions including the existing 200 Areas Interim Action ROD, February 1997 (EPA/ROD/R10-97/048) and the associated Explanation of Significant Differences for the Interim Action Record of Decision for the 200-UP-1 Groundwater Operable Unit, February 2009 (09-AMCP-0082).

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 [TPA]), and, to the extent practicable, the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* [C.F.R.] Part 300) (National Contingency Plan [NCP]). This decision is based on the Administrative Record file for this OU.

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

3.0 Assessment of Site

The response action selected in this Record of Decision 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 Selected Remedy

4.1 Overall Site Cleanup Strategy

The Central Plateau (200 Area National Priorities List [NPL] site) encompasses approximately 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 are grouped by geographic areas, process types, or cleanup components into multiple OUs. The Central Plateau OUs have been organized into two areas:

- ***The Inner Area*** is approximately 10 mi^2 (26 km^2) in the middle of the Central Plateau encompassing the region where chemical processing and waste management activities occurred. Cleanup levels for the Inner Area are expected to be based on industrial land use.

- ***The Outer Area*** is greater than 65 mi^2 (168 km^2) and includes much of the open area on the Central Plateau where limited processing activity occurred. Cleanup levels in the Outer Area are expected to be comparable to those being used for OUs along the Columbia River (River Corridor), which are for unrestricted surface use.

This ROD presents the selected interim remedial action for the 200-UP-1 OU as part of the overall groundwater remediation effort in the Central Plateau. The Central Plateau Inner Area is divided into the 200 West and 200 East Areas. Groundwater located in the 200 West Area is being addressed through separate CERCLA processes for the 200-ZP-1 and 200-UP-1 groundwater OUs. The remaining contaminated soil and facilities in the Inner Area and 200 East groundwater OUs will be addressed under separate CERCLA response actions for the corresponding OUs.

4.2 Principal Threat Wastes at the Site

The NCP (40 C.F.R. 300.430(a)(1)(iii)(A)) states that EPA expects to use treatment to address the principal threats posed by a site, wherever practicable. Principal threat wastes are source materials that are highly toxic or highly mobile that generally cannot be reliably contained or would pose a significant risk should exposure occur. Contaminated groundwater is generally not considered a principal threat waste because it has been impacted by releases from other sources or reservoirs of contamination that can be principal threat wastes (EPA, 1991, *A Guide to Principal Threat and Low Level Wastes*). Since the 200-UP-1 OU is a groundwater unit impacted by releases from other sources, principal threat wastes were not considered. The NCP expectation for contaminated groundwater is to return useable groundwater to its beneficial use wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site (40 C.F.R. § 300.430(a)(1)(iii)(F)).

4.3 Major Components of the Selected Remedy

The selected remedy for the 200-UP-1 OU addresses contaminated groundwater in the southern part of the 200 West Area. A brief description of the major components of the selected remedy is provided below.

4.3.1 Groundwater Extraction and Treatment Component

The groundwater extraction and treatment component will use a pump-and-treat system that will consist of a network of groundwater extraction wells, conveyance piping (with transfer pump stations), and use of the existing groundwater treatment facility in the 200 West Area, which will be modified to meet the 200-UP-1 OU selected remedy treatment requirements. Extraction wells will be designed and installed to remove contaminated groundwater from the aquifer and to reduce or prevent further plume migration. The pump-and-treat system will be designed and implemented in combination with monitored natural attenuation to achieve cleanup levels for all contaminants of concern (COCs) in the 200-UP-1 OU, except I-129, within the following time frames: 15 years for Tc-99, 25 years for uranium; 25 years for chromium (total and hexavalent) through pump-and-treat; 35 years for nitrate through pump-and-treat and monitored natural attenuation (MNA); and 125 years for carbon tetrachloride through pump-and-treat and MNA; and 25 years for tritium through MNA. Injection wells will be used to inject treated water back into the aquifer to provide flow path (gradient) control.

4.3.2 Monitored Natural Attenuation (MNA) Component

The selected remedy relies upon MNA for parts of the nitrate and carbon tetrachloride plumes and for the entire tritium plume. The parts of the nitrate plume that will be addressed through MNA are the diffuse (low-concentration) nitrate plume areas not captured by the pump-and-treat system. Carbon tetrachloride will require the longest MNA time frame estimated to be 125 years, which is consistent with the MNA timeframe for carbon tetrachloride identified in the ROD for the adjacent 200-ZP-1 OU. The tritium plume will be addressed through MNA due to its short radioactive half-life (12.3 years) and lack of an effective tritium groundwater treatment technology.

4.3.3 I-129 Hydraulic Containment and Treatment Technology Evaluation Component

The technology evaluation for I-129 that was completed as part of the feasibility study determined that there is no current treatment technology that can achieve the federal drinking water standard (DWS) of 1 pCi/L for the I-129 concentrations present in the 200-UP-1 OU. DOE will evaluate potential treatment options for I-129 as part of the selected remedy through further technology evaluation. If one or more viable technologies are identified, treatability tests will be conducted for those technologies. Hydraulic containment of the I-129 plume will be implemented until a subsequent remedial decision for the I-129 plume is made. Hydraulic containment will be performed using injection wells placed at the leading edge of the I-129 plume.

The selected remedy requires an interim waiver of the federal DWS of 1 pCi/L for I-129 which is an ARAR. In the event a viable treatment technology is not available, the use of a technical impracticability waiver under 40 CFR 300.430(f)(l)(ii)(c) may need to be considered as part of the final remedy.

4.3.4 Remedy Performance Monitoring Component

Remedy performance monitoring is required to be conducted over the life of the interim remedial action to evaluate and confirm its performance and optimize its effectiveness. Performance monitoring for the extraction and injection well network will include groundwater sampling and analysis for COCs, assessment of extraction well flow rates, and water level measurements. This will allow evaluation of each contaminant’s mass removal rate as well as determine the effectiveness of the injection well network to hydraulically contain the I-129 plume. Since cleanup decisions for the soil OUs located above the 200-UP-1 OU have not yet been identified, monitoring will also be conducted for the final contaminants of potential concern (COPCs), which include the COCs and the following contaminants: 1,4-dioxane, chloroform, tetrachloroethene, trichloroethene, and strontium-90. Monitoring for the final COPCs will help determine if they are impacting groundwater at concentrations that may pose an unacceptable risk to human health and the environment.

Performance monitoring of the 200 West Groundwater Treatment Facility includes sampling and analysis to evaluate the effectiveness of the facility to remove or treat COCs in extracted groundwater to meet treatment requirements before being returned to the aquifer. Performance monitoring will also be used to confirm that the natural attenuation processes for carbon tetrachloride, tritium and nitrate are performing as planned.

4.3.5 Institutional Controls Component

Institutional controls will be required for the 200-UP-1 OU as long as groundwater contamination precludes its use as a potential source of drinking water. These institutional controls include the requirement that DOE control access to groundwater to prevent exposure of humans to contaminated groundwater, except as otherwise authorized by EPA**,** and the requirement that DOE prohibit activities that would damage components of the remedy or disrupt or lessen performance of any component of the remedy, except as otherwise authorized in lead regulatory agency approved documents. The DOE is responsible for implementing, maintaining, reporting on, and enforcing the institutional controls required under this ROD. Although DOE may later transfer these procedural responsibilities to another party by contract, property conveyance agreement, or through other means, DOE shall retain ultimate responsibility for remedy integrity and institutional controls.

5.0 Statutory Determinations

Under CERLCA Section 121 and the NCP, 40 C.F.R. Section 300.430(f)(5)(ii), the lead agency must select remedies that are protective of human health and the environment and comply with applicable or relevant and appropriate requirements (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 off-site disposal of untreated wastes.

The Selected Remedy for the 200-UP-1 OU 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 (or satisfies requirements for a waiver), and is cost-effective. The Selected Remedy also utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The remedy for this OU satisfies the statutory preference for treatment as a principal element through the use of pump-and-treat technology to remove and treat contaminated groundwater which permanently and significantly reduces the toxicity, mobility, and volume of hazardous substances, pollutants, or contaminants.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action (and at 5 year intervals thereafter), in accordance with CERCLA Section 121(c) and the NCP, 40 C.F.R. Section 300.430(f)(4)(ii), to ensure that the remedy is, or will be, protective of human health and the environment.

6.0 ROD Data Certification Checklist

The information outlined in Table 1 is included in the Decision Summary (Part II) of this ROD. Additional information can be found in the Administrative Record for this OU.

Table 1. 200-UP-1 OU ROD Data Certification Checklist

Information	Location in ROD
Contaminants of Concern (COCs) and their respective concentrations	Section 7
Baseline risk represented by the COCs	Section 7
Cleanup levels established for COCs and the basis for these levels	Table 14
How source materials constituting principal threat wastes are addressed	Section 11
Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD	Section 6
Potential land and groundwater use that will be available at the site as a result of the selected remedy	Section 6
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	Section 12.3
Key factors that led to selecting the remedy	Section 12.1

7.0 Authorizing Signatures

USDOE Signature for the Record of Decision for the 200-UP-1 OU 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.

Matthew S. McCormick
Manager, Richland Operations Office
U.S. Department of Energy

9/26/12
Date

USEPA Signature for the Record of Decision for the 200-UP-1 OU 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.

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

9/27/2012
Date

State Signature for the Record of Decision for the 200-UP-1 OU 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
by Ron Skinnarland

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

9/27/12.
Date

PART II: DECISION SUMMARY

This Decision Summary provides an overview of the site characteristics, alternatives evaluated, and the analysis of those alternatives for the 200-UP-1 OU at the Hanford Site. It also identifies the selected remedy for this 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 this OU.

1.0 Site Name, Location, and Brief Description

The U.S. Department of Energy's (DOE's) Hanford Site is a 586 mi^2 (1,527 km^2) Federal facility located in southeastern Washington State along the Columbia River. 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 Tri-Cities and the surrounding communities in Benton, Franklin, and Grant Counties. For administrative purposes, the Hanford Site was divided into four National Priority List (NPL) sites under CERCLA, one of which is the 200 Area. The CERCLA site identification number for the 200 Area is WA 1890090078. The 200 Area includes the 200 West Area and 200 East Area as shown in Figure 1. Also referred to as the Central Plateau, the 200 Area is located on an elevated, flat plain, where there are no wetlands, perennial streams, or floodplains. The 200-UP-1 OU, also shown on Figure 1, consists of the groundwater beneath the southern portion of the 200 West Area of the Hanford Site.

The DOE is the lead agency for remediation of this 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*.

The 200-UP-1 OU groundwater contamination has resulted largely from releases during operations and from disposal of process liquid wastes associated with uranium and plutonium recovery processes in the 200 West Area. As effluents were discharged to these sites in the past, more mobile contaminants migrated through the vadose zone to the groundwater. Less mobile contaminants and residual contamination remain in the vadose zone soil. Currently, there are no liquid waste discharges to the ground above the OU (with the exception of sanitary drain fields). Waste sites and associated vadose contamination overlying the OU will be addressed under separate remedial actions.

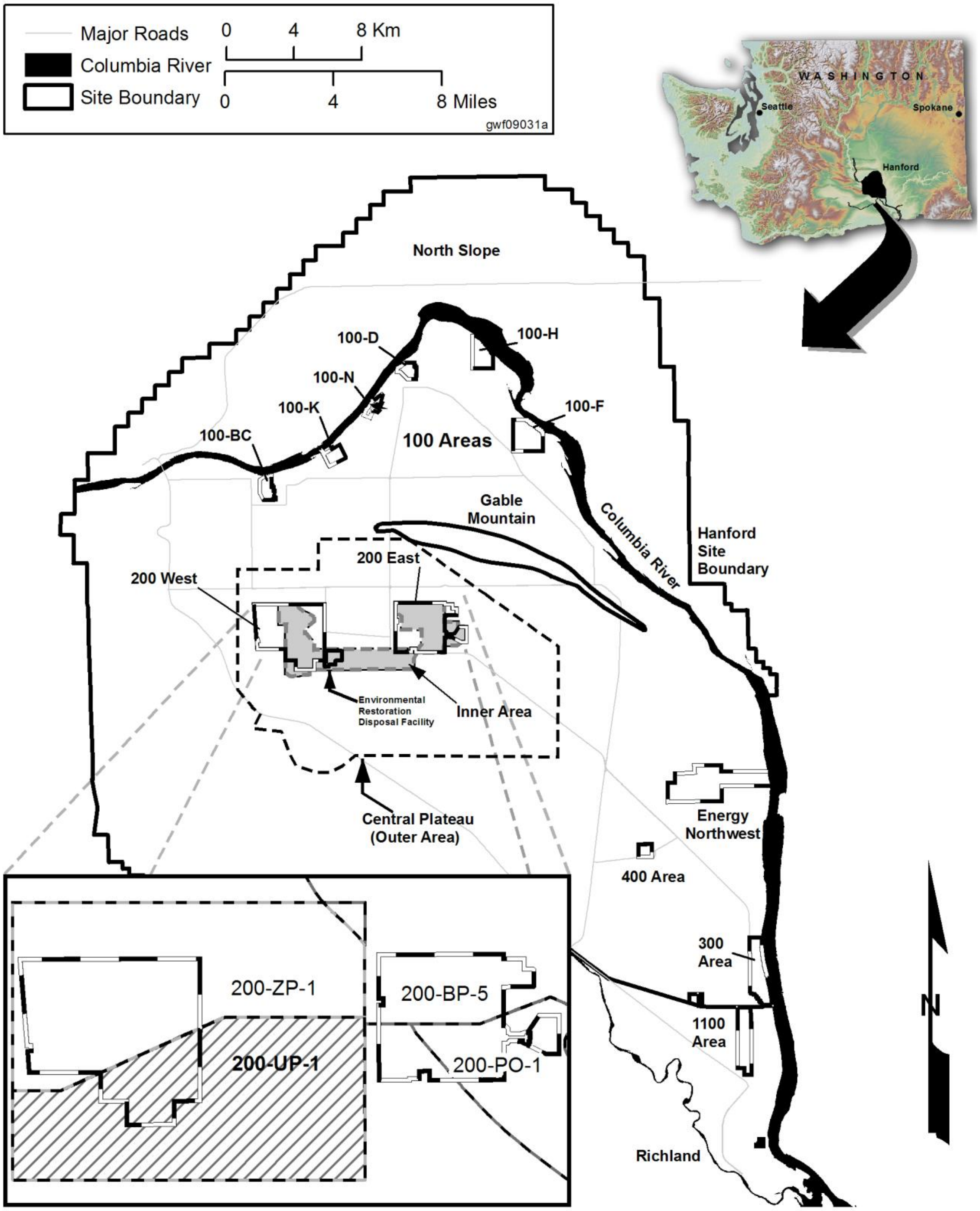
2.0 Site History and Enforcement Activities

This section provides background information on past activities at the Hanford Site that have led to the current contamination in the 200-UP-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

The 200 Area encompasses the 200 West and 200 East Areas, which contain inactive reactor fuel processing and active waste management facilities. Operations involved separation of special nuclear materials from spent nuclear fuel and storage of process liquids and wastes in tanks. The 200 West Area is grouped into four process areas: U Plant, Z Plant, S Plant (Reduction-Oxidation [REDOX] Plant), and T Plant. From the 1940s through the early 1990s, waste disposal operations from these facilities impacted groundwater. The primary waste sites that contributed to this contamination included ponds, cribs, and trenches that received liquid waste from S Plant and U Plant operations, and unplanned releases from underground single shell tank systems in Waste Management Area (WMA) S-SX. Single-shell tanks were built between 1944 and 1964 in 12 tank farms on the Hanford Site. Waste was sent to these tanks until

Figure 1. Hanford Site Map Illustrating the Location of the 200 West Area and 200-UP-1 OU



1980. All pumpable liquids have been removed from these tanks. Groundwater contamination from liquid waste disposal associated with plutonium concentration and recovery operations at Z Plant facilities has migrated from the adjacent 200-ZP-1 OU into the 200-UP-1 OU.

2.2 Previous Investigations, Interim Actions, Enforcement Activities and Operational 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 *Hanford Federal Facility Agreement and Consent Order*, also known as 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.

Previous investigations include the Remedial Investigation (RI) and Feasibility Study (FS) for this OU. During the RI for the 200-UP-1 OU, data were collected in accordance with DOE/RL-92-76 Rev. 1, *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit*, to characterize the nature and extent of chemical and radiological contamination and to define the hydrogeologic conditions. This is documented in DOE/RL-2009-122, *Remedial Investigation/Feasibility Study for the 200-UP-1 Groundwater Operable Unit.*

A number of groundwater interim remedial actions have been conducted in the 200-UP-1 OU. These actions are described below.

216-U-1 Crib and 216-U-2 Crib Groundwater Interim Remedial Action (1985): An interim remedial action was designed to pump-and-treat groundwater below these cribs. Pumping commenced in June 1985 and continued until November 1985. DOE completed this action under their own non-CERCLA authority since the 200 Area was not placed on the NPL until 1989. About 30 x 10^6 L (8 million gal) of groundwater were pumped and treated to remove 687 kg (1,514 lb) of uranium via ion exchange treatment. The maximum uranium concentration was reduced from about 72,000 pCi/L to about 17,000 pCi/L.

200-UP-1 Groundwater OU Interim Remedial Action (1997, amended in 2009 and 2010): A pilot-scale treatability test (DOE/RL-95-02, *Treatability Report for the 200-UP-1 Operable Unit – Hanford Site*) consisting of an onsite pump-and-treat system plus single extraction and injection wells was constructed adjacent to the 216-U-17 Crib. Phase I pump-and-treat operations commenced September 25, 1995, and continued until February 7, 1997. The treatability test demonstrated that the ion exchange resin and granular activated carbon were effective at removing Tc-99, uranium and carbon tetrachloride from groundwater.

On February 25, 1997, an interim ROD (EPA/ROD/R10-97/048, *Interim Remedial Action Record of Decision for the 200-UP-1 Operable Unit, Hanford Site, Benton County, Washington*) was issued. The *200-UP-1 Groundwater Remedial Design/Remedial Action Work Plan* (DOE/RL-97-36) was prepared to describe the detailed design of the groundwater extraction and treatment system to be used. This cleanup action started in 1997 and has since met its remedial action objective of reducing contamination in the area of highest concentrations of uranium and Tc-99 to below 10 times the cleanup level of 48 µg/L for uranium and 10 times the maximum contaminant level (MCL) of 900 pCi/L for Tc-99. This ROD was amended through an Explanation of Significant Difference (ESD) in 2009, which updated the uranium cleanup level, reducing it from 48 µg/L to 30 µg/L, and modified the pumping rates and approach due to a drop in the water table. This system removed nearly 886 × 10^6 L (234 × 10^6 gal) of contaminated groundwater with 220 kg of uranium, 127 g (2 Curies) of Tc-99, 41 kg of carbon tetrachloride and

49,000 kg of nitrate. The system was shut down in 2012.This remedial action also included institutional controls (ICs) to prevent exposure to contaminated groundwater in the 200-UP-1 OU.

A groundwater extraction system for Tc-99 at WMA S-SX was constructed in 2011 and started operation in August of 2012 as required by the *200-UP-1 Groundwater Remedial Design/Remedial Action Work Plan* (DOE/RL-97-36, Rev. 3). The design consists of a three-well extraction system, aboveground pipelines, and a transfer building to pump extracted groundwater to the 200 West Groundwater Treatment Facility for treatment and reinjection.

In addition to the actions above, the following actions have been or are being taken to address groundwater contamination in the 200-ZP-1 OU that have implications for the 200-UP-1 OU:

200-ZP-1 OU Interim Remedial Action (1995): In 1996, a pump-and-treat system was implemented to reduce the mass of carbon tetrachloride in the groundwater and to contain the plume where concentrations exceed 2 mg/L. This action was completed and the interim pump-and-treat system was deactivated in May 2012. Removal of carbon tetrachloride reduced the amounts of this contaminant migrating from the 200-ZP-1 OU towards the 200-UP-1 OU.

200-ZP-1 Record of Decision (2008): The *200-ZP-1 Record of Decision* was issued in 2008 and identifies the use of pump-and-treat technology, MNA, and ICs to remediate contaminated groundwater and prevent exposure during remediation. Groundwater pumping from this activity will impact the direction of groundwater flow and further reduce the levels of carbon tetrachloride present and migrating towards the 200-UP-1 OU. A large pump-and-treat facility, known as the 200 West Groundwater Treatment Facility began operation in 2012, which will be used to treat contaminated groundwater extracted from the 200-UP-1 OU.

3.0 Community Participation

This section describes how the public participation requirements of CERCLA and the NCP were met in the remedy selection process.

The Community Relations Plan, which was first issued in 1990 (Ecology et al., 2002), outlines stakeholder and public involvement processes and opportunities, including interactions with the State of Oregon, the Hanford Advisory Board (HAB), and the public. The Tribal Nations, the State of Oregon, the Hanford Advisory Board (comprising representatives of stakeholders in the community concerned with Hanford Site cleanup), and the public, are routinely informed on the progress of Hanford cleanup.

Draft versions of the RI/FS Report and of the Proposed Plan for this 200-UP-1 OU interim remedial action were shared with the Tribal Nations, the state of Oregon, and the HAB for their consideration and input. The input and advice from all parties relative to groundwater cleanup and this OU was reviewed in the development of the Proposed Plan to ensure it reflected consideration of stakeholder values, principles, and issues.

The RI/FS Report and Proposed Plan for this OU were made available to the public in July 2012, along with the rest of the Administrative Record file, located online at www.hanford.gov, and at both the Administrative Record Center and the Public Information Repositories at the locations below:

ADMINISTRATIVE RECORD
U.S. Department of Energy
Administrative Record Center
2440 Stevens Center Place, Room 1101
Richland, WA

PUBLIC INFORMATION REPOSITORIES
(Contains limited documentation, but provides access to the online Administrative Record)

USDOE Public Reading Room
Washington State University, Tri-Cities
Consolidated Information Center, Room 101-L
2770 University Drive
Richland, WA 99352

University of Washington
Suzzallo Library
Government Publications Division
Seattle, WA 98195

Portland State University
Branford Price Millar Library
Science and Engineering Floor
1875 SW Park Avenue
Portland, OR 97207

Gonzaga University
Foley Center Library
East 502 Boone Avenue
Spokane, WA 99258

The following activities were conducted as part of the formal community participation process under CERCLA and the NCP, 40 C.F.R. § 300.430(f)(3):

- The notice of availability of the Proposed Plan was published in a local newspaper, the *Tri-City Herald*, on July 17, 2012. The public notice informed the public that they could request a public meeting on the Proposed Plan. Two inquiries were made about potential public meetings, but no requests were made to have a public meeting on this Proposed Plan, so no public meeting was held.

- A public comment period for the Proposed Plan was held from July 17 to August 16, 2012. There were no requests for an extension of this comment period.

- Responses to the comments received during the Proposed Plan public comment period are included in the Responsiveness Summary, which is Part III of this ROD.

4.0 Scope and Role of the Response Action

This section describes the overall Hanford Site cleanup strategy, including the planned sequence of actions, the scope of the problems that the actions will address, and the authorities under which the 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 contamination problems in the 200 Area are complex due to the multiple waste sites, contaminated facilities, and groundwater contamination plumes located therein. As a result, these waste sites, facilities, and groundwater plumes are grouped by geographic areas, process types, or cleanup components into several OUs. Each OU, or grouping of OUs, has its own plan of study and enforceable schedule that will result in a 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* (Action Plan).

The 200-UP-1 OU is part of the groundwater remediation effort in the 200 West Area. The selected remedy is an interim remedial action which addresses contamination that has already reached groundwater. The final ROD for the 200-UP-1 OU will be pursued when future impacts to groundwater from source units and the vadose zone are adequately understood and the evaluation of potential technologies to treat I-129 is completed.

4.2 Overall Central Plateau Cleanup Plan

The Central Plateau (200 Area NPL Site) is a complex site with multiple OUs. The OUs with soil contamination include: four canyon facility OUs; three Central Plateau soil site OUs (two Inner Area, one Outer Area); deep vadose zone OU; burial grounds OU; pipelines OU, and OUs with key plutonium bearing waste sites in the Inner Area. The groundwater OUs on the Central Plateau include: 200-UP-1, 200-ZP-1, 200-PO-1 and 200-BP-5. The RI/FS process will be completed for each of the OUs within the Central Plateau that could serve as a source of groundwater contamination. As part of this process, contaminant sources and associated vadose zone contamination will be characterized to assess possible future impacts to groundwater from the overlying contamination and to determine the need for remedial actions to protect groundwater.

Remedial action decisions for soil contamination will be made under separate OU RODs. Under the Tri-Party Agreement, OUs within the Central Plateau are addressed under CERCLA, and in some cases in conjunction with ***Hazardous Waste Management Act (HWMA)*** corrective action authority**.** Dangerous waste treatment, storage, and/or disposal (TSD) units subject to HWMA closure requirements are or will be addressed under approved HWMA closure plans.

5.0 Site Characteristics

The following sections provide information on the Hanford Site and 200-UP-1 OU characteristics, the conceptual site model (CSM), and on the nature and extent of contamination in this OU.

5.1 Site Overview

The following sections briefly describe the meteorology, topography, and hydrogeologic setting in the vicinity of the 200-UP-1 OU.

5.1.1 Meteorology

The Hanford Site lies within the semi-arid shrub-steppe Pasco Basin of the Columbia Plateau in southeastern Washington State. This area is characterized by low annual rainfall of approximately 17 cm/year (6.8 in/year). Most precipitation occurs during the late autumn and winter, with more than one-half of the annual amount occurring from November through February. Snowfall accounts for about 38 percent of all precipitation from December through February.

The prevailing surface winds on the Hanford Site's Central Plateau are generally from the northwest and southwest and are the strongest during the winter and summer months. The Cascade Mountains serve as a source of cold and dense air drainage. This drainage results in a northwest to west-northwest prevailing wind direction that averages 2.7 to 3.1 m/s (6 to 7 mph), and faster during the spring and summer, averaging 3.6 to 4.0 m/s (8 to 9 mph). The fastest wind speeds are usually associated with flow from the southwest; however, summertime drainage winds from the northwest frequently exceed speeds of 13 m/s (30 mph).

The daily maximum temperatures vary from about 2°C (35°F) in late December and early January to 36°C (96°F) in late July. The record maximum temperature of 45°C (113°F) occurred in 2006, 2002, and 1961. On average the daily minimum temperature of less than -18°C (about 0°F) occurs 3 days per year. The annual average relative humidity is 55 percent, averaging about 76 percent in the winter and 36 percent in the summer.

5.1.2 Topography

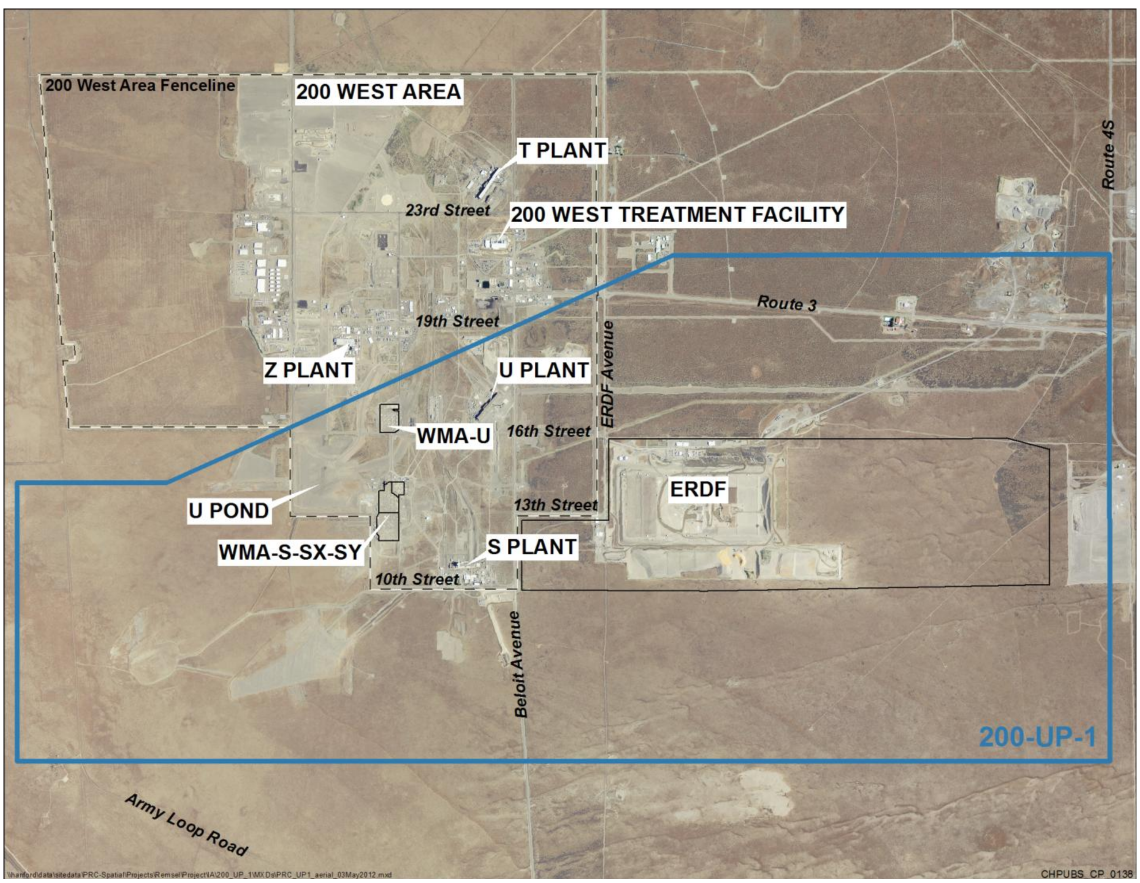
Hanford Site topography has been modified within the past several million years by Pleistocene cataclysmic flooding, Holocene eolian activity, and landsliding. Pleistocene floods eroded sediments and scoured into basalt bedrock, forming "scabland" topography visible north of the Pasco Basin, and left large-scale erosional channels and flood bars visible within the Central Plateau at the Site.

The topography above the 200-UP-1 OU is relatively flat to gently rolling, with a surface elevation ranging from about 183 to more than 213 m (600 and 700 ft) above mean sea level. The topography across the 200-UP-1 OU reflects the remnant terrain associated with the Cold Creek Bar, a large-scale paleo-flood feature that dominates the area. Groundwater is much deeper in this portion of the Hanford Site because of the increased vadose zone thickness associated with the paleo-bar deposits.

5.1.3 Surface Features

Features visible on the ground surface in the 200 West Area include the four main uranium separations and plutonium recovery process canyon buildings (U Plant, S Plant, T Plant and Z Plant), the active Environmental Restoration Disposal Facility (ERDF) which is a lined landfill used to dispose of CERCLA wastes, WMA U and S-SX where underground single-shell tanks are located, U Pond and several active streets including 10^{th}, 13^{th}, 16^{th}, 23^{rd}, Beloit Avenue and ERDF Avenue. Figure 2 shows the locations of these current landmarks.

Figure 2. Primary Site Features for the 200-UP-1 OU



5.1.4 Geology

The 200-UP-1 OU is in the central part of the Pasco Basin. Over the last 16 million years, the basin filled with materials that form bedrock (volcanic lava flows) and unconsolidated sediments (silt, sand, and gravel). Beneath the ground surface, major geologic units of interest (from oldest to youngest) include the following: (1) the Elephant Mountain Member basalt of the Saddle Mountains Basalt Formation and related interbeds within the Columbia River Basalt Group, (2) the Ringold Formation, (3) the Cold Creek Unit (CCU), (4) the Hanford formation, and (5) Holocene surficial deposits.

Unconsolidated and partly consolidated fluvial (river-derived), lacustrine (lake), and cataclysmic flood sediments of the Miocene through Holocene ages (approximately 8.5 million years to the present) overlie the basalts. The 200-UP-1 OU is focused on these sedimentary suprabasalt units above the basalt bedrock because this sediment contains the uppermost unconfined aquifer system within the region. Figure 3 and Figure 4 show the stratigraphy of the 200 Area and the major units of interest.

The Elephant Mountain Member of the Saddle Mountains Basalt Formation is the uppermost basalt unit (i.e., bedrock) in the 200 Areas and is laterally continuous throughout most of the 200 Areas. The Ringold Formation consists of an interstratified fluvial-lacustrine sequence of unconsolidated to semiconsolidated clay, silt, sand, and granule-sized gravel to cobbles that were deposited by the ancestral Columbia River. The CCU has been divided into five lithofacies: fine-grained, laminated to massive (fluvial-overbank and/or eolian deposits, formerly the early Palouse soil); fine- to coarse-grained, calcium-carbonate cemented (calcic paleosol, formerly the caliche); coarse-grained, multilithic (mainstream alluvium, formerly the pre-Missoula gravels); coarse-grained, angular, basaltic (colluvium); and coarse-grained, rounded, basaltic (sidestream alluvium, formerly sidestream alluvial facies). The Hanford formation is the informal stratigraphic name used to describe the Pleistocene cataclysmic flood deposits and consists predominantly of unconsolidated sediments that range from boulders to gravel, sand, silty sand, and silt. The sorting ranges from poorly sorted (for gravel facies) to well sorted (for fine sand and silt facies). Surficial deposits consist of very fine- to medium-grained sand to occasionally silty sand. Clastic dikes are also present throughout the central part of Hanford.

5.1.5 Hydrogeology

Groundwater contamination moves within the uppermost (suprabasalt) aquifer system of the 200-UP-1 OU. The suprabasalt aquifer system beneath the site is unconfined to semi-confined, depending on the depth below the water table. This aquifer system is within the unconsolidated to indurated sand and gravel that may include the Hanford formation, CCU, and Ringold Formation, which overlie basalt bedrock. In some areas, layers of silt and clay confine and separate portions of the suprabasalt aquifer. In the 200-UP-1 OU, the suprabasalt aquifer system is almost entirely within Ringold Formation sediment. Figure 5 shows the hydrogeology beneath the 200-UP-1 OU.

Confined aquifers occur within the underlying basalt flows and their sedimentary interbeds. These interbed aquifers are confined by the overlying competent basalt layers and the Ringold lower mud unit where this unit is directly on top of basalt. The vadose zone overlying the 200-UP-1 OU is composed primarily of laterally discontinuous, highly permeable Hanford formation sediment, the CCU, the upper Ringold unit, and upper portions of the Ringold unit E.

Groundwater beneath the site flows primarily from recharge areas along the elevated western and southwestern margins of the site to the east and north toward the Columbia River (watershed sink). Groundwater flow patterns historically were modified by groundwater mounds created by the discharge of large volumes of wastewater to the ground. Because large discharges no longer occur at most of the liquid waste disposal sites, the water table in the affected areas is returning to pre-Hanford conditions. Within the 200-UP-1 OU, the 200 West Area recharge mound is dropping, leaving many monitoring

Figure 3. Major Geologic Units of Interest in the 200 Area

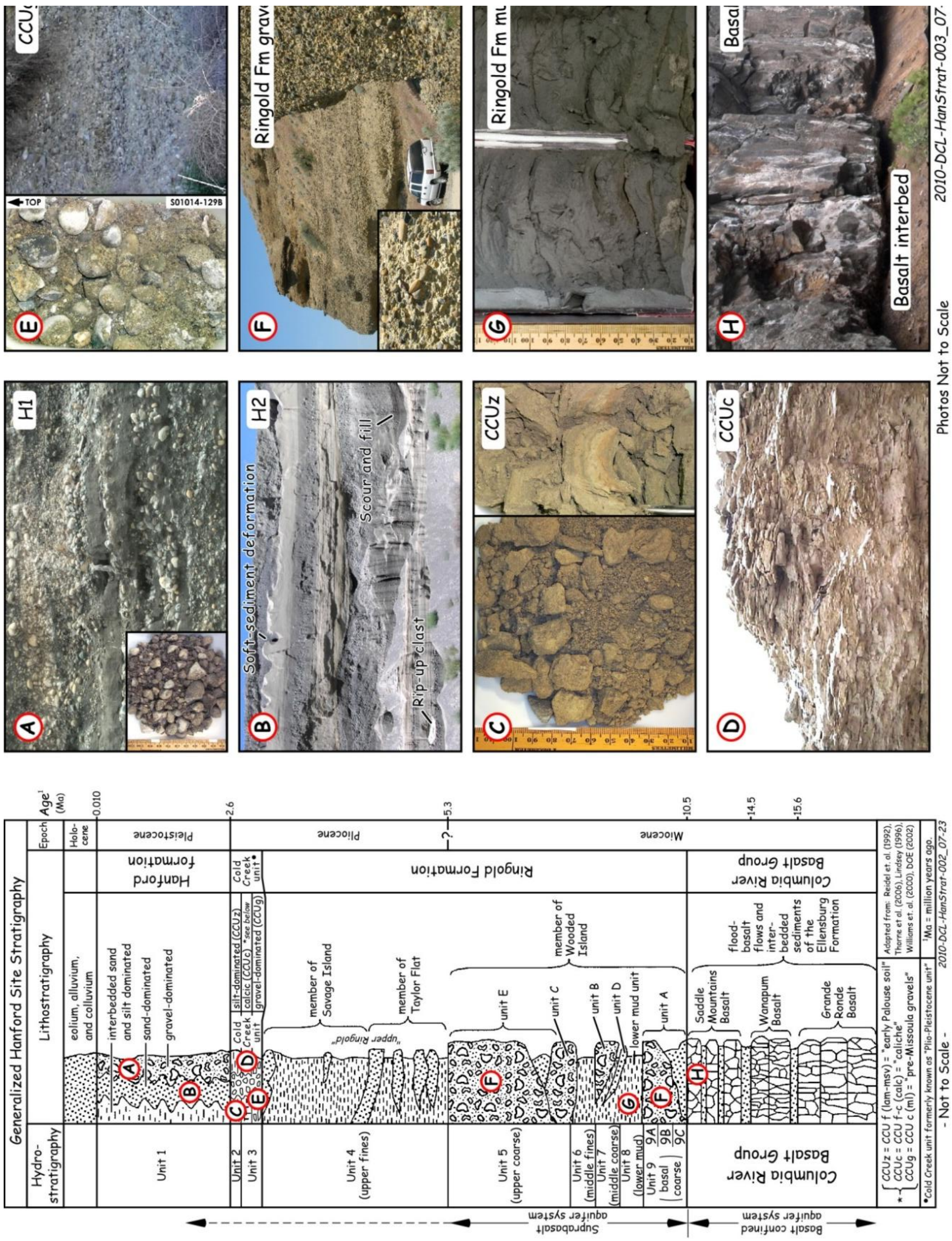


Figure 4. Generalized Stratigraphic Column for the 200 Area

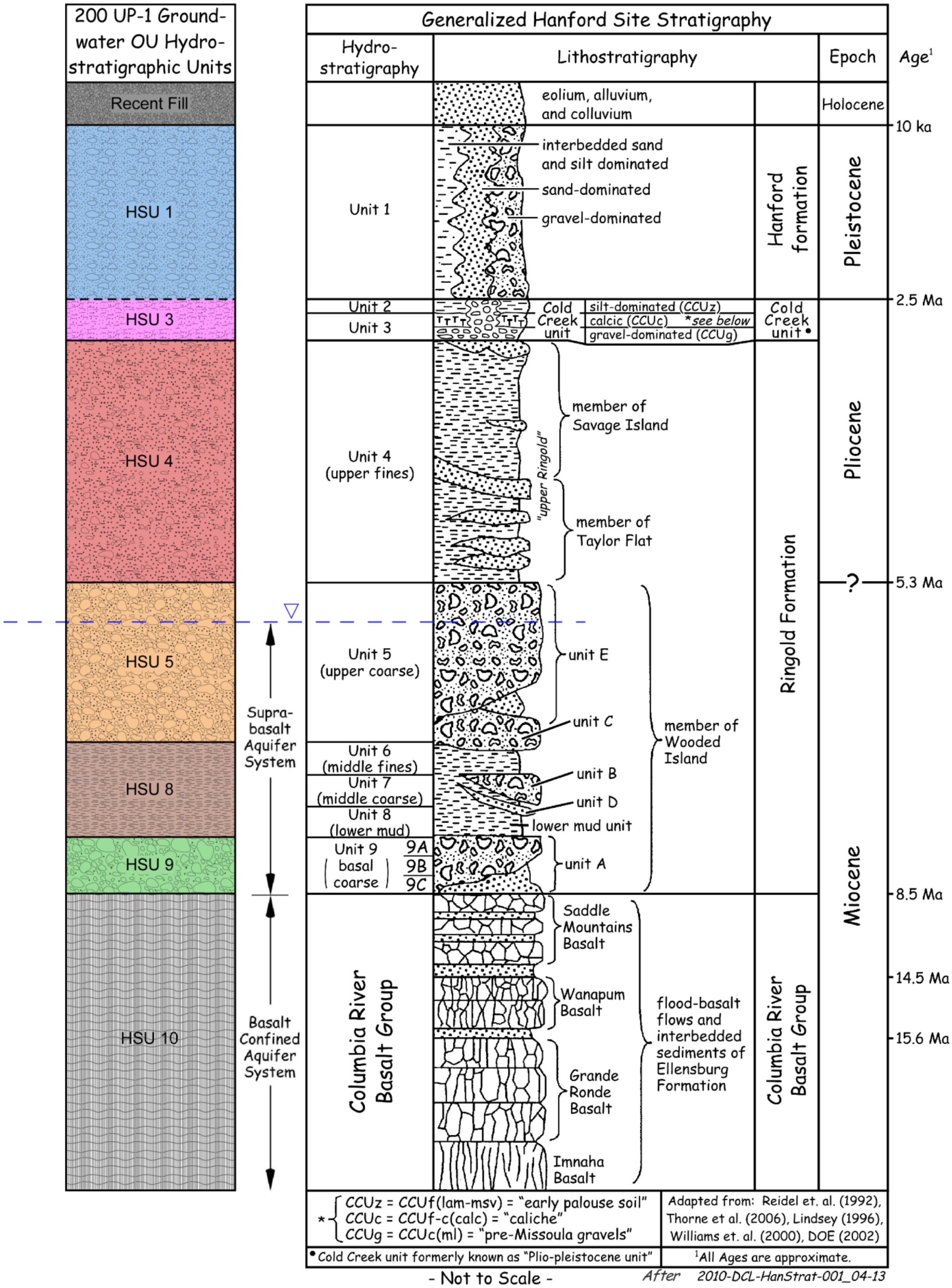
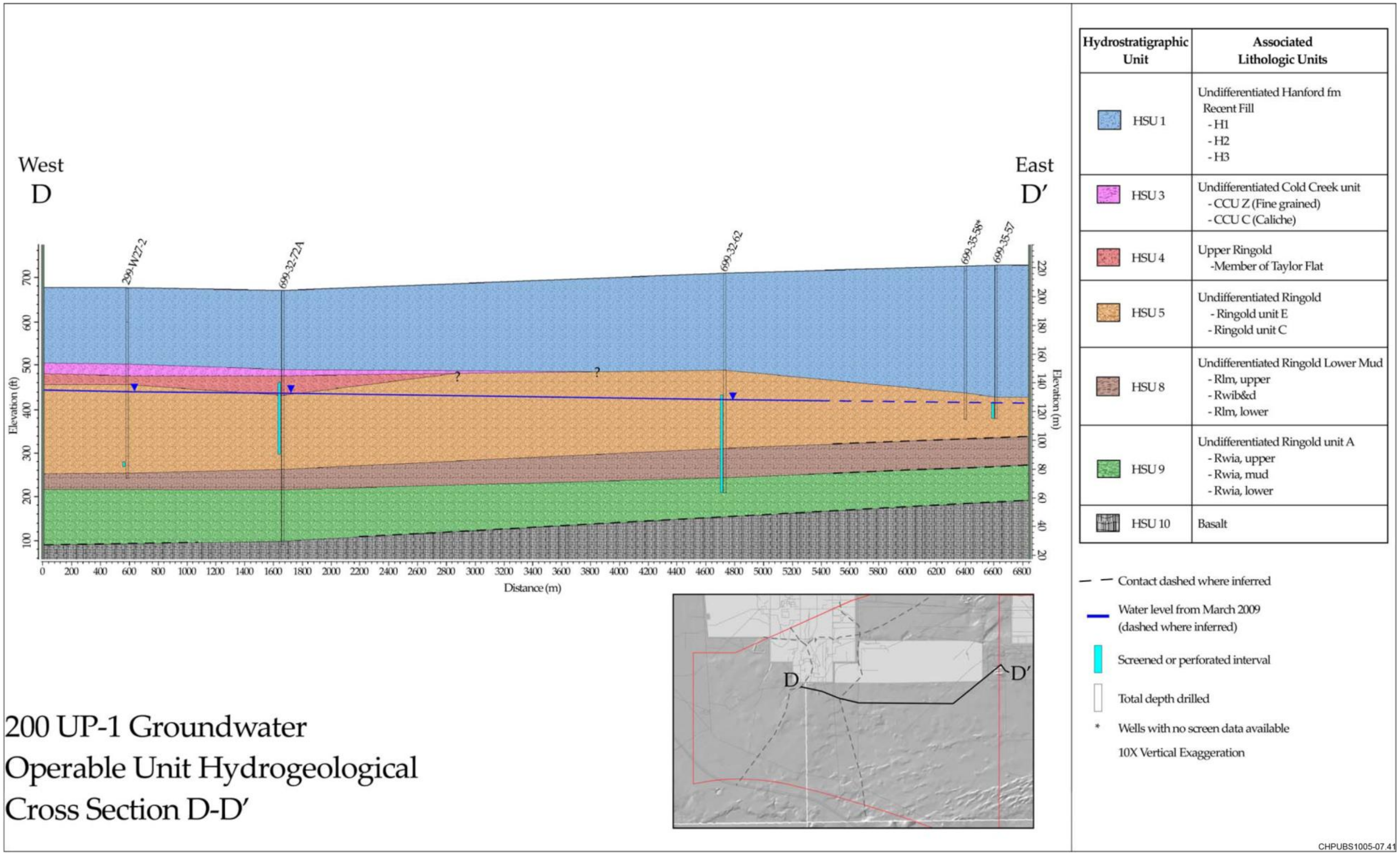


Figure 5. Cross Section D-D' Illustrating Hydrogeology Beneath the 200-UP-1 OU



wells dry, and changing groundwater flow patterns and gradients across the Central Plateau. Subsequently, the water table in the 200 West Area has a relatively lower gradient than during years of peak liquid discharge to the ground. The depth to groundwater within the 200 West Area and throughout most of the 200-UP-1 OU is approximately 91 m (300 ft) below ground surface.

5.2 Conceptual Site Model

A conceptual site model (CSM) illustrates current and potential future site conditions including contaminant sources, release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. Figure 6 schematically presents the exposure pathway analysis in the form of a human and ecological CSM. This figure presents a complete CSM, although not all pathways are applicable in the 200-UP-1 OU, as signified by use of gray dashed lines instead of black (e.g., the Columbia River pathway is shown as incomplete because contamination in 200-UP-1 OU is not expected to reach the Columbia River at concentrations that present an unacceptable risk, so fish consumption, for instance, is not applicable).

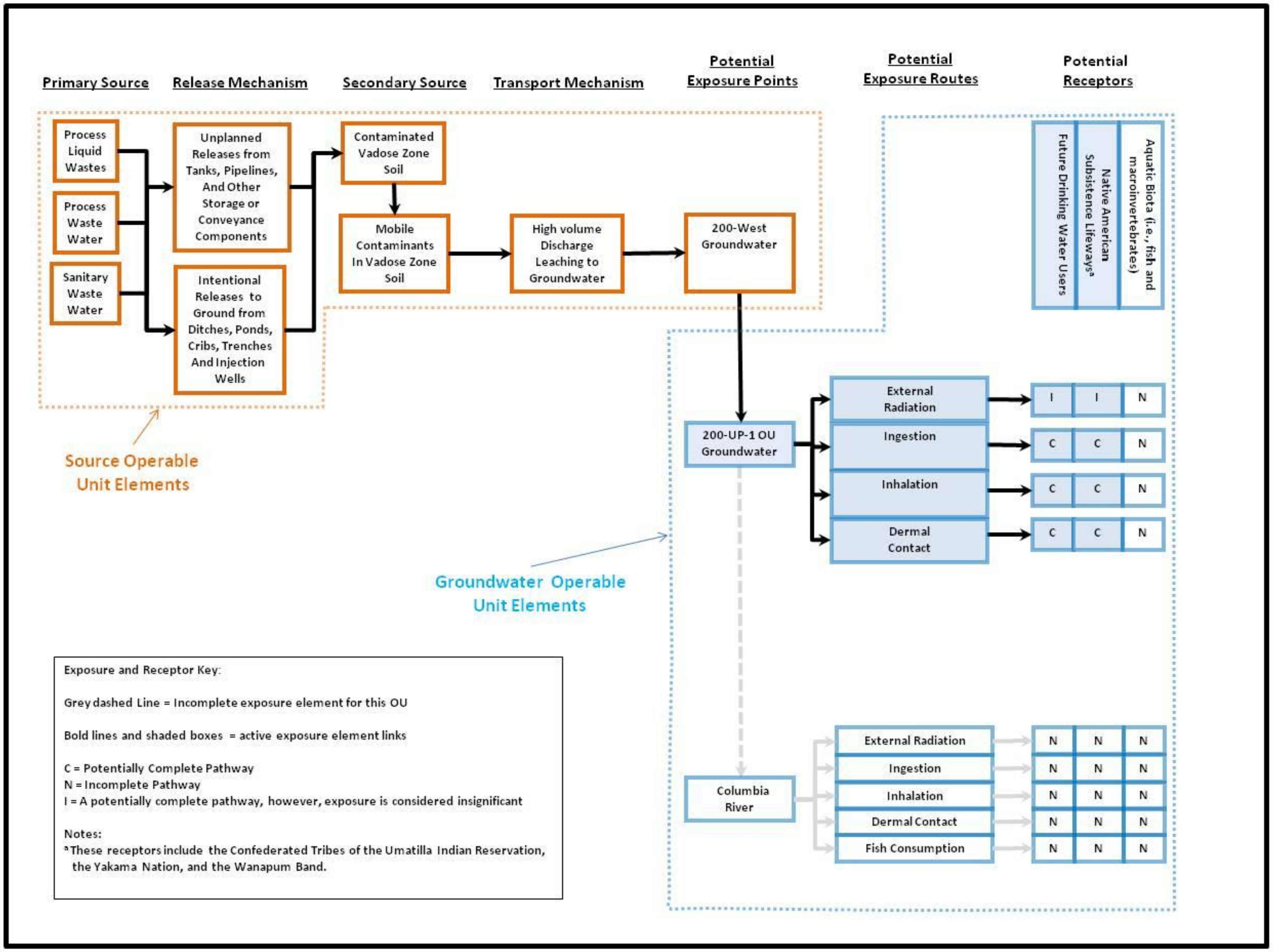
The primary sources of contaminants that are known or suspected to have contributed to contamination in the 200-UP-1 OU include liquid process wastes and wastewater generated during historical operations of S Plant (REDOX) Plant; U Plant; S-SX Tank Farm; and U Tank Farm. The contaminants observed in groundwater within the 200-UP-1 OU resulted from planned releases of these process liquid wastes and wastewater to the soil via discharge to engineered structures (cribs, trenches, ditches, ponds, leach fields, or injection wells). Unplanned releases typically resulted from inadvertent releases of the same or similar, waste materials from tanks, pipelines, or other waste storage or conveyance components. Most of the liquid waste and wastewater that contributed to observed groundwater contamination entered the soil column directly and migrated downward through the soil column by gravity to reach the underlying groundwater. In some instances, this downward migration through the vadose zone is continuing. Additional investigation of vadose zone contamination will be conducted before a final remedy is selected for the 200-UP-1 OU. Upon entering the groundwater at the water table, contaminants migrate in a downgradient direction away from the point of entry. Groundwater flow directions within 200-UP-1 OU have varied substantially over the period of historical Hanford operations. During the first years of operation, groundwater flow direction was generally west to east. As discharge of large volumes of wastewater to surface infiltration ponds within the 200 West Area continued, substantial groundwater mounds developed; groundwater then flowed radially away from these mounds in all directions. When these large volume discharges were stopped in the 1990s, the mounds began to dissipate and flow directions began to return to a more natural condition (generally west to east). The groundwater flow system has not yet returned to a natural state.

There are currently no actual exposures of either human or ecological receptors to groundwater within the 200-UP-1 OU because groundwater use is restricted. Based on fate and transport modeling, it is anticipated that groundwater contamination will not disperse beyond the boundaries of the 200-UP-1 OU at concentrations that present an unacceptable risk. However, the goal is to return the aquifer to its highest beneficial use, which is identified as a source of drinking water. Based on this understanding, future adult and child receptors could potentially be exposed if they extract and use the groundwater within the 200-UP-1 OU for drinking water and other domestic purposes.

Potential routes of exposure to groundwater contaminants include the following:

- Ingestion of contaminated water by drinking or in food preparation
- Inhalation of contaminant vapors during showering or other household activities
- Dermal contact exposure to contaminants in groundwater
- External radiation exposure from radioactive contaminants in groundwater

Figure 6. 200-UP-1 OU Conceptual Site Model



5.3 Sampling Strategy

During the RI for the 200-UP-1 OU, data were collected in accordance with DOE/RL-92-76, *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit*. Sampling results from monitoring 93 wells within and around the 200-UP-1 OU from 2004 to 2009 were used. Figure 7 shows the location of the monitoring wells and their proximity to overlying facilities and waste sites. The wells selected for sampling included those from the monitoring well network of the 200-UP-1 OU, as established in the associated Sampling and Analysis Plan (SAP) (DOE/RL-2002-10), and the monitoring wells from WMAs U and S-SX, and the 216-S-10 ditch and pond system. The dataset used for the data quality assessment includes 259 individual analytical parameters. The analytical data for all groundwater monitoring samples and their associated field quality control samples are summarized in annual groundwater monitoring reports.

Natural background concentrations of inorganic chemicals and radionuclides for the Hanford Site were presented in *Hanford Site Background: Part 3, Groundwater Background* (DOE/RL-96-61) and were determined by evaluating historical sample results and analysis of new sample results. The background monitoring wells were chosen through a systematic process of identifying wells in the unconfined aquifer not affected by contaminants originating from the Hanford Site. The background levels are based on the 90^{th} percentile of these values, consistent with the standard protocols for background calculations.

5.4 Sources of Contamination

The following section presents a discussion of the U Plant and S Plant facilities, their operating history, and the related waste disposal practices that have impacted 200-UP-1 OU groundwater. By the mid-1990s, all processing operations and associated liquid waste discharges on the Hanford Site had ceased.

5.4.1 U Plant Source Area

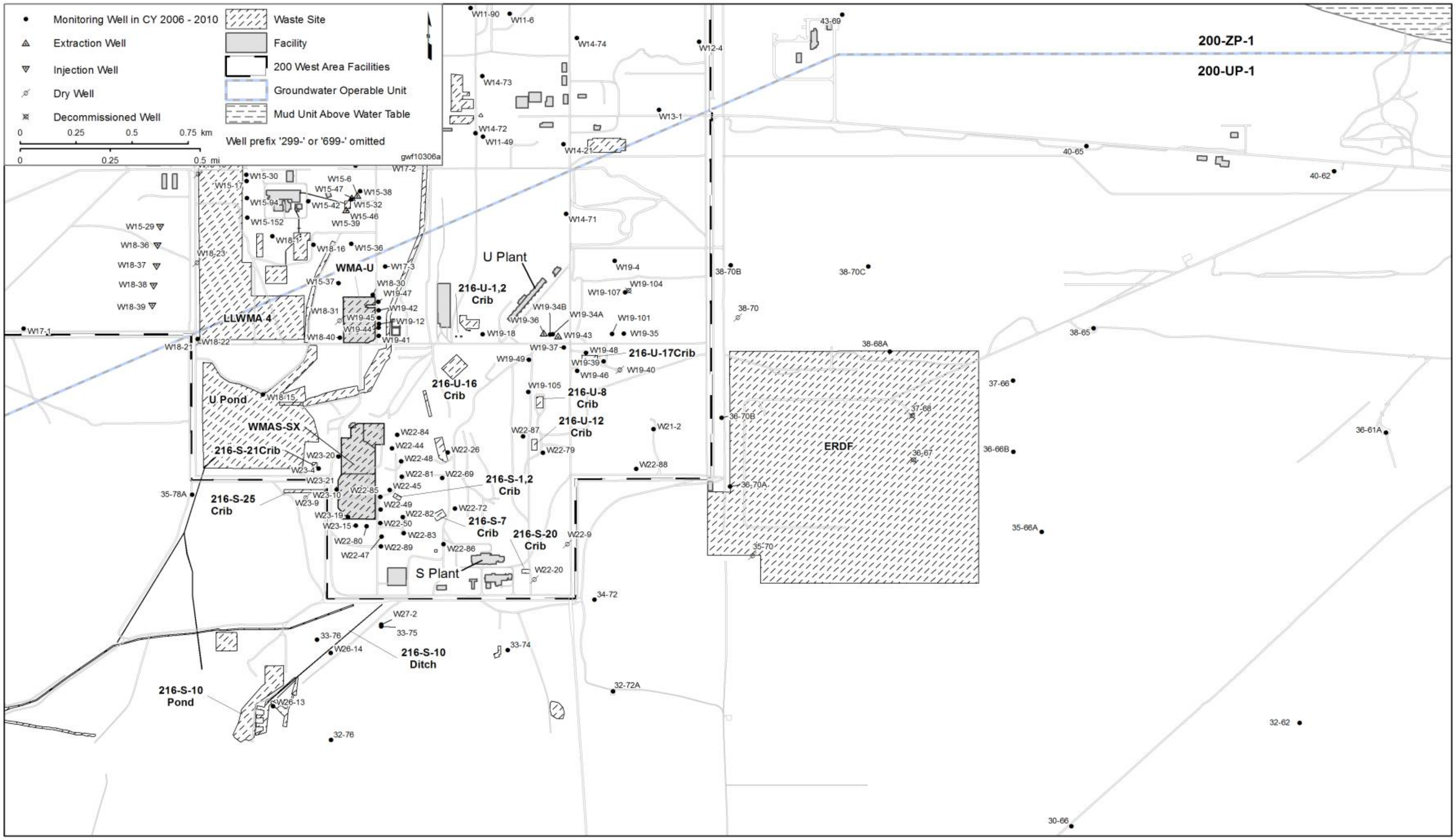
The primary waste-generating processes in the U Plant area were associated with the operation of the 221-U Building and its ancillary support facilities. Operations in the 221-U Building complex included uranium reclamation, uranyl nitrate calcination, and decontamination and reclamation of process equipment. The primary waste-generating facilities and associated processes included the following:

- 221-U Building (U Canyon) (Uranium Recovery Process)
- 224-U Building (UO_3 Conversion Process)
- 276-U Solvent Facility (Solvent Treatment)
- 222-U Laboratory (Analytical Laboratory Programs)

The **221-U Building**, also known as the 221-U Canyon Building, was the primary location of the uranium recovery program. The 221-U Building was originally designed as a bismuth phosphate separations facility, but was not operated in that manner because B Plant and T Plant had enough capacity to meet the plutonium production requirements. In 1952, the U Plant complex was converted to support the uranium recovery process. The process was designed to use an organic solvent to extract uranium from waste generated by the bismuth phosphate process.

Bismuth phosphate waste sludge was stored in underground single-shell tanks (SSTs) in both the 200 West and 200 East Areas. The sludge was sluiced from the SSTs and transferred to U Plant, where it was dissolved with nitric acid. The uranium in the acidified feed was separated from the bulk of the fission products and small amounts of plutonium in the solvent extraction process. The solvent extraction process used a light phase solvent, tributyl phosphate in a kerosene (paraffin hydrocarbon) diluent to extract the uranium from the aqueous phase in countercurrent extraction columns. The aqueous phase waste stream from the solvent extraction process was neutralized with sodium hydroxide and transferred to cribs in the B Plant complex. The uranium from the organic phase was stripped using nitric acid and then concentrated to be a uranyl nitrate hexahydrate feed to the 224-U Building.

Figure 7. Location of RI/FS Monitoring Wells, Overlying Facilities, and Waste Sites Associated with the 200-UP-1 OU



Within the extraction process, an evaporator condensate stream containing radioactive and chemical contaminants was generated in the evaporators that concentrated process liquids. An off-gas stream containing radioactive and chemical contaminants was also generated in the evaporation process and the vessel vent system. The steam condensate stream produced from heating process equipment and tanks was generally uncontaminated. Cooling water from evaporator condensers and process equipment was an additional source of uncontaminated waste.

Spills of process liquids within the building created an additional waste stream source. Sumps collected spilled liquids and other cell drainage and discharged the materials to cribs. 221-U Building process wastes were discharged to various WMUs including: 216-U-1 Crib, 216-U-2 Crib, 216-U-7 French Drain, 216-U-8 Crib, 216-U-10 Pond, 216-U-14 Ditch, and 216-U-16 Crib.

The **224-U Building** (UO_3 Plant) was immediately southeast of the 221-U Building and was a complex comprising several buildings, tank farms, storage areas, and loading facilities. The building was constructed in 1944 to concentrate plutonium-bearing product solutions for plutonium processing, but was not used for that purpose. It was operated as a training facility from 1944 to 1950 and was converted in 1952 to a uranium reduction facility. It was converted again in 1955 in support of the Plutonium-Uranium Extraction (PUREX) Plant. The 224-U Building was decontaminated and demolished in 2010.

The PUREX uranyl nitrate hexahydrate was transferred to the 224-U Building by tanker truck, where it was converted to powdered UO_3. The building produced process condensate waste from the concentration and calcination of uranyl nitrate hexahydrate. The UO_3 Plant process condensate was a highly acidic waste stream containing high concentrations of uranium, nitrate, and technetium-99 (Tc-99) during active concentration and calcination operations. The process condensate stream was mixed with other liquid mainly from sumps and rainwater collected in radiation areas.

Since 1955, UO_3 Plant wastewater was discharged to the 216-U-10 Pond through the 216-U-14 Ditch and 216-U-1, 216-U-2, 216-U-8, 216-U-12, 216-U-16, and 216-U-17 Cribs. Noncorrosive steam condensate from the building heating systems, process equipment, condensers (cooling water), and natural precipitation/rain from the nonradiation areas was sent through the 207-U Retention Basin to the 216-U-14 Ditch. After 1980, DOE required neutralization of the UO_3 Plant process condensate prior to disposal. Phosphoric acid and potassium hydroxide were used as buffering and neutralizing agents.

The **276-U Solvent Facility** treated used organic solvents from the uranium extraction processes at the 221-U Building. The solvents (particularly tributyl phosphate) were treated and cleaned by a carbonate scrub process and returned to the 221-U Building. A carbonate scrub solution waste was generated that contained sludge materials cleaned from the solvents and discharged to the associated cribs. Spent solvents were also a part of this waste stream. These waste solvents and sludges were disposed to the 216-U-15 trench.

The **222-U Laboratory**, located directly southeast of the 221-U Building, was used from about 1947 to 1970 for laboratory analysis in support of the uranium recovery process and the UO_3 process. This facility disposed of various general laboratory liquid wastes to the 216-U-4 Reverse Well, 216-U-4A French Drain, and 216-U-4B French Drain.

5.4.1.1 U-Plant-Related Tanks

Sixteen SSTs were operated in the northwest corner of the U Plant Source Area, all of which were contained in the 241-U Tank Farm WMA. Of these tanks, 12 had a 2,014,700 L (533,000 gal) capacity, and 4 had a 208,000 L (55,000 gal) capacity. A number of SSTs in the 241-U Tank Farm WMA have leaked and represent a potential source of groundwater contamination in the 200-UP-1 OU. The 241-U Tank Farm WMA continues to store mixed radioactive and hazardous waste.

Settling Tank 241-U-361 is a tank with a well-documented operating history that served as a settling tank for liquid wastes en route to the 216-U-1 and 216-U-2 Cribs (1951 through 1967). The wastes included cell drainage from the 221-U Building, waste from the UO_3 Plant, contaminated solvent from the 276-U Settling Tank, and decontamination and reclamation wastes from the 221-U Building. Approximately 4,000 kg (8,900 lb) of uranium was discharged to this tank, the bulk of which flowed into the 216-U-1 and 216-U-2 Cribs; it is estimated to contain 104,000 L (27,500 gal) of plutonium sludge with approximately 2,125 Ci beta/gamma. The ground surface above the 216-U-361 Settling Tank has been covered with about two feet of clean soil. The tank is not known to have leaked or to be a continuing source of contamination.

5.4.1.2 U-Plant Related Cribs, French Drains, and Reverse Wells

Cribs, French drains, and reverse wells were designed to dispose of wastewater into the ground without exposure to the open air. Cribs are shallow excavations that are either backfilled with permeable material or held open by wood structures. Both types of cribs were covered at ground level with an impermeable material. Waste flowed directly into the backfilled material or open space and percolated into the vadose zone soils. French drains were generally constructed of steel or concrete pipe and were either open or filled with gravel. Reverse wells were vertical drilled columns designed to inject wastewater into the ground at depth. The cribs, drains, and wells received low-level liquids until the specific retention or radionuclide capacity of the unit was met. The following subsections describe the major waste units associated with U Plant operations.

Cribs

The **216-U-1** and **216-U-2 Cribs** are located north of 16th Street and east of the 207-U Retention Basin. Wastes flowed to these cribs from the 241-U-361 Settling Tank. The cribs operated from 1951 until 1967, and 4,040 kg (8,900 lb) of uranium was reportedly discharged there. The uranium reacted with the sediments to form carbonate-phosphate compounds. After 1967, other cribs (notably 216-U-12) were used to dispose of this wastewater. In 1984, a newer crib (216-U-16*)* was installed south of the 216-U-1/U-2 Cribs. By 1985, liquid discharges to the 216-U-16 Crib formed a perched groundwater zone above a caliche layer. The perched groundwater moved north under the 216-U-1 and 216-U-2 Cribs. Acid wastes discharged to the cribs reacted with the uranium complexes to form compounds that are soluble and relatively non-sorbing on the sediments. The uranium was transported through the caliche layer to the unconfined aquifer and, consequently, uranium concentrations (at the time) rose from about 166 pCi/L to about 72,000 pCi/L in nearby monitoring wells.

The **216-U-8 Crib** is located west of Beloit Avenue and south of 16th Street. The crib operated from 1952 until 1960, receiving approximately 378,000,000 L (100,000,000 gal) of acidic process condensate from the 221-U and 224-U Buildings and the 291-U Stack Drainage System. In 1960, the surface above the 216-U-8 Crib began to subside. In response to this subsidence, the incoming line was blanked off and waste was diverted to the 216-U-12 Crib. The 216-U-8 Crib reportedly holds the largest inventory of waste uranium of any 200 West Area crib.

The **216-U-12 Crib** is located southwest of the intersection of Beloit Avenue and 16th Street, operated from 1960 to 1988, and was taken out of service once the crib began to subside. The 216-U-12 Crib reportedly received 150,000,000 L (40,000,000 gal) of liquid waste. Drainage was received from the 291-U Stack Drainage System, the acidic (pH 1) UO_3 Process Condensate System, wastes from the C-5 and C-7 tanks, and storm drain wastes from the 224-U Building. Approximately 3.1 kg (6.9 lb) of thorium was received from the 241-WR Vault in October 1965. The crib was removed from service as the 216-U-17 Crib was placed into service.

The **216-U-16 Crib** is located south of 16th Street and midway between Beloit Avenue and Cooper Avenue. The 216-U-16 Crib is a large, gravel-filled, drain field-type crib that operated from 1984 until 1987, receiving a combined 409,000,000 L (108,201,000 gal) of UO_3 laboratory, process condensate, 271-U Compressor cooling water, 221-U Building chemical sewer waste, 224-U Building process condensate, and chemical sewer waste. By 1985, enough liquid waste had been discharged to the crib to create the perched groundwater zone described previously that moved north below the 216-U-1 and 216-U-2 Cribs and mobilized uranium to the groundwater. The 216-U-15 Trench received miscellaneous liquid waste and interfacial sludge from the treatment of spent solvent from the 276-U Solvent Facility. The re-conditioned solvent was then returned to U Plant for reuse.

The **216-U-17 Crib** was constructed in 1988 to replace the 216-U-12 Crib, which had received its maximum-allowed inventory of radioactive wastes; 2,110,000 L (558,200 gal) of 224-U Building process condensate was discharged to this crib. After a brief cessation of effluent disposal to the crib in 1991, flows resumed in 1992, limited to 10 gallons per minute (gpm). In 1995, disposal to the crib ceased.

French Drains

The **216-U-3 French Drain** is located south of the 241-U Tank Farm, and operated from 1954 until 1955, receiving approximately 791,000 L (209,000 gal) of low-salt, neutral-basic condensate from the 241-U steam condenser on waste tanks at the 241-U Tank Farm.

The **216-U-4A French Drain** received 222-U Laboratory hood sink wastes after the 216-U-4 Reverse Well began to plug in 1955. From 1955 to 1970, the drain received 545,000 L (144,000 gal) of acidic plutonium and fission product decontamination waste.

The **216-U-4B French Drain** located south of the 222-U Laboratory received hot cell and hood liquid waste from the 222-U Laboratory. It operated from 1960 to 1968, receiving approximately 33,000 L (8,700 gal) of low-salt, neutral/basic lab waste.

The **216-U-7 French Drain** was connected to the U Plant counting box and is located south of the 221-U Building. From 1952 to 1957, the drain received liquid wastes from a counting box floor drain during the metal recovery program at the 221-U Building, with about 140 kg (300 lb) of uranium introduced in the form of uranyl nitrate hexahydrate. The uranyl nitrate hexahydrate introduced to the drain was identified as an unplanned release.

Reverse Wells

The **216-U-4 Reverse Well** was the only reverse well in the U Plant Area and is located northwest of the west corner of the 222-U Laboratory Building. It was a State of Washington registered underground injection well that operated from 1947 to 1955, receiving 302,400 L (80,000 gal) of decontamination waste from laboratory hood sinks (acidic plutonium and fission product waste). In 1955, the well was deactivated.

5.4.1.3 Ponds, Ditches, Trenches and Basins

The U Plant Area ponds, ditches, trenches and basins were designed to percolate wastewater into the ground. Until its closure in 1985, the 216-U-10 Pond was at the center of this disposal system and was fed by ditches that originated at the various waste-generation facilities.

Ponds

The **216-U-10 Pond System** was constructed in 1944 to receive low-level liquid effluent from PFP. It originally consisted of two drainage ditches that carried water to the pond. The pond system was active until 1985 and received a total of 1.62×10^{11} L (4.3×10^{10} gal) of contaminated liquid. The system received powerhouse cooling water, steam condensate wastewater laundry wastes, chemical sewer wastes, laboratory wastes, tank condenser water, and Pacific Northwest National Laboratory operations waste (231-Z Laboratory and 242-S Evaporator steam condensate). The large volumes of low-level wastewater and occasional isolated releases of considerably higher levels resulted in the accumulation of transuranic, fission products, and activation product inventories, estimated to include 8.2 kg (18 lb) of plutonium, 1,500 kg (3,300 lb) of uranium, 15.3 Ci of cesium-137 (Cs-137), and 22.6 Ci of strontium-90 (Sr-90).

Ditches

The **216-U-14 Ditch** began operation in 1944 and was an open ditch running from northeast to southwest across about 1.6 km (1 mi) of the 200 West Area. It originated 487.6 m (1,600 ft) north of U Plant and terminated at the 216-U-10 Pond. The ditch was originally known as the laundry ditch because it received wastewaters from the 2724-W Laundry Building. It also received other waste types that included: cooling water, wastewater, chemical sewer liquids, and evaporator condensate. Reportedly, 567,000 L (150,000 gal) of wastewater per day was discharged to this ditch. In 1986, approximately 3,000 L (800 gal) of 50 percent reprocessed nitric acid was released to the ditch. The total release to the ditch was about 102,058 kg (225,000 lb) of corrosive solution (pH <2.0) and 45.36 kg (100 lb) of uranium. In 1992, a portion of the ditch was backfilled with clean soil in response to TPA Milestone 17-17B (Ecology et al., 1989a).

Trenches

The **216-U-11 Trench** was located immediately west of the 216-U-10 Pond. It was active from 1944 to 1957 to receive overflow from the pond. The site contains less than 0.1 Ci beta activity. The site has been covered with soil and seeded. Aliases for this site are U Swamp Extension Ditch, U-12, U-11 Ditch, U-11 Old Ditch, and U-11 New Ditch.

The **216-U-15 Trench** was first used in May 1957 and backfilled almost immediately after receiving wastes. This trench is located north of 16th Street and west of the 271-U Building. The trench was opened to receive about 26,500 L (7,000 gal) of activated charcoal and diatomaceous earth containing about 1 Ci of fission products from 338-U Tank in the 276-U Solvent Storage Area. While the information for this trench varies, it is reported that 40,000 kg (88,000 lb) of hexone, 13,000 kg (29,000 lb) of tributyl phosphate, and possibly paraffin hydrocarbons were disposed. Waste was pumped to the trench through aboveground lines that were removed after the waste transfer operation was completed.

Retention Basin

The 207-U Retention Basin is the only basin within the U Plant Area. This retention basin consisted of two concrete-lined, open settling ponds where wastewater was held before overflowing into the 216-U-14 Ditch. The basin started operating in 1952, receiving steam condensate and cooling water from the UO_3 Plant and chemical sewer waste from the 221-U Building. After 1972, the basin received only cooling water from the 224-U Building.

5.4.2 S Plant Source Area

The primary waste-generating processes in the S Plant (REDOX) Area are associated with the operation of the S Plant. REDOX was built around 1950 and was shut down in 1967. This was the first process to recover both plutonium and uranium from fission products. It was built to improve the Site's plutonium and uranium recovery process from the initial bismuth phosphate plutonium separations process. The new REDOX process used a continuously operating solvent extraction process (hexone) to extract plutonium and uranium from acidic, fission-product-rich solutions in which the fuel rods had been dissolved. The volumes of concentrated fission-product-rich solutions were much smaller than the solutions produced by the bismuth phosphate process, thereby reducing the volume sent to SSTs. Radioactive decay occurring in these wastes caused self-heating. In some wastes, radioactive decay caused these wastes to boil. The high-heat sludges created wastes known as self-boiling wastes.

The 202-S Building and the 222-S Laboratory generated significant wastes and, depending on the type of wastes, the liquids were discharged to one of 26 waste ponds, cribs, ditches, French drains, and trenches. Open-air ponds and ditches received the highest volumes of generally nonradioactive contact cooling water and steam condensates from the major 202-S process vessels used to heat and cool chemical solutions. More radioactive (and chemical-rich), but less voluminous quantities of condensed process vapors and cell drainage were sent to cribs. The nonradioactive, low-volume chemical sewer wastes were generally sent to ponds and ditches. Relatively very low-volume radioactive waste streams were sent to the French drains. Building septic systems used tile fields to dispose of nonradioactive wastes.

The S Plant complex also contained the 222-S Laboratory, 233-S Concentration Facility, and a series of support buildings and waste handling and storage facilities. The 222-S Laboratory supported the 200 Areas for process control and environmental sample analysis. An evaporator (242-S) was added at the S-SX, SY Tank Farm complex in 1973 to aid in tank volume reduction. The following sections discuss the details of the chemicals/materials used and the related major waste disposal locations.

5.4.2.1 S-Plant-Related Tanks

Several types of tanks are present in the S Plant Source Area including 4 catch tanks, 27 SSTs, 3 double-shell tanks (DSTs), and 1 receiver tank. Catch tanks are generally associated with diversion boxes and other transfer units, and were designed to accept overflows and spills. The receiver tank (frequently called a double-contained receiver tank or vault) received waste from SSTs; SSTs were used to collect and store large quantities of mixed wastes. DSTs also are used to store large quantities of mixed wastes.

Of the 27 SST WMAs in the S Plant Aggregate Area, 12 are contained within the 241-S Tank Farm and 15 are contained within the 241-SX Tank Farm. The three DSTs are located in the 241-SY Tank Farm. The 241-S Tank Farm is located northeast of the Cooper Avenue and 13th Street intersection. The 241-S and 241-SX Tank Farms were constructed from 1950 to 1951 and 1953 to 1954, respectively. The tank designs were very similar in both tank farms with the tanks being vertical cylinders with a domed top, and constructed of reinforced concrete with a carbon steel liner on the base and sides. The tanks are all underground. The 12 tanks in the 241-S Tank Farm are numbered 241-S-101 through 241-S-112, and the 15 tanks in the 241-SX Tank Farm are numbered 241-SX-101 through 241-SX-115. The 241-S Tanks and 241-SX Tanks have a capacity of 3,785,412 L (1,000,000 gal) each.

SSTs in the WMAs S and SX are known contributors to groundwater contamination within the 200-UP-1 OU. The high-heat sludges from the REDOX process created self-boiling conditions in a number of S and SX SSTs. These high-temperature conditions caused the tanks to be susceptible to stress corrosion cracking that attacked the welds in the tank walls and bottom, leading to many of these tanks releasing waste into the soil column. All pumpable liquids from the SSTs have been removed to minimize the potential for future leaks.

The DSTs in the 241-SY Tank Farm were constructed from 1974 to 1976. The tanks were designed as vertical cylinders with an inner primary tank, an outer secondary tank surrounded by a steel-reinforced concrete shell, and a steel-reinforced domed top. The three tanks in the 241-SY Tank Farm are numbered 241-SY-101 through 241-SY-103, with a capacity of 3,785,412 L (1,000,000 gal) each. None of these DSTs have leaked.

5.4.2.2 Cribs and French Drains

The following subsection presents information on the cribs and trenches in the S Plant area that are believed to be the major contributors to groundwater contamination in the southern portion of the OU. Similar to the cribs described previously for U Plant, the S Plant cribs are shallow excavations that are either backfilled with permeable material or held open by wooden structures. Both types of cribs are covered with an impermeable layer at the surface. Wastewater flowed directly into the crib and percolated into the vadose zone soils. French drains were generally constructed of steel or concrete pipe and were either open or filled with gravel. The S Plant Area contained 12 cribs and two French drains. The cribs and drain received low-level waste for disposal and were designed to receive liquid until the unit's specific retention or radionuclide capacity was met.

Cribs

The **216-S-1** and **216-S-2 Cribs** are located northwest of the 202-S Building. The cribs were in service from 1952 to 1956 and received approximately 1.6×10^8 L (4.2×10^7 gal) of cell drainage waste from the D-1 Receiver Tank and redistilled condensate from the D-2 Receiver Tank located in the 202-S Building. These radioactive process condensate wastes were acidic and contained high concentrations of volatile radionuclides including tritium and iodine-129 (I-129).

The **216-S-5 Crib** is located southwest of the 207-S Retention Basin and west of the 216-S-10D Ditch. The crib operated from 1954 to 1957 and was built as a replacement for the contaminated 216-S-17 Pond. The crib received 4.1×10^9 L (1.1×10^9 gal) of acidic process vessel cooling water and steam condensate from the 202-S Building. The unit was deactivated because of insufficient capacity and a series of vessel coil failures, which resulted in operational problems and surface contamination.

The **216-S-6 Crib** was located southwest of the 202-S Building and southwest of the 200 West Area perimeter fence. The crib received waste from 1954 until 1972. The crib received a total of 4.47×10^9 L (1.18×10^9 gal) of low-salt, neutral/basic liquid waste (DOE/RL-91-60). Until 1967, the crib received process vessel cooling water and steam condensate from the 202-S Building. After 1967, the crib received steam condensate from the D-12 and D-14 waste concentrators in the 202-S Building.

The **216-S-7 Crib** is located northwest of S Plant. The crib began operating in 1956 as the replacement for the 216-S-1 and 216-S-2 Cribs and was retired in 1965. Until 1959, the crib received cell drainage from the D-1 Receiver Tank, process condensate from the D-2 Receiver Tank, and condensate from the H-6 condenser in the 202-S Building. The crib received a total of 3.9×10^8 L (1.0×10^8 gal) of waste. The site was retired in July 1965.

The **216-S-9 Crib** is located east of the 241-S and 241-SY Tank Farms. The crib operated from 1965 to 1969, as the replacement for the 216-S-7 Crib, receiving 5.03×10^7 L (1.33×10^7 gal) of process condensate from the D-2 Receiver Tank. The waste was primarily composed of nitric acid and contained high concentrations of tritium and I-129.

The **216-S-13 Crib** is located west of the 202-S Building and north of 10th Street. The crib was built in 1952 and stopped receiving waste in 1972. Until 1967, it received liquid waste from the 203-S Decontaminated Metal Storage Facility, the 204-S Uranyl Nitrate Hexahydrate facility, and the 276-S Organic Solvent Make-up Facility. After 1967, the crib received occasional sump waste from the 204-S Uranyl Nitrate Hexahydrate facility. The unit received a total of 5.0×10^6 L (1.3×10^6 gal) of low-salt, neutral/basic waste, mainly composed of nitrate, sodium, and sodium dichromate.

The **216-S-20 Crib** is located southeast of the 202-S Building and north of 10th Street. The crib operated from 1952 until 1973, receiving 1.35×10^8 L (3.57×10^7 gal) of waste. Until 1953, the crib received miscellaneous waste from laboratory hoods and decontamination sinks in S Plant via the 219-S Waste

Handling Facility. From 1963 to 1969, the crib received miscellaneous waste from laboratory hoods and decontamination sinks in the 222-S Laboratory via the 219-S Waste Handling Facility. After 1969, 300 Area laboratory wastes were rerouted to the 216-T-28 Crib.

The **216-S-21 Crib** is located southeast of the 216-U-10 Pond, north of 13th Street, and west of the 241-S Tank Farm. From 1954 to 1969, the crib received 241-SX Tank Farm condensate generated from self-boiling waste and collected in the condensers in the 401-SX Condenser Facility. The unit was retired in 1969, after receiving 8.7×10^7 L (2.3×10^7 gal) of low-salt and neutral/basic liquid waste. The chemicals disposed were sodium and ammonium nitrate.

The **216-S-25 Crib** is located northwest of the 202-S Building outside the 200 West Area perimeter fence, south and east of the 216-U-10 Pond. The unit began operation in 1973 and received 242-S Evaporator process steam condensate through 1980. From 1980 until 1984, the crib received 3.0×10^8 L (8.0×10^7 gal) of cooling water from the 241-SX Tank Farm. In 1985, the crib was reactivated to receive treated groundwater from the 1985 216-U-1 and 216-U-2 pump-and-treat.

The **216-S-26 Crib** is located southeast of the 222-S Laboratory outside the 200 West Area perimeter fence. It operated from 1984 to 1988 and received 1.64×10^8 L (4.02×10^7 gal) of steam condensate, equipment cooling water, and sink wastes. The wastes contained a variety of chemicals including acetone, nitrate, nitric acid, and lesser amounts of sulfuric and hydrofluoric acids. The crib also received three or more 4,200 L (1,100 gal) tanker discharges of PFP caustic flush water with a pH of 12.5, which retarded percolation of the fluids and prevented the crib from ever recovering to normal flows.

French Drains

The **216-S-3 French Drain** is located along the east border of the 241-S Tank Farm, east of the 241-S-104 SST. This drain operated from 1953 to 1956 and received 4.2×10^6 L (1.06×10^6 gal) of condensate from the 241-S-101 and 241-S-104 storage tanks in the 241-S Tank Farm. The waste solution was low-salt and neutral/basic liquids.

The **216-S-4 French Drain** was active from 1953 to 1956 and received 1,000,000 L (264,000 gal) of waste from the condensers on the 241-S-101 and 241-S-104 Tanks. It is located north of 13th Street, between the 241-S Tank Farm and the 216-U-10 Pond.

5.4.2.3 Ponds, Ditches, Trenches and Basins

Generally, low-level liquid waste was disposed into the ponds. Ponds typically have natural or diked surface depressions used for disposal of high-volume, low-level liquid effluent and designed to promote percolation of the liquid effluent. As the liquid infiltrated into the ground, many of the radionuclides were absorbed and concentrated by the upper soil layer. The major units are described below.

Ponds

The **216-S-10P Pond** is located southwest of the 202-S Building and covers approximately 20,300 m^2 (218,000 ft^2). The pond was designed to percolate approximately 567,000 L (150,000 gal) of waste per day. The pond operated from 1954 to 1984 and received approximately 4.12×10^9 L (1.07×10^9 gal) of liquid discharge. Until 1965, the pond received the chemical sewer waste from the S Plant Complex and overflow from the high water tower. In the 1960s, the pond received bearing cooling water from the S Plant Complex. The pond was backfilled with soil in 1984.

The **216-S-11 Pond** is located southwest of the 202-S Building and covers approximately 6,070 m^2 (65,300 ft^2). The pond began operation in 1954 and closed in 1965. The pond received waste from air conditioning drains and chemical sewers from the 202-S Building. In 1965, the 216-S-10D Ditch was dammed, diverting all building effluent to the 216-S-10P Pond. A total of 2.23×10^9 L (5.89×10^8 gal) of liquid waste was discharged to this unit. The pond was covered in 1975.

The **216-S-15 Pond** is located directly east of the 241-S Tank Farm. The pond was built in 1951 and retired in 1952. The pond received 10,000 L (2,600 gal) of condenser spray cooling water from the 241-S-110 SST. The waste was low-salt, neutral/basic, and was mainly composed primarily of nitrate and methyl isobutyl ketone (MIBK).

The **216-S-16P Pond** is located southwest of the 202-S Building. The total unit area is approximately 125,400 m^2 (1,350,000 ft^2) and operated from 1957 to 1975, receiving approximately 4.07×10^{10} L (1.08×10^{10} gal) of liquid waste. The waste included 3.7×10^2 g (0.81 lb) of plutonium. Until 1967, the pond received process cooling water and steam condensate from the S Plant Complex. After 1967, the pond received condenser and vessel cooling water from the concentrator boil-down operations in the 202-S Building.

The **216-S-17 Pond** is located southwest of the 202-S Building. The pond has a total area of approximately 85,000 m^2 (920,000 ft^2). The pond operated from 1951 to 1954, receiving approximately 6.44×10^9 L (1.7×10^9 gal) of liquid waste. Until 1953, it received the process cooling water and steam condensate from the S Plant Complex. After 1953, it received 202-S Building effluent and the overflow from 216-U-10 Pond via the 216-U-9 Ditch. A series of process vessel coil failures beginning in 1952 resulted in the release of high levels of radioactivity to the 207-S Retention Basin and subsequently to the 216-S-17 Pond. This pond has been backfilled with soil.

Ditches

Ditches were long, open, unlined excavations used to transfer low-level liquid wastes from process facilities to ponds. Two ditches in the S Plant Area are discussed below:

The **216-S-10D Ditch** is located southwest of the 202-S Building. The ditch operated from 1951 to 1991 and received and transferred 4.3×10^8 L (1.16×10^8 gal) of liquid waste. Discharges were received from the 202-S Building, 241-S Tank Farm, 211-S Valve House, 276-S Solvent Handling Facility, and 2901-S-901 Water Tower. These streams were transferred to the 216-S-10P and 216-S-11 Ponds.

The **216-S-16D Ditch** is located southwest of the 202-S Building. The ditch operated from 1957 to 1975. A total of 4.07×10^8 L (1.1×10^8 gal) of liquid waste was discharged to this unit, including process cooling water and steam condensate from S Plant.

Trenches

Trenches are unlined excavations used for disposing process waste into the subsurface by infiltration. Quantities were limited, as compared to cribs or ponds, and all of the trenches have now been backfilled.

Retention Basins

Retention basins were used for intermittent storage of liquid waste before it was transferred to ponds, ditches, or cribs. The 207-S Retention Basin had the potential to contribute to groundwater contamination.

The **207-S Retention Basin**, also referred to as the 202-S Building Retention Basin, is a concrete structure with a volume of 3,220,000 L (850,000 gal) and a surface area of approximately 230 m^2 (4,600 ft^2). The basin received low-level liquid wastes, such as process cooling water and steam condensate from the 202-S Building, from 1951 through 1954. The wastes were discharged to the 216-S-17 or 216-S-16P Ponds.

5.5 Nature and Extent of Contamination

The types and characteristics of contaminants of concern (COCs) for the 200-UP-1 OU are described in this section. The COCs exhibit varying levels of mobility in groundwater, but all are sufficiently water soluble such that their solubility is not a limiting factor to their being transported in the 200-UP-1 OU aquifer system. Table 2 lists the physical characteristics of COCs. Table 3 presents the COC plume area, thickness, volume, 90^{th} percentile concentration, and mass for COCs in the 200-UP-1 OU. The individual COC plumes range in size from tritium (the largest) at approximately 805 ha (1,989 ac) to uranium (the smallest) at approximately 41 ha (102 ac).

There are currently no actual exposures of either human or ecological receptors to groundwater within the 200-UP-1 OU because groundwater use is restricted. In the absence of any further remedial action, fate and transport modeling indicates that groundwater contamination from the 200-UP-1 OU will not disperse beyond the OU boundaries at concentrations that would pose an unacceptable risk. Although the aquifer where the 200-UP-1 OU is located is not currently used as a source of drinking water, it is identified as a potential future domestic water source. Potential routes of exposure considered a scenario where water is used for domestic purposes.

The following potentially complete exposure pathways were identified:

- Ingestion of contaminated water by drinking or in food preparation
- Inhalation of contaminant vapors during showering or other household activities
- Dermal contact exposure to contaminants in groundwater
- External radiation exposure from radioactive contaminants in groundwater (this is not a significant pathway)

Table 2. Physical Characteristics of 200-UP-1 OU Contaminants of Concern in Groundwater

Chemical Name	Chemical Group	Distribution Coefficient K_d (mL/g)	Molecular Weight (g/mole)	Radioactive Half-Life (yr)
Carbon Tetrachloride	Volatile	0.011	153.82	N/A
Chromium	Metal	0	51.99	N/A
Hexavalent Chromium	Metal	0	51.99	N/A
Uranium, soluble salts	Metal	0.4	238.03	N/A
Nitrate	Nutrient	0	62.00	N/A
Iodine-129	Radionuclide	0.1	129.91	16,000,000
Technetium-99	Radionuclide	0	98.91	210,000
Tritium	Radionuclide	0	6.03	12.33

Table 3. 200-UP-1 OU Plume Area, Mass, and Pore Volume Estimates

COC	Porosity[a]	Plume Area (ha/acres)	Estimated Plume Thickness (m/ft)	Plume Pore Volume (billion L/gal)	90th Percentile Concentration	Estimated COC Mass
Uranium	0.2	41/102	15/50	1.26/0.33	206 µg/L	570 lb (260 kg)
Nitrate, as NO3	0.2	601/1,484	24/80	29/7.7	133 mg/L	8,600,000 lbs (3,900,000 kg)
Total Chromium	0.2	109/269	24/80	5.3/1.4	99 µg/L	1,150 lbs (525 kg)
Hexavalent Chromium	0.2	581/1,437	24/80	28/7.5	52 µg/L	3,243 lbs (1,474 kg)
Tritium	0.2	805/1,989	30/100	49/13	51,150 pCi/L	2,510 Ci
Technetium-99	0.2	124/307	20/65	4.9/1.3	4,150 pCi/L	20.5 Ci
Iodine-129	0.2	460/1,138	30/100	28/7.4	3.5 pCi/L	0.1 Ci
Carbon Tetrachloride	0.2	458/1132	55/180	53/13.3	189 µg/L	20,925 lb (9522 kg)

a. Porosity of 0.2 from DOE/RL-2007-28, *Feasibility Study Report for the 200-ZP-1 Groundwater Operable Unit*, Table D-58.

Figure 8 conceptually illustrates the hydrogeologic units beneath the Central Plateau with the 200-UP-1 OU location identified, the artificial recharge and mounding, and the lateral and vertical extent of groundwater contaminant plumes from the contaminant source areas under current conditions.

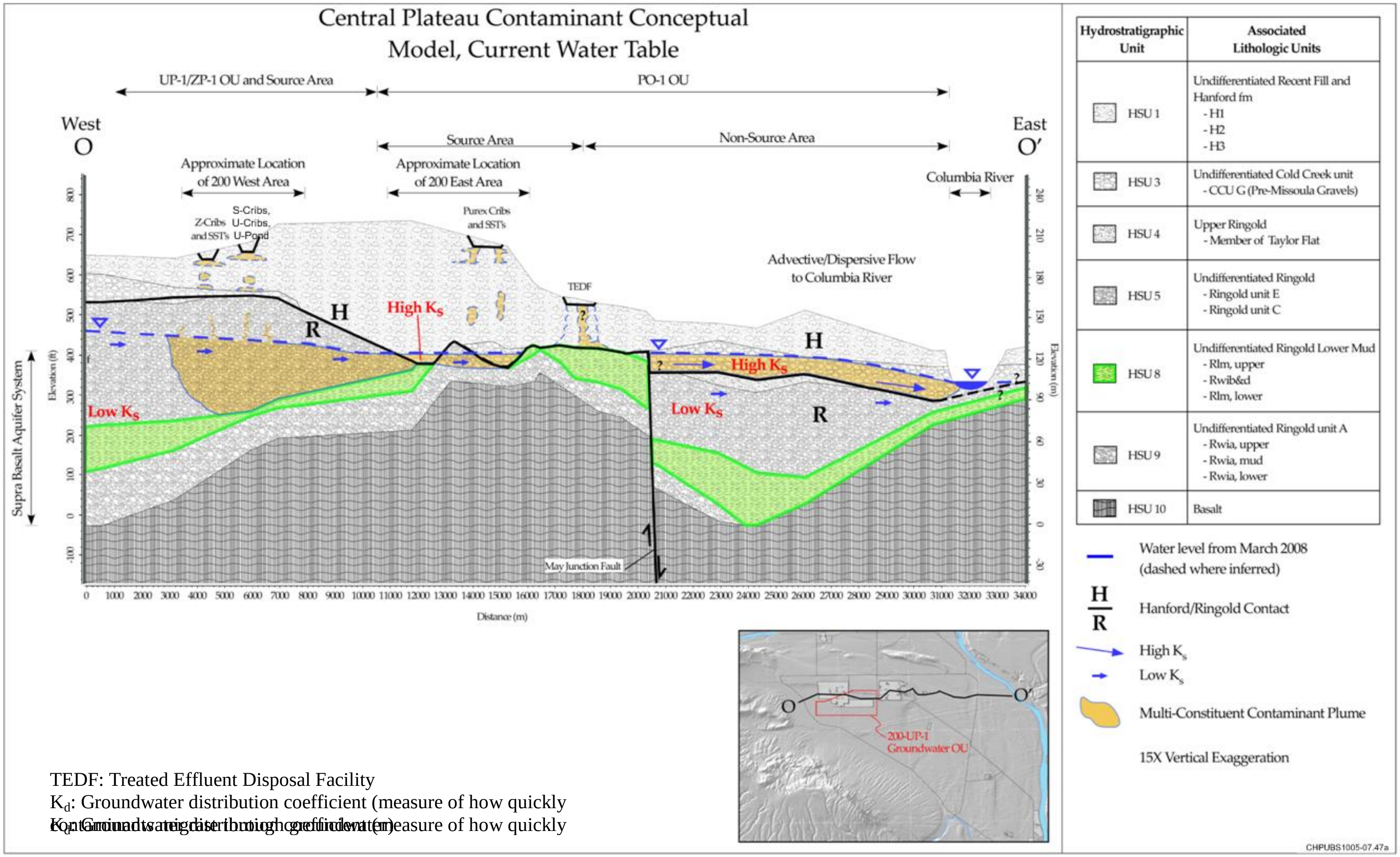
Figure 9 shows the major groundwater contamination plumes (locations and size) in the 200 West Area for carbon tetrachloride, uranium, nitrate, chromium (total and hexavalent), I-129, Tc-99, and tritium. The 200-ZP-1 plumes to the north are shown, as well.

The 200-UP-1 OU plumes include:

- A uranium plume originating from U Plant cribs
- A widespread nitrate plume originating from U Plant and S Plant cribs and WMA S-SX
- A chromium (total and hexavalent) plume associated with WMA S-SX and a dispersed chromium (total and hexavalent) plume in the southeast corner of the OU that originated from an S Plant crib
- A widespread I-129 plume originating from U Plant and S Plant cribs
- Five separate Tc-99 plumes associated with WMA U, U Plant cribs and WMA S-SX
- A widespread tritium plume originating from S Plant cribs

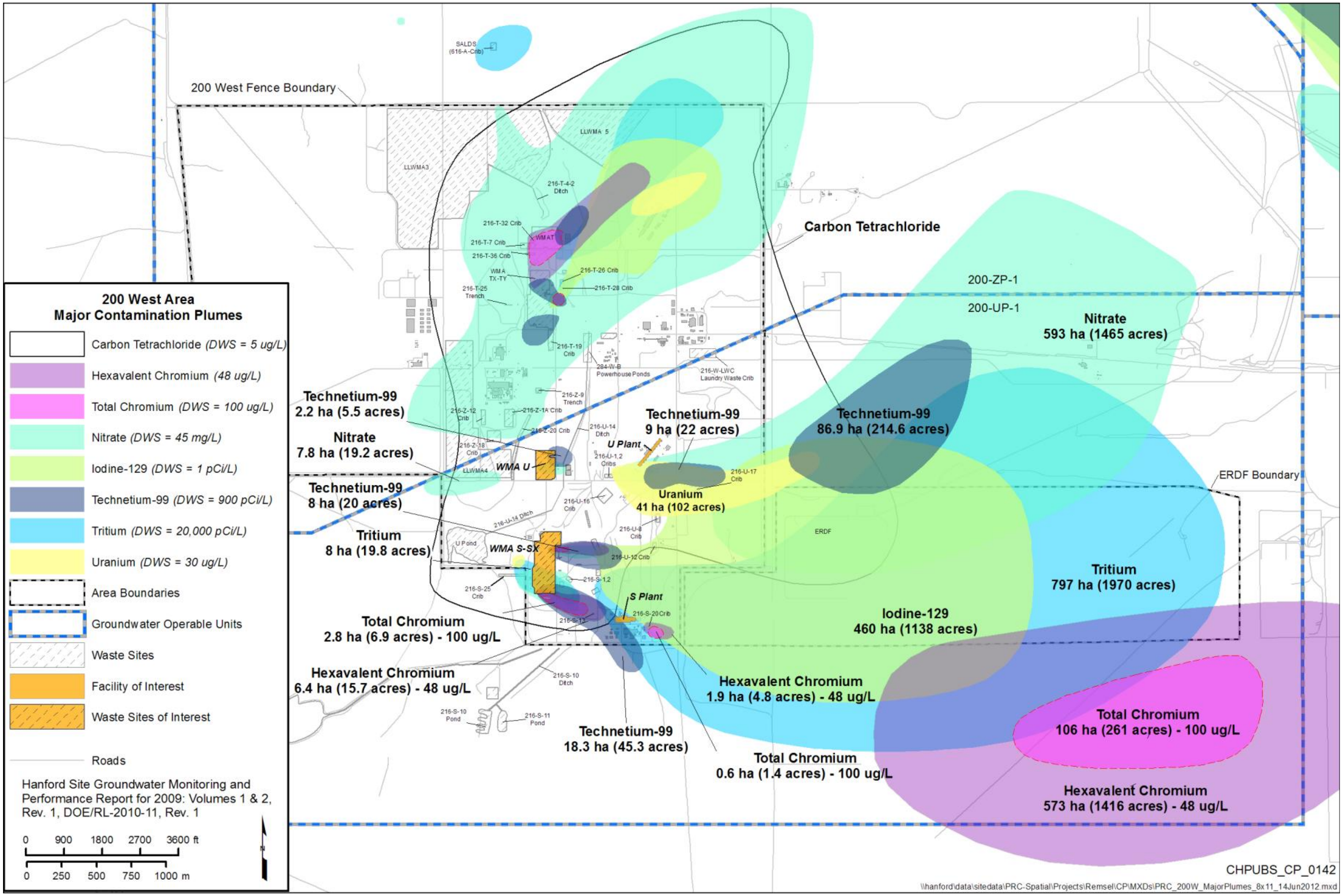
In addition to the plumes that formed within the 200-UP-1 OU, a widespread carbon tetrachloride plume exists over a large portion of the 200 West Area. This plume originated from operation of Plutonium Finishing Plant (Z Plant) facilities and has extended south and east from the 200-ZP-1 OU into the 200-UP-1 OU.

Figure 8. Conceptual Site Model Representing Current Groundwater Conditions, 200-UP-1 OU



TEDF: Treated Effluent Disposal Facility
K_d: Groundwater distribution coefficient (measure of how quickly
contaminants migrate through groundwater (m)
K_d: Groundwater distribution coefficient (measure of how quickly

Figure 9. 200-UP-1 OU Contaminant Plume Map



6.0 Current and Potential Future Site and Resource Uses

6.1 Current Land Use

Current land use on the 200 West Area of the Central Plateau where the 200-UP-1 OU is located is industrial, and public access to the site is restricted. This area includes U Plant, S Plant, WMA U, and the WMA S-SX Single Shell Tanks and numerous ponds, cribs, trenches and ponds used for waste management.

6.2 Anticipated Future Land Use

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 by DOE 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. The core zone described in the HAB advice corresponds to the Inner Area shown in Figure 1.

Land use in the 200 West and 200 East Areas are anticipated to remain industrial for the foreseeable future and will be used for ongoing waste disposal operations and infrastructure services.

6.3 Groundwater Beneficial Use

The NCP at 40 C.F.R. § 300.430(a)(1)(iii)(F) states that EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. The State of Washington defines groundwater as potable in WAC 173-340-720(2), unless the exclusion criteria in WAC 173-340-720(2)(a) through (c) can be demonstrated (insufficient yield, natural constituents that make it unsuitable as a drinking water source).

The groundwater beneath the Central Plateau within the 200-UP-1 OU does not meet the exclusion criteria; therefore, it is classified by the State as potable. The State of Washington has further determined that the highest beneficial use for potable groundwater, including the potable groundwater at the Hanford Site, is as a potential source of domestic drinking water (WAC 173-340-720(1)(a)).

Based on anticipated yield and natural water quality, under EPA's groundwater classification program, the 200-UP-1 OU groundwater would be designated Class IIB, groundwater that is a potential source of drinking water. This is also consistent with the State of Washington's determination that the 200-UP-1 OU groundwater meets the WAC 173-340-720 definition for potable groundwater, which is the highest recognized beneficial use.

6.4 Current Groundwater Use

Groundwater beneath the Central Plateau is currently contaminated, and withdrawal is prohibited as a result of institutional controls placed on its use by DOE. Under current Site use restrictions, there are no complete human exposures. There are no ecological exposure pathways for the 200-UP-1 OU since this groundwater does not discharge to surface water or reach the Columbia River at levels that present an unacceptable risk. Further, regardless of land use designations for soils, groundwater within this OU will not become a future source of drinking water until drinking water standards are achieved. Based on the selected remedy, it is expected that it will take 125 years for contaminants, except I-129, to be cleaned up to drinking water standards. Currently, a technology that can treat I-129 contamination at the concentrations present in the 200-UP-1 OU to drinking water standards has not been identified. Groundwater in the 200-UP-1 OU contaminated by I-129 above drinking water standards will not be available as a drinking water source.

7.0 Summary of Site Risks

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

7.1 Summary of Human Health Risk Assessment

The human health risk assessment for the 200-UP-1 OU was developed to quantitatively evaluate both the cancer risks and noncancer health hazards from exposure to radionuclides and nonradioactive contaminants present in groundwater. The baseline risk assessment estimates what risks the site poses if no action were 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 baseline risk assessment for this OU.

7.1.1 Identification of Contaminants of Concern

The remedial investigation evaluation of the nature and extent of contamination is discussed and summarized in Section 5.5 of this ROD. Based on the remedial investigation, which includes the results of the risk assessment, the COCs identified for the 200-UP-1 OU are carbon tetrachloride, uranium, nitrate, chromium (total and hexavalent), iodine-129 (I-129), technetium-99 (Tc-99), and tritium. Table 4 shows the range of detected concentrations and the frequency of detection for each COC in the groundwater.

Data from 2004 to 2009 (samples collected between January 12, 2004, and April 28, 2009) for 93 wells screened in the unconfined aquifer of the 200 West area were used. Unconfined aquifer wells are the most likely locations in the aquifer for eventual use as domestic water wells. In addition, the wells are screened where the contamination is known to be present in order to gain a better understanding of contaminant concentrations. The Ringold Upper Mud Unit is a confining layer present across the 200-UP-1 OU and effectively works to keep contamination in the unconfined aquifer from entering the confined aquifer. There is generally an upward gradient from the confined to the unconfined aquifer, which further restricts movement of contaminants into the confined aquifer.

Table 4. 200-UP-1 OU COC Frequency, Minimum, and Maximum Values

COC	Total Samples	Total Detects	Frequency of Detects	Units	Min Detected Result	Max Detected Result
Carbon tetrachloride	628	564	90%	µg/L	0.061	1,600
Chromium	280	191	68%	µg/L	1.3	846
Hexavalent Chromium	74	42	57%	µg/L	2.0	236
Iodine-129	452	79	17%	pCi/L	0.58	39
Nitrogen in Nitrate and Nitrite	55	53	96%	µg/L	2,000	79,300
Technetium-99	1094	952	87%	pCi/L	5.0	137,000
Tritium	451	348	77%	pCi/L	220	1.02E+06
Uranium	743	736	99%	µg/L	0.097	613

The analytical data were processed removing filtered results, data of questionable quality, and data reported in multiple ways to obtain a single set of results per sampling location and sample collection time. In total, 67,806 records were obtained before data processing occurred. Unfiltered results were used because they reflect conditions that would be present by direct extraction of groundwater from a supply well and filtered results would underestimate chemical and radiological concentrations. All sample results rejected for quality assurance/control reasons were not used. When contaminants were reported by more than one analytical method, the data were processed to select the method that provided the most reliable results. After data processing, the final dataset used to select COCs contained 44,133 records.

7.1.2 Exposure Point Concentrations (EPCs)

EPCs are used to determine the contaminant concentrations to which a receptor (human or ecological) could be exposed. The scenarios for exposure must also be identified for risk calculations. The "high end" exposure estimate is defined as the highest exposure that is reasonably expected to occur at a site but that is still within the range of possible exposures, referred to as the reasonable maximum exposure (RME) (EPA/540/1-89/002, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*). For the 200-UP-1 OU risk assessment, which assumed no land-use controls, the RME is a scenario where people could be exposed to contaminated groundwater when using it for domestic purposes such as drinking, bathing, or cooking.

EPA Superfund guidance (OSWER 9285.6-10, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*) recommends using the 95 percent upper confidence limit (95% UCL) on the mean concentration for estimating EPCs. The 95% UCL on the mean represents a value that when calculated for a random data set equals or exceeds the true mean 95% of the time. Experience at the Hanford Site indicates that averages and UCLs can sometimes be unreliable for groundwater datasets. This is in part due to Hanford groundwater data being usually collected from areas with known contamination, which results in data sets containing higher contaminant concentrations and frequencies of detection. Additionally, the groundwater at the 200-UP-1 OU exhibits an aquifer setting where multiple contaminants are present in overlapping plumes and the highest concentrations have different locations within the plumes.

The 90th percentile, which represents a value that is greater than 90% of the values in a data set, was identified as a potential value to use for EPCs. The 95% UCL and the 90th percentile values were calculated for the 200-UP-1 OU data set. In comparing these two values, the 90th percentile (with few exceptions) is a higher concentration than the 95% UCL. The comparison shows that the 90th percentile concentration values are more conservative than the 95% UCL values. For those few instances where the 90th percentile value was lower than the 95% UCL, both values were used to determine potential risks and it was determined that these contaminants would have been eliminated during the COPC selection process, regardless of which value was used. Since the 90th percentile values are more conservative than the 95% UCL values, the 90th percentile was used to determine EPCs for the 200-UP-1 OU risk assessment. Table 5 shows EPC values used to estimate the risk for each COC based on the 90th percentile calculations.

Table 5. COC Exposure Point Concentration Values

COC	Units	Number of Detections	Exposure Point Concentration (90th Percentile)	Exposure Point
Chromium	µg/L	191/280	99	Contact with groundwater through inhalation of vapors, ingestion, or dermal contact
Hexavalent Chromium	µg/L	42/74	52	
Uranium	µg/L	736/743	206	
Iodine-129	pCi/L	79/452	3.5	
Technetium-99	pCi/L	952/1094	4,150	
Tritium	µg/L	348/451	51,150	
Carbon tetrachloride	µg/L	564/628	189	
Nitrogen in Nitrate and Nitrite	µg/L	53/55	30,650	

7.1.3 Exposure Assessment

The potential pathways for exposure were depicted in Figure 6 which shows the conceptual site model for the 200-UP-1 OU. There are currently no actual exposures of either human or ecological receptors to groundwater within the 200-UP-1 OU. Except for monitoring purposes, groundwater is not currently withdrawn from the aquifer. Based on fate and transport modeling, it is anticipated that groundwater contamination in the 200-UP-1 OU will not disperse beyond the boundaries of the OU at concentrations that would pose an unacceptable risk. Based on this understanding and for the purpose of the risk assessment calculations, future adult and child receptors could potentially use the groundwater from the 200-UP-1 OU for drinking water and other domestic purposes.

Potential routes of exposure to groundwater contaminants include the following:

- Ingestion of contaminated water by drinking or in food preparation
- Inhalation of contaminant vapors during showering or other household activities
- Dermal contact exposure to contaminants in groundwater
- External radiation exposure from radioactive contaminants in groundwater (not a significant pathway)

7.1.4 Toxicity Assessment

The purpose of the toxicity assessment is to weigh the available and relevant evidence regarding the potential for contaminants to cause adverse health effects in exposed individuals and to provide a quantitative estimate of the relationship between the magnitude of exposure and the likelihood of adverse effects (EPA 540/1-89/002).

State and Federal maximum contaminant levels (MCLs) were used as part of the toxicity assessment. MCL goals are developed using an oral reference dose (RfD) for contaminants that exhibit a threshold toxic effect. The RfD is an estimate (with uncertainty spanning an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is unlikely to cause noncancer effects during a human lifetime.

The EPA has set current groundwater MCLs for radionuclides at a 4 mrem/yr dose basis for the sum of the doses from beta particle and photon emitters, 15 pCi/L for gross alpha emitter activity concentration (including Radium-226 but excluding uranium and radon), and 5 pCi/L combined activity concentration for Radium-226 and Radium-228. A mass concentration MCL has been established for uranium in groundwater as 30 μg/L. The current MCLs for beta emitters specify that MCLs are to be calculated based on an annual dose equivalent of 4 mrem to the total body or any internal organ. It is further specified that the calculation is performed on the basis of a 2 L/day (0.5 gal/day) drinking water intake, using the 168-hour data listed in NBS Handbook 69, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure*.

Washington State regulations were also considered in the toxicity assessment. Toxicological parameter values are obtained from the "Cleanup Levels and Risk Calculations" (CLARC) (Ecology, 2009a) Web-based compendium of technical information related to the calculation of cleanup levels under the MTCA (WAC 173-340) cleanup procedures. The sources for the oral cancer potency values and oral RfDs are provided in the "Cleanup Levels and Risk Calculations" (CLARC) database (Ecology, 2009a). The sources for identifying RfDs and carcinogenic potency factors are defined in WAC 173-340-708(7) and WAC 173-340-708(8), respectively.

In general, the sources of toxicity values defined by WAC 173-340-708(7) and (8) differ from the recommended hierarchy for sources as described in OSWER Directive 9285.7-53 (Cook, 2003, "Human Health Toxicity Values in Superfund Risk Assessments"). As a result of this difference, toxicity values were determined using the following recommended reference hierarchy (Cook, 2003):

- Tier 1—The EPA IRIS
- Tier 2—The EPA Provision Peer Reviewed Toxicity Values
- Tier 3—Other Toxicity Values

Tier 3 toxicity values include additional EPA and non-EPA sources of toxicity information, including: the California EPA Toxicity Criteria Database, the Agency for Toxic Substances and Disease Registry Minimal Risk Levels for Hazard Substances, and toxicity values in EPA/540/R-97-036, *Health Effects Assessment Summary Tables: FY 1997 Update*. Each of the Tier 3 toxicity values can be found in "Regional Screening Levels for Chemical Contaminants at Superfund Sites" (EPA, 2009). When Tier 1, Tier 2, or Tier 3 toxicity values were not available for a chemical, the toxicity values from the National Center for Environmental Assessment were used, which values can be found in the Oak Ridge National Laboratory Risk Assessment Information System (RAIS) database.

For carbon tetrachloride, the toxicity assessment used an oral cancer slope factor of 0.13 $(\text{mg/kg-day})^{-1}$, an oral RfD of 0.0007 (mg/kg-day), and an inhalation unit risk factor of 1.5E-05 $(\mu g/m^3)^{-1}$, as well as the inhalation reference concentration of 0.19 (mg/m^3) published by the Agency for Toxic Substances and

Disease Registry. Long-term exposure to high levels of carbon tetrachloride in drinking water can damage the central nervous system, eyes, lungs, liver and kidneys.

The RfD of 0.003 mg/kg-day that is published by EPA's Integrated Risk Information System (IRIS) was used to develop the WAC 173-340-720 groundwater cleanup level for hexavalent chromium. Long-term exposure to high levels of hexavalent chromium can cause lung cancer, nasal septum ulcerations and perforations, skin ulcerations, and allergic and irritant contact dermatitis.

A derived RfD of 7.1 mg N_{O3}-/kg-day for nitrate was calculated from the RfD reported in IRIS (1.6 mg/kg-day) for nitrate as nitrogen (NO_3--N) using the mass fraction of nitrogen in nitrate. Exposure to high levels of nitrate in drinking water in infants 6 months or younger can cause shortness of breath and blue baby syndrome.

7.1.5 Risk Characterization

Human Health Baseline Risk Assessment Results

A calculated cancer risk estimates the probability that additional cases of cancer may develop within a population if the people are exposed to contamination over the course of a lifetime. This risk estimate is referred to as the excess lifetime cancer risk (ELCR). To evaluate health risks, EPA has developed the following acceptable exposure values under CERCLA. For contaminants that are known or suspected to cause cancer, acceptable exposure levels are generally concentration levels that represent an ELCR range for an individual of one in a million (referred to as 1×10^{-6}) to one in ten thousand (referred to as 1×10^{-4}).

The 200-UP-1 OU ELCR values were calculated for the final COPCs. The final COPCs for the 200-UP-1 OU are chromium (total and hexavalent), uranium, 1,4-dioxane, carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, iodine-129, strontium-90, technetium-99, tritium, and nitrate. As explained above, the EPCs for contaminants were identified using 90^{th} percentile values. The 90^{th} percentile value represents the current groundwater concentrations for each contaminant.

A hazard quotient (HQ) is used to express the risk for contaminants that are non-cancer causing due to exposure to chemicals. An HQ is a numerical expression that indicates whether the concentration of an individual specific chemical is likely to result in adverse health effects. A hazard index (HI) is the summation of the HQs for all chemicals to which an individual may be exposed. An HI value of 1.0 or less indicates that no adverse human health effects to the non-cancerous contaminants are expected to occur.

The results of the 200-UP-1 OU baseline risk assessment indicate the potential cumulative ELCR from all nonradiological carcinogenic COPCs is 5.8×10^{-4}, meaning 5.8 additional people out of 10,000 could develop cancer if exposed over a life-time to nonradiological carcinogenic contaminants in the 200-UP-1 OU groundwater. This ELCR value is greater than the WAC 173-340, "Model Toxics Control Act—Cleanup" (MTCA) risk threshold of 1×10^{-5} for multiple hazardous substances and the upper CERCLA NCP (40 CFR 300.430) threshold of 1×10^{-4}.

The HI from non-carcinogenic hazards is 41, which is greater than the EPA and the WAC target HI of 1 (WAC 173-340-708, "Human Health Risk Assessment Procedures"), meaning adverse human health effects could occur if exposed over a life-time to non-cancer causing contaminants in the 200-UP-1 OU groundwater. Table 6 and Table 7 present the quantified results of the baseline risk assessment. Table 6 shows each contaminant's individual contribution to risk with carbon tetrachloride being the major cancer and non-cancer risk contributor.

Table 6. 90th Percentile Current Groundwater Concentrations of Nonradiological COPCs, MTCA B Non-Cancer Cleanup Levels and HQs, and Associated MTCA B Cleanup Level and Cancer ELCRs

Final COPC	Units	90th Percentile Concentration	Non Carcinogen Hazard: MTCA B Cleanup Level Noncarcinogens at HQ=1[a]	Non Carcinogen Hazard: 90th Percentile HQ	Non Carcinogen Hazard: Percent Contribution to HI	Cancer Risk: MTCA B Cleanup Level Carcinogens at 10^{-6} ELCR Risk Level[b]	Cancer Risk: 90th Percentile ELCR	Cancer Risk: Percent Contribution to ELCR
Carbon Tetrachloride	µg/L	189	5.6	34	83%	0.34	5.6×10^{-4}	95.6%
Chloroform	µg/L	7.2	80	0.09	0%	1.4	5.1×10^{-6}	0.9%
1,4-Dioxane	µg/L	6.0	800	<0.01	0%	4.0	1.5×10^{-6}	0.3%
Tetrachloroethene (PCE)	µg/L	1.0	80	0.01	0%	0.081	1.2×10^{-5}	2.1%
Trichloroethene (TCE)	µg/L	3.3	--	--		0.49	6.7×10^{-6}	1.2%
Total ELCR						--	5.8×10^{-4}	100%
Total Chromium	µg/L	99	24,000	<0.01	0%	--	--	
Hexavalent Chromium	µg/L	52	48	1.1	3%	--	--	
Nitrate as NO_3	mg/L	133	113.6	1.2	3%	--	--	
Nitrate as N	mg/L	30.1	25.6	1.2	3%			
Uranium (total)	µg/L	206	48	4.3	11%	--	- -	
Hazard Index				41	100%			

a. Contaminant concentration that would result in HQ=1 using the equations and methods described in WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards" (Washington State cleanup levels for unrestricted use).

b. Contaminant concentration that would result in ELCR=1 x 10^{-6} for individual contaminants using the equations and methods described in WAC 173-340-720, "Model Toxics Control Act—Cleanup," "Groundwater Cleanup Standards" (Washington State cleanup levels for unrestricted use).

Table 7. 90th Percentile Current Groundwater Concentrations for Radiological COPCs, Associated ELCR and Federal DWS

Final COPC	90th Percentile Concentration (pCi/L)	Federal DWS (pCi/L)	Federal DWS ELCR	Individual Dose Fraction of DWS	Individual Dose for Radiological Contaminants	90th Percentile ELCR	% Contribution to ELCR
I-129	3.5	1	2.8×10^{-6}	3.5	14	9.80×10^{-6}	4%
Strontium-90	0.66	8	8.5×10^{-6}	0.08	0.32	6.80×10^{-7}	0%
Tc-99	4,150	900	4.7×10^{-5}	4.6	18.4	2.16×10^{-4}	78%
Tritium*	51,150	20,000	1.9×10^{-5}	2.6	10.4	4.94×10^{-5}	18%
Sum of Fractions				**10.8**			-
Cumulative Annual Dose (mrem)				-	**43.1**		-
Cumulative ELCR for Radioactive COPCs				-		$\mathbf{2.76 \times 10^{-4}}$	**100%**

Other noncancer HI risk contributors are uranium, nitrate, and hexavalent chromium. The primary noncancer health effects associated with exposure to the primary HI contributors are liver toxicity (carbon tetrachloride), methemaglobenemia (nitrate), kidney toxicity (uranium), and nasal septum atrophy (nitrate).

Risk from radionuclides is estimated by the types and amount of radiation they emit. To protect public health, EPA has established DWSs for several types of radioactive contaminants: beta emitters (4 mrem/yr); gross alpha standard (15 pCi/L); and uranium (30 µg/L) (EPA 816-F-09-0004). Cancer risk factors were estimated for the radionuclide COPCs and are presented in Table 7 as individual fractions of the federal DWS (90th percentile groundwater concentration divided by the federal DWS), the sum of the fractions, the individual contaminant dose, and the cumulative annual dose (sum of fractions multiplied by the 4-mrem standard). The total ELCR for radiological COPCs is 2.76×10^{-4}, meaning 2.76 additional people out of 10,000 could develop cancer if exposed over a lifetime to radiological contaminants in the 200-UP-1 OU groundwater. This value also exceeds the CERCLA NCP (40 CFR 300.430) risk threshold of 1×10^{-4}.

A domestic groundwater-user scenario (ingestion, dermal, and inhalation) was developed as the RME for the risk assessment because the NCP expects that useable groundwater will be returned to beneficial use wherever practicable. Under EPA's groundwater classification program, the 200-UP-1 OU groundwater would be designated Class IIB, groundwater that is a potential source of drinking water, and the State of Washington has determined that the highest beneficial use of groundwater at Hanford is as a potential source of drinking water. Thus, the contaminants and related risk associated with the use of the groundwater in the 200-UP-1 OU (as a source of domestic drinking water) was evaluated. The results of the risk evaluation indicate that there are significant risks associated with the domestic use of the groundwater that exceeds acceptable risk thresholds. However, there are no current risks to onsite industrial workers or offsite human receptors from the contaminated groundwater because the existing Hanford Site access and institutional controls prevent groundwater use and exposure.

7.1.6 Uncertainties

New wells are generally sampled quarterly the first year after installation, semi-annually the second year after installation, and annually thereafter. Biennial sampling is used for existing perimeter wells that have shown stable concentrations for several years. If irregular, decreasing, or increasing trends appear, the sampling frequencies are adjusted accordingly. Sampling and analysis results from these programs comprehensively define the suite of contaminants associated with existing source area plumes. Differences in sampling frequencies (annually or tri-annually) may create uncertainties associated with the temporal representative qualities of the dataset, and may underestimate risk.

The EPCs for groundwater are calculated as the 90th percentile concentration. The protectiveness and risk evaluation methodology uses a reasonable maximum exposure concentration for each COPC for the 200-UP-1 OU, rather than performing the evaluation on a specific well or location. In general, EPA Superfund guidance recommends using a 95 percent UCL on the average for estimating EPCs. However, experience at the Hanford Site indicates that averages and UCLs cannot be reliably calculated for groundwater datasets using this approach. The 200-UP-1 OU exhibits an aquifer setting where multiple groundwater contaminants are in overlapping plumes, and the highest concentrations have different locations within the plumes. The 90th percentile from a distribution of groundwater concentration data as an EPC is a different approach from Superfund guidance for estimating EPCs in risk assessments (OSWER 9285.6-10). For the final COPCs, the 90th percentile concentrations are greater than the 95 percent UCL values, which is a more conservative estimate for the 200-UP-1 OU data set.

The toxicological database was also a source of uncertainty. EPA has outlined some of the sources of uncertainty in the risk assessment guidance (EPA/540/1-89/002) and (Cook, 2003), including the extrapolation from high to low doses and from animals to humans. This extrapolation is contingent on the species, gender, age, and strain differences in the uptake, metabolism, organ distribution, and target site susceptibility of a toxin. The human population's variability with respect to diet, environment, activity patterns, and cultural factors are also sources of uncertainty.

7.2 Summary of Ecological Risk Assessment

There were no exposure of ecological receptors to 200-UP-1 OU contamination at levels that could pose unacceptable risk. Based on fate and transport modeling, it is anticipated that groundwater contamination will not disperse beyond the boundaries of the 200-UP-1 OU at concentrations that present an unacceptable risk, even if no remedial action is taken to address the contamination. Due to this lack of direct or indirect exposure by ecological receptors to groundwater contamination from the 200-UP-1 OU at concentrations that pose unacceptable risk now or in the future, no baseline quantitative ecological risk evaluation was conducted. The human health baseline risk assessment demonstrated that cancer risks and HIs are clearly above threshold levels for acceptable risk.

7.3 Basis for Action

The response action selected in this Record of Decision 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.

8.0 Remedial Action Objectives (RAOs)

This section presents the RAOs for the remediation of the contaminated groundwater in the 200-UP-1 OU. The goal for remediation of the 200-UP-1 OU is to restore groundwater to its highest beneficial use as a potential source of drinking water.

8.1 Specific Remedial Action Objectives

Based on the expectations for groundwater restoration, the RAOs are:

- **RAO 1:** Return the 200-UP-1 OU groundwater to beneficial use as a potential drinking water source.

- **RAO 2:** Prevent human exposure to contaminated 200-UP-1 OU groundwater that exceeds acceptable risk levels for drinking water.

8.2 Basis and Rationale for Remedial Action Objectives

The RAOs are based on restoring the 200-UP-1 OU groundwater as a potential future drinking water source. The NCP establishes an expectation 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[a][1][iii][F]). EPA generally defers to state definitions of groundwater classification provided under EPA-endorsed Comprehensive State Groundwater Protection Programs (EPA/540/G-88/003).

Based on anticipated yield and natural water quality, under EPA's groundwater classification program, the 200-UP-1 OU groundwater would be designated Class IIB, groundwater that is a potential source of drinking water. This is also consistent with the State of Washington's determination that the 200-UP-1 OU groundwater meets the WAC 173-340-720 definition for potable groundwater, which is the highest recognized beneficial use.

Groundwater from the 200-UP-1 OU is contaminated and is not currently withdrawn from the aquifer for beneficial use; however, the potential beneficial use of the groundwater is as a drinking water source. All current land-use activities associated with the land located above the 200-UP-1 OU are industrial in nature. Consistent with the beneficial-use classifications of Washington State and the EPA, the goal for remediating 200-UP-1 OU groundwater is to reduce contamination to levels that will allow its use as a future drinking water source.

8.3 Purpose of Remedial Action Objectives

RAO 1 calls for returning the 200-UP-1 aquifer to beneficial use as a potential drinking water source. The risks identified above that are associated with the use of 200-UP-1 groundwater as a drinking water source will be addressed by reducing the COC concentrations in 200-UP-1 OU groundwater to levels corresponding to or below the federal DWSs or WAC 173-340-720 groundwater cleanup levels identified in Table 14.

RAO 2 calls for the prevention of groundwater use until cleanup levels protective of domestic groundwater use are achieved. Risks will be addressed by preventing exposure to the contaminated groundwater by prohibiting use of groundwater for drinking or other domestic uses until RAO 1 is achieved.

9.0 Description of Alternatives

This section describes the remedial alternatives that were developed and evaluated in the FS. The FS considered a range of remedial technologies and process options based on their effectiveness, implementability, and relative costs for attaining RAOs. For groundwater response actions, the NCP (40 CFR 300) specifies development of a limited number of cleanup alternatives that attain cleanup levels within varying timeframes. For the active remediation technology of pump-and-treat, increasing pumping rates and increasing numbers of extraction wells at varied locations were evaluated to define the variability and sensitivity in remediation timeframes and to optimize a pumping strategy. Multiple groundwater pumping scenarios were considered in assembling four potential remedial alternatives. Three viable alternatives were retained for detailed analysis. One of the alternatives did not restore the groundwater in a reasonable timeframe and therefore was not carried forward.

The three alternatives (numbered Alternatives 2 through 4), along with the NCP required “No Action” alternative, are:

- *No Action Alternative*. Under 40 CFR 300.430(e)(6), a No Action Alternative is required to provide a baseline for comparison against the other alternatives. A No Action Alternative means no further action is taken to protect human health and the environment. Under this alternative, no remedial actions would be taken and all groundwater interim actions including monitoring and ICs would be discontinued.

- *Alternative 2* – *45 Years Active Remediation, MNA, Hydraulic Containment, and ICs*. Groundwater restoration through 45 years of pump-and-treat, MNA for the portions of the contaminated groundwater remaining after pumping, hydraulic containment for I-129 and ICs until cleanup levels are met.

- *Alternative 3* – *35 years Active Remediation, MNA, Hydraulic Containment, and ICs*. Groundwater restoration through 35 years of pump-and-treat and MNA, and additional MNA for the portions of the contaminated groundwater remaining after pumping, hydraulic containment for I-129 and ICs until cleanup levels are met.

- *Alternative 4* – *25 Years Active Remediation, MNA, Hydraulic Containment, and ICs*. Groundwater restoration through 25 years of pump-and-treat, MNA for the portions of the contaminated groundwater remaining after pumping, hydraulic containment for I-129 and ICs until cleanup levels are met.

In the Proposed Plan, Alternative 3 was described as 35 years of active remediation, MNA for the portions of the contaminated groundwater remaining after pumping, hydraulic containment for I-129, and ICs until cleanup levels are met. The feasibility study for the 200-UP-1 OU Alternative 3 was based on achieving groundwater restoration for Tc-99, tritium, uranium, chromium, and nitrate within 35 years. However, cleanup levels for these contaminants can be achieved within 35 years with only a 25 year pump-and-treat program when combined with 10 years of MNA for nitrate after the pumping period. While Alternative 4 would also include a 25 year pump-and-treat program followed by MNA, it will require additional groundwater extraction in the diffuse part of the nitrate plume to reach the nitrate cleanup level in 25 years.

Alternatives 2 through 4 also include a treatment technology evaluation for reducing the concentrations of I-129 present in the 200-UP-1 OU to cleanup levels. If one or more viable technologies are identified, treatability tests will be conducted for those technologies. Hydraulic containment of the I-129 plume will be implemented until a subsequent remedial decision for the I-129 plume is made. Existing interim actions for the 200-UP-1 OU would be superseded by these alternatives.

These remedial alternatives include the use of institutional controls, which are non-engineered instruments such as administrative or legal measures to protect human health and the environment from exposure to contamination. Institutional controls that would be imposed under Alternatives 2 through 4 would prohibit the use of the groundwater for drinking or other domestic use until cleanup levels protective of those uses are achieved. The current implementation, maintenance, and periodic inspection requirements for the current 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. *The Sitewide Institutional Controls Plan* also serves as a reference for the selection of institutional controls in the future.

9.1 Description of No Action Alternative and Remedy Components

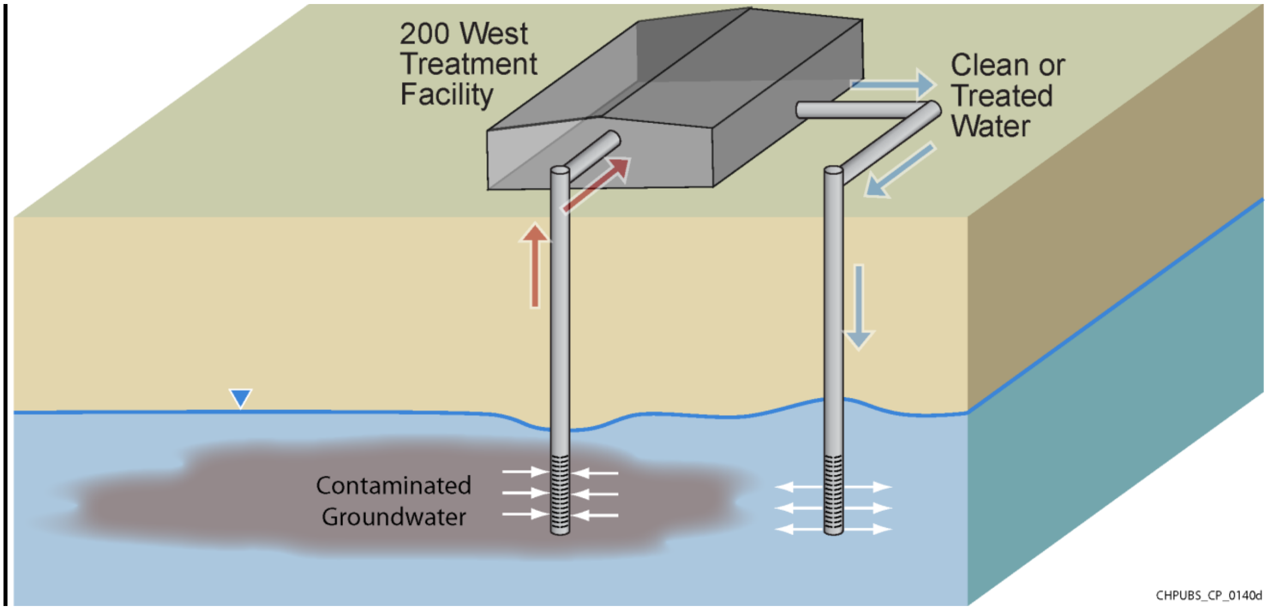
9.1.1 No Action Alternative

This alternative would leave the 200-UP-1 OU “as is” (i.e., in its current state). No institutional controls or maintenance would be implemented or continued and no active remedial action would be taken to address potential threats to human health and the environment; therefore, there are no distinguishing protectiveness or implementation features associated with this alternative. The NCP requires consideration of a No Action alternative to provide a baseline to compare against other alternatives (40 CFR 300.430(e)(6)).

9.1.2 Groundwater Extraction and Treatment Component of Alternative 2- Alternative 4

Each of the alternatives, except the No Action Alternative, includes using groundwater pump-and-treat systems. These systems consist of a network of groundwater extraction wells, conveyance piping (with transfer pump stations), and use of the existing groundwater treatment facility in the 200 West Area. Figure 10 provides a conceptual overview of a groundwater pump-and-treat system. Extraction wells would be designed, installed and operated to remove contaminated groundwater from the aquifer and to reduce or prevent further plume migration. Injection wells would be used to inject treated water back into the aquifer to provide flow path (gradient) control.

Figure 10. Conceptual Overview of Groundwater Pump-and-Treat



Treatment of contaminated groundwater would occur at the 200 West Groundwater Treatment Facility using various chemical, physical, and biological treatment processes designed specifically to treat the following COCs: carbon tetrachloride, uranium, nitrate, chromium (total and hexavalent), and Tc-99. The facility consists of two main processes and includes a separate radiological pretreatment process for groundwater containing Tc-99 and uranium using ion-exchange resins, and a central treatment process that utilizes anaerobic and aerobic biodegradation for organic contaminants, membrane filtration for removal of particulate matter, and air stripping for removal of volatile organic contaminants. The treated effluent will meet federal DWSs for the five COCs listed above and will be returned to the aquifer using vertical injection wells.

9.1.3 Monitored Natural Attenuation Component of Alternative 2- Alternative 4

MNA relies on natural processes within the aquifer to achieve reductions in the toxicity, mobility, volume, concentration, and/or bioavailability of the COCs. These natural processes include physical, chemical, and biological transformations that occur without human intervention. MNA is a viable component for the 200-UP-1 OU remedial alternatives; especially for tritium because of its short radioactive half-life (12.3 years). There is no groundwater treatment technology for this constituent. Chapter 7 of the RI/FS Report documents information supporting the conclusion that MNA will occur in combination with pump-and-treat activities to achieve the remediation goals.

Alternatives 2 and 3 rely upon MNA for the diffuse (low-concentration) nitrate plume areas not captured by the extraction wells that target the uranium plume and the high-concentration portion of the nitrate plume located near the U Plant area. MNA for tritium and carbon tetrachloride is a common component of each alternative except the No Action Alternative. MNA will address that portion of the carbon tetrachloride plume that remains after the active pumping period. Carbon tetrachloride will require the longest MNA time frame estimated to be 125 years, which is consistent with the MNA timeframe for carbon tetrachloride identified in the ROD for the adjacent 200-ZP-1 OU.

9.1.4 I-129 Hydraulic Containment and Treatment Technology Evaluation Component of Alternative 2- Alternative 4

The technology evaluation for I-129 that was completed as part of the feasibility study determined that there is no current treatment technology that can achieve the federal DWS of 1 pCi/L for the I-129 concentrations present in the 200-UP-1 OU. Therefore, pump-and-treat is not currently a viable remedy for this contaminant. Under Alternatives 2 through 4, DOE would evaluate potential treatment options for I-129 as part of the selected remedy through further technology evaluation. If one or more viable technologies are identified, treatability tests would be conducted for those technologies.
Alternatives 2 through 4 also include hydraulic containment of the I-129 plume. Hydraulic containment is achieved by installing injection wells at the leading edge of the I-129 plume, which provides flow path (gradient) control. Hydraulic containment of the I-129 plume would be implemented until a subsequent remedial decision for the I-129 plume is made.

Alternatives 2 through 4 include a waiver of the federal DWS of 1 pCi/L for I-129 which is an ARAR. Alternatives 2 through 4 are for an interim remedial action which will only be part of the total remedial action for 200-UP-1 OU that will attain or otherwise waive the ARAR for I-129 upon completion of remedial action as required by CERCLA Section 121(d)(4), “Cleanup Standards,” “Degree of Cleanup.” A subsequent ROD will be needed to complete the total remedial action for the 200-UP-1 OU. In the event a viable treatment technology is not available, the use of a technical impracticable waiver under 40 CFR 300.430(f)(l)(ii)(c) may need to be considered as part of the final remedy.

9.1.5 Remedy Performance Monitoring Component of Alternative 2- Alternative 4

Remedy performance monitoring of the groundwater will be conducted to evaluate the overall effectiveness of the selected remedy over time. Performance monitoring for the extraction well network will include: groundwater sampling and analysis for the final COPCs (which are the COCs and 1,4-dioxane, chloroform, tetrachloroethene, trichloroethene, and strontium-90) and assessment of extraction well flow rates and water level measurements. This will allow evaluation of each contaminant’s mass removal rate and determination of the effectiveness of the pump-and-treat component as well as the effectiveness of the injection well network to hydraulically contain the I-129 plume.

Performance monitoring of the 200 West Groundwater Treatment Facility includes sampling and analysis to evaluate the efficiency of COC removal from extracted groundwater and to ensure the groundwater meets the injection requirements before being returned to the aquifer. Performance monitoring will also be used to confirm that the natural attenuation processes for carbon tetrachloride, tritium and nitrate are performing as planned.

9.1.6 Institutional Controls Component of Alternative 2- Alternative 4

ICs are instruments, such as administrative and/or legal restrictions, that are designed to control or eliminate specific pathways of exposure to contaminants until remedial goals are achieved. DOE is responsible for implementing, maintaining, reporting on, and enforcing ICs for the Hanford Site and for current CERCLA response actions. Institutional controls will be required for the 200-UP-1 OU as long as groundwater contamination precludes its use as a potential source of drinking water. These institutional controls include the requirement that DOE control access to groundwater to prevent exposure of humans to contaminated groundwater, except as otherwise authorized by EPA and the requirement that DOE control activities that would damage components of the remedy or disrupt or lessen performance of any component of the remedy. DOE would be responsible for implementing, maintaining, reporting on, and enforcing the institutional controls. Although DOE may later transfer these procedural responsibilities to another party by contract, property conveyance agreement, or through other means, DOE would retain ultimate responsibility for remedy integrity and institutional controls.

9.1.7 Operations and Maintenance (O&M) Component of Alternative 2- Alternative 4

O&M of each remedial alternative (except the No Action Alternative) is required to ensure that the remedy achieves RAOs and that activities necessary to operate and maintain the remedy from completion of construction through decontamination and decommissioning of the remedy, after RAOs have been attained, are conducted.

O&M activities for the groundwater and MNA remedy components primarily include inspection, maintenance, and periodic replacement of monitoring wells, whereas pump-and-treat components include routine and preventative maintenance programs as well as replacement of pump-and-treat system components at the end of their design life. Alternative 2, which has a longer duration, includes multiple replacements of system components.

9.2 Common Elements of Each Alternative

Alternatives 2 through 4 share several common components, including groundwater pump-and-treat, remedy performance monitoring, MNA, hydraulic containment of 1-129, an I-129 treatment evaluation and treatability tests of identified viable technologies, O&M, and ICs, as described above under the description of remedy components.

The key chemical-specific requirements that are applicable or relevant and appropriate to Alternatives 2 through 4 for the remediation of the 200-UP-1 OU are the federal and state DWSs or MCLs(40 CFR 141, WAC 173-340-720[4][b][iii][A] and [B]) and state groundwater cleanup standards (WAC 173-340-720[7][b]). Alternatives 2 through 4 include a waiver of the federal DWS of 1 pCi/L for I-129 which is an ARAR. Alternatives 2 through 4 are for an interim remedial action which will only be part of the total remedial action for 200-UP-1 OU that will attain or otherwise waive the ARAR for I-29 upon completion of remedial action as required by CERCLA Section 121(d)(4), "Cleanup Standards," "Degree of Cleanup."

9.3 Expected Outcomes of Each Alternative

The expected outcomes of each alternative are described below.

9.3.1 Expected Outcomes of the No Action Alternative

Under 40 CFR 300.430(e)(6), a No Action Alternative is included to provide a baseline for comparison against the other alternatives. Under the No Action Alternative, no active remedial action would be taken to address potential threats to human health and the environment posed by the COCs present. While radioactive decay and other natural attenuation processes would reduce COC concentrations in groundwater over time, no monitoring would be conducted to track concentration changes or plume migration. This alternative would not achieve ARARs in a reasonable time frame or be protective of human health and the environment.

9.3.2 Expected Outcomes of Alternative 2

Alternative 2, *45 Years Active Remediation, MNA, Hydraulic Containment, and ICs*, is summarized below:

- Estimated Capital Cost: $88 million (non-discounted)
- Estimated O&M and Periodic Cost: $367 million (non-discounted)
- Estimated Present Value: $314 million
- Time to Achieve Cleanup Levels: 15 years for Tc-99, 40 years for uranium, and 45 years for chromium (total and hexavalent) through pump-and-treat; 35 years for nitrate and 125 years for carbon tetrachloride through pump-and-treat and MNA; 25 years for tritium through MNA.

Approach and Description
Alternative 2 combines groundwater pump-and-treat at an estimated total pumping rate of 330 gpm for parts of the carbon tetrachloride plume, the Tc-99 plumes, the uranium plume, the high concentration nitrate plume, and the chromium (total and hexavalent) plumes, with hydraulic containment of the I-129 plume at an estimated injection rate of 150 gpm. Alternative 2 is to be designed to achieve cleanup levels for Tc-99 within 15 years, for uranium within 40 years, and for chromium (total and hexavalent) within 45 years. Limited modifications to the 200 West Groundwater Treatment Facility are required for this alternative. The facility would be maintained and updated to extend operations for up to 45 years. MNA for the low concentration nitrate plume area and tritium plume is expected to achieve cleanup levels within 35 years, and 25 years, respectively. A total duration of approximately 125 years (including active restoration and MNA) is required for carbon tetrachloride to reach cleanup levels. ICs will prevent exposure and groundwater use until cleanup levels are achieved.

Estimated number of wells and pumping rates are as follows:

- Tc-99 pump-and-treat operation in the WMA S-SX area—three extraction wells with a total pumping rate of 80 gpm for 15 years.
- Pump-and-treat for the uranium plume and high concentration nitrate plume area—two extraction wells and two injection wells with a total pumping rate of 100 gpm for 40 years.
- Pump-and-treat for the chromium (total and hexavalent) plume—two extraction wells and two injection wells with a total pumping rate of 150 gpm for 45 years.

9.3.3 Expected Outcomes of Alternative 3
Alternative 3, *35 Years Active Remediation, MNA, Hydraulic Containment, and ICs*, is summarized below:

- Estimated Capital Cost: $131 million (non-discounted)
- Estimated O&M and Periodic Cost: $293 million (non-discounted)
- Estimated Present Value: $329 million
- Time to Achieve Cleanup Levels: 15 years for Tc-99, 25 years for uranium, and 25 years for chromium (total and hexavalent) through pump-and-treat; and 35 years for nitrate and 125 years for carbon tetrachloride through pump-and-treat and MNA; 25 years for tritium through MNA.

Approach and Description
Alternative 3 combines groundwater pump-and-treat at an estimated extraction rate of 430 gpm for parts of the carbon tetrachloride plume, the Tc-99 plumes, the uranium plume, the high concentration nitrate plume, and the chromium (total and hexavalent) plumes, with hydraulic containment of the I-129 plume at an estimated injection rate of 150 gpm. Alternative 3 is to be designed to achieve cleanup levels for Tc-99 within 15 years, for uranium within 25 years, for chromium (total and hexavalent) within 25 years, and for nitrate within 35 years through pump-and-treat and MNA. MNA for the tritium plume achieves cleanup levels within 25 years.

A total duration of approximately 125 years (including active restoration and MNA) is required for carbon tetrachloride to reach the cleanup level. ICs will prevent exposure and groundwater use until cleanup levels are achieved.

Alternative 3 includes the same remedy components described in Alternative 2, but adds additional groundwater extraction from the nitrate and chromium areas in order to reduce the concentrations of these contaminants more quickly. The estimated number of wells and pumping rates are as follows:

- Pump-and-treat for the uranium plume and high concentration nitrate plume area – two extraction wells and two injection wells with a pumping rate of 150 gpm for 25 years. 10 years of MNA would be used to achieve cleanup levels for nitrate for a total of 35 years.
- Pump-and-treat for the chromium (total and hexavalent) plumes – two extraction wells and two injection wells with a total pumping rate of 200 gpm for 25 years.

This alternative requires that the additional flow and COC concentrations from the extraction wells be accommodated at the 200 West Groundwater Treatment Facility with the installation of additional biological treatment process equipment. This additional capacity and space for the needed equipment has already been designed into the plant's foot print.

9.3.4 Expected Outcomes of Alternative 4

Alternative 4, *25 Years Active Remediation, MNA, Hydraulic Containment, and ICs*, is summarized below:

- Estimated Capital Cost: $142 million (non-discounted)
- Estimated O&M and Periodic Cost: $309 million (non-discounted)
- Estimated Present Value: $352 million
- Time to Achieve Cleanup Levels: 15 years for Tc-99, 25 years for uranium, 25 years for chromium (total and hexavalent), and 25 years for nitrate through pump-and-treat; 125 years for carbon tetrachloride through pump-and-treat and MNA; 25 years for tritium through MNA.

Approach and Description

Alternative 4 is identical to Alternative 3, but it would require at least one additional extraction well pumping at a rate of 100 gpm for 20 years to address the low-concentration portion of the nitrate plume. This increases the overall estimated pumping rate to 530 gpm. The duration of active remediation for Alternative 4 is 25 years. Alternative 4 is to be designed to achieve cleanup levels for Tc-99 within 15 years, for uranium within 25 years, for chromium (total and hexavalent) within 25 years, and for nitrate within 25 years. MNA for the tritium plume achieves cleanup levels within 25 years and MNA for carbon tetrachloride remains at 125 years under this alternative.

10.0 Comparative Analysis of Alternatives

This section of the ROD summarizes the comparative analysis of alternatives presented in 200-UP-1 OU FS. 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 alternative 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 for 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 acceptance and community acceptance, are defined as "modifying criteria." Table 9 at the end of this section shows a summary of the detailed analysis of the alternatives. Table 10, also located at the end of this section, shows a summary of the comparative analysis of the alternatives.

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 by considering how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

All of the alternatives, except the No Action Alternative, protect human health by preventing exposure to contaminated groundwater through the use of ICs until cleanup levels are achieved for all COCs. The No Action alternative is not protective of human health and the environment because it does not prevent exposure or plume migration and does not require action to achieve cleanup levels protective of human health. Alternatives 2 through 4 are protective of human health by preventing exposure to contaminated groundwater through the use of ICs until cleanup levels are achieved. Alternative 4 achieves cleanup levels for Tc-99, uranium, chromium, and nitrate sooner than Alternative 2 and achieves cleanup levels for nitrate sooner than Alternative 3. Alternatives 3 and 2 are protective of human health and the environment; however, these two alternatives rely on groundwater extraction and treatment combined with MNA to address the diffuse nitrate plume. Under all three alternatives tritium and parts of the carbon tetrachloride plume not addressed through pump-and-treat are addressed through MNA and the I-129 plume is hydraulically contained while a technology evaluation effort to identify viable treatment options is completed.

10.2 Compliance with ARARs

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 environmental 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.

Alternatives 2 through 4 comply with location-specific, action-specific, and chemical-specific ARARs. All of the alternatives, except the No Action Alternative, comply with chemical-specific ARARs within time frames that decrease from 45 years under Alternative 2, to 35 years under Alternative 3, to 25 years under Alternative 4 for all COCs except carbon tetrachloride and I-129. Compliance with the chemical-specific DWS ARAR for carbon tetrachloride requires up to 125 years for all three alternatives. Alternatives 2 through 4 include an interim waiver of the federal DWS of 1 pCi/L for I-129, which is an ARAR. I-129 will undergo a technology evaluation to identify potential treatment options. The I-129 plume will be hydraulically contained under Alternatives 2 through 4 until a subsequent remedial decision for the I-129 plume is made.

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, after RAOs have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Alternatives 2, 3 and 4 provide good and comparable levels of long-term effectiveness and permanence for the Tc-99, uranium, chromium, and carbon tetrachloride plumes because the volume of contaminated groundwater that is treated for these COCs is similar, although the pumping rates will vary. Alternative 4 is superior with respect to nitrate because it addresses the diffuse portion of the nitrate plume through pump-and-treat. Under all three alternatives, treatment residuals would be immobilized and disposed at a secure long-term management facility (ERDF). All three alternatives provide comparable levels of long-term effectiveness and permanence for I-129 and tritium because the remedial alternative components addressing these two COCs are the same.

10.4 Reduction of Toxicity, Mobility, and Volume (TMV) Through Treatment

The reduction of toxicity, mobility, or volume through treatment criterion assesses the anticipated performance of the treatment technologies that may be included as part of a remedial action.

Alternative 4 provides the highest degree of TMV reduction for the Tc-99, uranium, nitrate, chromium, carbon tetrachloride and nitrate plumes because COC mass is removed more quickly from the aquifer through pump-and-treat. Alternative 3 has comparable levels of TMV reduction to Alternative 4 for all COCs except nitrate. Although the total volume of groundwater pumped and treated is similar amongst the three alternatives, Alternative 2 has less early uranium and chromium TMV reduction because it employs lower pumping rates over a longer period of time. All three alternatives have comparable levels of TMV reduction for carbon tetrachloride, Tc-99, I-129 and tritium because the approach for addressing these COCs is the same.

10.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts on human health and the environment that may be posed during construction and implementation of the remedy.

Alternatives 2, 3, and 4 provide similar levels of short-term effectiveness relative to potential adverse impacts to the community because the 200-UP-1 OU is located in a remote portion of the Hanford Site where community exposure would not occur.

With respect to potential adverse impacts to workers and the environment, all work associated with these alternatives can be performed safely with minimal risk to workers and the environment by conducting the work per existing Site safe work procedures.

At 25 years, Alternative 3 and 4 have the shortest active remediation time frame followed by Alternative 2 at 45 years. However, under all three alternatives, up to 125 years is required for MNA to address the carbon tetrachloride plume remaining after pumping. Each of the alternatives is similar with respect to short term effectiveness.

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 construction work associated with all three alternatives is readily implementable using existing Hanford Site safe work procedures. The 200 West Groundwater Treatment Facility has been constructed and is operational. As pumping rates and the amount of groundwater extracted increase, the degree of difficulty associated with remedy implementation increases. Alternative 4 is expected to pose implementation challenges because of the increased O&M associated with operation of the biological treatment process required to treat the larger volumes of nitrate contaminated groundwater resulting from operation of the nitrate extraction wells. More aggressive pumping of nitrate contamination adds additional complexity for operations and creates additional solid material handling, dewatering and onsite disposal. The biological treatment process consists of using microorganisms to reduce contaminant concentrations. Increased amounts of nitrate could potentially result in periodic overload of the biological system and result in shut-down periods of the facility as their populations are restored. Additionally, increased microorganism activity results in more solid material requiring dewatering and disposal. Although Alternative 2 does not require modification of the 200 West Groundwater Treatment Facility for addition biological treatment processing, whereas Alternatives 3 and 4 do, Alternative 2 will require remedial process optimization to ensure that pumping and treatment throughput rates can be maintained over the active remediation time period. Under Alternative 2, optimization would be more difficult than under Alternatives 3 and 4 since there would be less treatment capability. Therefore, Alternative 2 was judged to be more difficult to implement than Alternative 3 and comparable in difficulty to Alternative 4.

10.7 Cost

Cost estimates are developed for each remedial action alternative for comparison purposes. Cost estimates are developed with an expected accuracy range of –30 to +50 percent. The types of costs that shall be assessed are: (1) Capital costs, including both direct and indirect costs (2) Annual operations and maintenance costs; and (3) Net present value of capital and O&M costs (40 CFR 300.430 (e)(9)(iii)(G)).

Alternative 2 at a total present value cost of $314 million has the lowest cost followed by Alternative 3 at $329 million, and Alternative 4 at $352 million. The total present value costs for Alternatives 2, 3, and 4 does include cost for I-129 technology evaluation work, including potential treatability testing. The present value cost represents the dollars that would need to be set aside today, at the defined interest rate (2.0%), to ensure that funds would be available in the future as they are needed to perform the remedial alternative. The costs are shown in Table 8. The cost estimates were developed in accordance with EPA/540/R-00/002. The TRACE, V 3.0 cost estimating workbook (CHPRC, 2012), Tool for Response Action Cost Estimating Microsoft Excel® Workbook (TRACE) was used in conjunction with Microsoft Excel (MS Excel)™ software to develop the cost estimate for each of the RA alternatives. These estimates were prepared to meet the -30 to +50 percent range of accuracy recommended in EPA (EPA/540/G-89/004) CERCLA guidance.

Table 8. Comparison of Remedial Alternative Costs for the 200-UP-1 OU

Item Description	No Action	Alternative 2	Alternative 3	Alternative 4
Capital Cost	$0	$88,048,000	$131,348,000	$141,629,000
Total O&M and Periodic Cost (non-discounted)	$0	$367,413,000	$293,477,000	$308,876,000
Average Year over Year O&M and Periodic Cost through Remedy Completion	$0	$7,204,000	$7,158,000	$9,964,000
Total Non-Discounted	$0	$455,461,000	$424,825,000	$450,505,000
Total Present Value (Discounted)*	$0	$313,901,000	$328,940,000	$352,038,000
Total Present Value – 30%	$0	$219,731,000	$230,258,000	$246,427,000
Total Present Value +50%	$0	$470,852,000	$493,410,000	$528,057,000

Note 1: Present Value real discount rate percent used is 2.0 percent.

Note 2: The initial capital costs for construction of the 200 West Groundwater Treatment Facility were accounted for in the 200-ZP-1 ROD in 2008.

Note 3: Periodic costs include costs for institutional controls for 150 years.

* The total net present value cost, capital cost, O&M cost, and periodic costs do not include design, construction and O&M/periodic allowances for an I-129 final remedy.

10.8 State Acceptance

The State acceptance criterion addresses the State's position and key concerns related to the preferred alternative and other alternatives and State comments on ARARs or the proposed use of waivers.

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-UP-1 OU interim remedy. Ecology supports the proposed 200-UP-1 OU interim 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-UP-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 interim ROD against the seven MTCA requirements: (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 believes that the 200-UP-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 being attained for contaminants other than I-129, and while a technology for addressing I-129 is evaluated. Ecology expects the Department of Energy to work aggressively toward identifying such a technology as required by the ROD. Compliance monitoring must be addressed in corrective action, and Ecology notes that the interim 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 may remediate past and potential future contaminants coming into groundwater from the single-shell tank farm waste management areas (U, S and SX) and 216-S-10 Pond and Ditch. These units/areas are geographically located above the 200-UP-1 OU.

Ecology will review any monitoring plan required by this ROD. Ecology will either determine that the groundwater requirements, including 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 groundwater requirements for other TSD units, or Ecology will impose required unit groundwater requirements through conditions in the Site-wide Permit.

10.9 Community Acceptance

The Community Acceptance criterion is assessed by determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. Public comments were accepted during a 30 day public comment period on the Proposed Plan. Overall, the public was generally supportive of this interim remedial action. Commenters also expressed support for more aggressive pumping rates. The public's comments, along with the Tri-Parties' responses, are included in the Responsiveness Summary in Part III of this ROD.

Table 9. Detailed Analysis of Alternatives Summary for the 200-UP-1 OU

Criteria	No Action Alternative	Alternative 2 - 45 Years Active Remediation and MNA	Alternative 3 - 35 Years Active Remediation and MNA	Alternative 4 - 25 Years Active Remediation and MNA
Overall Protection of Human Health and the Environment				
Human Health Protection				
Direct contact	There is some risk reduction through natural attenuation. There are no current groundwater users.	Active treatment of Tc-99, uranium, chromium (total and hexavalent), carbon tetrachloride, and concentrated portion of nitrate plume through P&T reduces risk; ICs prevent exposure until active treatment and MNA achieves protective cleanup levels (see Table 14). I-129 is addressed through hydraulic containment and ICs until a subsequent remedial decision for I-129 is identified.	More aggressive active treatment for uranium, chromium (total and hexavalent), carbon tetrachloride, and concentrated portion of nitrate plume through P&T accelerates risk reduction; ICs prevent exposure until active remediation and MNA achieve protective cleanup levels (see Table 14). I-129 is addressed through hydraulic containment and ICs until a subsequent remedial decision for I-129 is identified.	Same as alternative 3 except provides additional treatment of nitrate plumes through P&T, reduces nitrate risk within the shortest practicable time frame; ICs prevent exposure until active remediation and MNA achieve protective cleanup levels (see Table 14). I-129 is addressed through hydraulic containment and ICs until a subsequent remedial decision for I-129 is identified.
Groundwater ingestion for existing users				
Groundwater ingestion for future users	This alternative does not protect future users because it contains no measures to eliminate, reduce, or control exposures or restore groundwater to protective levels for ingestion for future users.			
Environmental Protection	COC plumes migrate but do not leave the OU at levels that pose an unacceptable risk.	Active pump and treatment reduces COC migration through flow path control and reduces COC concentrations; hydraulic containment prevents further expansion of I-129 plume.	Same as alternative 2 expect includes higher extraction rates for uranium, chromium (total and hexavalent), carbon tetrachloride, and concentrated portion of nitrate plume which accelerates COC concentration reductions.	Same as Alternative 3, except provides extraction of diffuse part of the nitrate plume, which reduces the time needed to reach the nitrate cleanup level.
Compliance with ARARs				
Chemical-specific	Groundwater will exceed MCLs.	These alternatives comply with chemical-specific ARARs within time frames that decrease from 45 years under Alternative 2, to 35 years under Alternative 3, to 25 years under Alternative 4 for all COCs except carbon tetrachloride and I-129. Compliance with the chemical-specific DWS ARAR for carbon tetrachloride requires up to 125 years for all three alternatives. These alternatives include an interim remedial action waiver for the DWS for I-129 until a subsequent remedial decision is identified.		

Criteria	No Action Alternative	Alternative 2 - 45 Years Active Remediation and MNA	Alternative 3 - 35 Years Active Remediation and MNA	Alternative 4 - 25 Years Active Remediation and MNA
Location-specific	Would not invoke any location-specific ARARs because there would be no action.	Will meet location-specific ARARs: *Archeological and Historic Preservation Act of 1974, National Historic Preservation Act of 1966, Native American Graves Protection and Repatriation Act of 1990, Endangered Species Act of 1973, and Migratory Bird Treaty Act of 1918*		
Action-specific	Would not invoke any action-specific ARARs because there would be no action.	Will meet action-specific ARARs. Off gas from groundwater treatment operations would meet air discharge standards. COC concentrations in treated water would meet UIC requirements. Management of waste generated would meet substantive solid and dangerous waste requirements. Well construction, placement and maintenance would meet substantive state water well standards		
Other criteria and guidance	Would not apply because there would be no action.	No other criteria or guidance were identified for consideration in these remedial alternatives.		
Long-term Effectiveness and Permanence				
Magnitude of Residual Risk				
Direct contact	Some reduction in risk would occur from natural attenuation processes for carbon tetrachloride, tritium, chromium (total and hexavalent), and nitrate. I-129, Tc-99, and uranium would pose long-term risk. There would be no ICs to prevent exposure to contaminated groundwater.	ICs can be maintained and extended as necessary to protect against inadvertent exposure until cleanup levels are achieved. Treatment residuals transported to secure facility for long-term management. Carbon tetrachloride will continue to pose a risk during the 125 year MNA period needed to achieve its cleanup level. Tritium will decay to its cleanup level within 25 years. I-129 will be hydraulically contained until a subsequent remedial decision is identified. I-129 will continue to pose a long-term risk.		
Groundwater ingestion for existing users				
Groundwater ingestion for future users				
Adequacy and Reliability of Controls	No controls over contamination. No reliability.	Active treatment using P&T technology and MNA with disposal of treatment residuals at ERDF is a reliable means for removing and managing contaminant mass long-term and achieving cleanup levels. ICs are reliable tool for preventing exposure until cleanup levels are achieved. Contaminants will not remain above health based cleanup levels after the remedy has been implemented, except for I-129. I-129 will be hydraulically contained until a subsequent remedial decision is identified.		

Criteria	No Action Alternative	Alternative 2 - 45 Years Active Remediation and MNA	Alternative 3 - 35 Years Active Remediation and MNA	Alternative 4 - 25 Years Active Remediation and MNA
Reduction of Toxicity, Mobility, or Volume through Treatment				
Treatment Process Used	None.	Extraction wells, ion exchange, biological, air stripping, granular activated carbon, injection wells.		
Amount Destroyed or Treated	None.	Volume of groundwater treated and mass of contaminants removed is expected to be comparable between these two alternatives. Under Alternative 3 the treatment occurs within a shorter time frame.		Because this alternative includes extraction of the diffuse part of the nitrate plume, the volume of groundwater treatment and mass of nitrate removed is greatest under this alternative and comparable to Alternatives 2 and 3 for the remaining COCs.
Reduction of Toxicity, Mobility and Volume	None.	The contaminant mass above Federal and/or State drinking water standards will be removed through pump-and-treat for uranium, chromium (total and hexavalent), the concentrated portion of the nitrate plume, and portions of the carbon tetrachloride plume remaining after pumping. The remaining portions of the carbon tetrachloride plume will be addressed through a 125 year period of MNA. Tritium will require a 25 year MNA period. I-129 concentrations will not be reduced and the I-129 plume will be hydraulically contained until a subsequent remedial decision is identified.		The contaminant mass above Federal and/or State drinking water standards will be removed through pump-and-treat for uranium, chromium (total and hexavalent), the entire nitrate plume, and portions of the carbon tetrachloride plume remaining after pumping. The remaining portions of the carbon tetrachloride plume will be addressed through a 125 year period of MNA. Tritium will require a 25 year MNA period. I-129 concentrations will not be reduced and the I-129 plume will be hydraulically contained until a subsequent remedial decision is identified.
Irreversible Treatment	None.	Technologies used for treatment of radionuclides, volatile organics, an inorganics are irreversible as is MNA component. Treatment through IX and vapor phase granular activated carbon treatment media used in 200 West Groundwater Treatment Facility is irreversible.		
Type and Quantity of Residuals Remaining	No treatment.	Nitrate and carbon tetrachloride remaining above cleanup levels after active treatment through pump-and-treat addressed through MNA.		Carbon tetrachloride remaining above cleanup levels after active

Criteria	No Action Alternative	Alternative 2 - 45 Years Active Remediation and MNA	Alternative 3 - 35 Years Active Remediation and MNA	Alternative 4 - 25 Years Active Remediation and MNA
After Treatment		Treatment residuals will be transported to secure facility for long-term management. Comparable amounts of treatment residuals would be produced under Alternatives 2 and 3.		treatment through pump-and-treat addressed through MNA. Treatment residuals will be transported to secure facility for long-term management. Because this alternative includes extraction of the diffuse part of the nitrate plume, more treatment residuals will be produced than under Alternatives 2 and 3.
Short-term Effectiveness				
Community Protection	Continued risk to the community because no remedial action is performed.	Due to remote site location no potential adverse impacts to community during construction and system operation were identified.		
Worker Protection	No increased risk to workers because no remedial action is performed.	All work associated with these alternatives can be performed safely with minimal risk to workers and the environment by conducting the work per existing Site safe work processes to reduce any potential adverse impacts to workers and the environment. Risks include possible injuries during well construction and piping installation and potential exposure to contaminated groundwater.		
Environmental Impacts	COCs would remain in the aquifer because no remedial action is performed.	Vapor emissions during groundwater treatment operations will be monitored to ensure that air emission standards are met. Pump-and-treat operations would impact groundwater flow in the aquifer, creating a cone of influence around each extraction well and reinjeting water to provide flow path (gradient) control.		
Time until actions complete	Not applicable because no action is taken.	45 years total to meet cleanup levels for uranium, nitrate, chromium (total and hexavalent), tritium, and Tc-99. 125 years of MNA for carbon tetrachloride. I-129 is addressed through hydraulic containment until a subsequent remedial decision for I-129 is identified.	35 years total to meet cleanup levels for uranium, nitrate, chromium (total and hexavalent), tritium, and Tc-99. 125 years of MNA for carbon tetrachloride. I-129 is addressed through hydraulic containment until a subsequent remedial decision for I-129 is identified.	25 years total to meet cleanup levels for uranium, nitrate, chromium (total and hexavalent), tritium, and Tc-99. 125 years of MNA for carbon tetrachloride. I-129 is addressed through hydraulic containment until a subsequent remedial decision for I-129 is identified.

Criteria	No Action Alternative	Alternative 2 - 45 Years Active Remediation and MNA	Alternative 3 - 35 Years Active Remediation and MNA	Alternative 4 - 25 Years Active Remediation and MNA
Implementability				
Ability to Construct and Operate	No construction or operations.	The groundwater treatment facility is already constructed and operational. Installing new extraction/injection wells and uranium ion exchange can be readily done. Does not require modification of the treatment facility, but will require remedial process optimization to ensure that pumping and treatment throughput rates can be maintained over the 45 year pump-and-treat time frame. Optimization would be more difficult than Alternatives 3 and 4 since there would be less treatment capability. MNA for tritium, nitrate, and carbon tetrachloride can be readily implemented. Hydraulic containment for I-129 is similar to flow-path control approach used in 200-ZP-1 OU and readily implementable.	The groundwater treatment facility is already constructed and operational. Installing new extraction/injection wells and adding uranium ion exchange to the treatment facility can be readily done. Requires modification to the treatment facility for additional biological treatment processes. MNA for tritium, nitrate, and carbon tetrachloride can be readily implemented. Hydraulic containment for I-129 is similar to flow-path control approach used in 200-ZP-1 OU and readily implementable	The groundwater treatment facility is already constructed and operational. Installing new extraction/injection wells and adding uranium ion exchange to treatment facility can be readily done. Requires modification to the treatment facility for additional biological treatment processes. Pumping of the diffuse part of the nitrate plume results in increased amounts of nitrate sent to the treatment facility and requires additional biological treatment than under Alternative 3. Larger amounts of nitrate sent for treatment could potentially result in periodic overload of the biological system and result in unplanned shut-down periods if not adequately accounted for in design and operation. MNA for tritium and carbon tetrachloride can be readily implemented. Hydraulic containment for I-129 is similar to flow-path control approach used in 200-ZP-1 OU and readily implementable.
Ease of Doing More Action if Needed	May need to go through the feasibility study and Record of Decision Process again.	Additional extraction and injection wells can be readily installed. Additional treatment capacity at 200 West Groundwater Treatment Facility can be made available.		

Criteria	No Action Alternative	Alternative 2 - 45 Years Active Remediation and MNA	Alternative 3 - 35 Years Active Remediation and MNA	Alternative 4 - 25 Years Active Remediation and MNA
Ability to Monitor Effectiveness	No monitoring. May result in exposure to contaminated groundwater.	Groundwater and treatment plant effluent monitoring can readily be conducted to monitor the effectiveness of these alternatives.		
Ability to Obtain Approvals and Coordinate with Other Agencies	No approval necessary.	Since DOE, EPA, and Ecology work together under the Tri-Party Agreement, there are no expected coordination issues. Work plans will require lead regulatory agency approval. Ability to obtain such approvals is comparable for all 3 alternatives.		
Availability of Services and Capacities	No services or capacities required.	Readily available.		
Availability of Equipment, Specialists, and Materials	None required.	Readily available.		
Availability of Technologies	None required.	Technologies readily available for all COCs except I-129. Technology evaluation for I-129 treatment is a component for each alternative.		
Cost				
Total Capital Cost	$0	$88,048,000	$131,348,000	$141,629,000
Total Annual O&M + Total Periodic Cost (non-discounted)	$0	$367,413,000	$293,477,000	$308,876,000
Total Non-Discounted Cost	$0	$455,461,000	$424,825,000	$450,505,000
Total Present Value)	$0	$313,901,000	$328,940,000	$352,038,000
Modifying Criteria				
State Acceptance	No	No	Yes	Yes
Community Acceptance	No	No	Yes	Yes

Table 10. Summary of 200-UP-1 OU Comparative Analysis of Alternatives

Criteria	No Action	Alternative 2 – 45 Years Active Remediation and MNA	Alternative 3 – 35 Years Active Remediation and MNA	Alternative 4 – 25 Years Active Remediation and MNA
Overall Protection of Human Health and the Environment	No	Yes	Yes	Yes
Compliance with ARARs	No	Yes, with an interim action waiver for the I-129 MCL of 1piC/L.		
Long-Term Effectiveness and Permanence	NA	Good. ICs can be maintained and extended as necessary to protect against inadvertent exposure until cleanup levels are achieved. Treatment residuals transported to secure facility for long-term management. Carbon tetrachloride will continue to pose a risk during the 125 year MNA period needed to achieve its cleanup level. Tritium will decay to its cleanup level within 25 years. I-129 will be hydraulically contained until a subsequent remedial decision is identified. I-129 will continue to pose a long-term risk.		
Reduction in Toxicity, Mobility, and Volume through Treatment	NA	Moderate. P&T and MNA reduce TMV for Tc-99, uranium and chromium, and nitrate. Tritium toxicity reduction occurs through MNA. I-129 mobility reduced through hydraulic containment until a subsequent remedial decision is identified. Immobilized treatment residuals transported to secure facility for permanent disposal.	Moderate. P&T and MNA reduce TMV for nitrate comparable to Alternative 2. TMV reduction is accelerated over Alternative 2 with more aggressive pumping rates for uranium and chromium. Tc-99 TMV reduction comparable to Alternative 2. Tritium toxicity reduction occurs through MNA. I-129 mobility reduced through hydraulic containment until a subsequent remedial decision is identified. Immobilized treatment residuals transported to secure facility for permanent disposal.	Good. TMV reduction is accelerated over Alternative 3 with the additional groundwater extraction from the diffuse part of the nitrate plume. TMV reduction comparable to Alternative 2 and Alternative 3. Tritium toxicity reduction occurs through MNA. I-129 mobility reduced through hydraulic containment until a subsequent remedial decision is identified. Immobilized treatment residuals transported to secure facility for permanent disposal.
Short-Term Effectiveness	NA	Good. Nominal short-term risks to workers during extraction and injection well installation and operation, during routine treatment facility O&M, and during periodic groundwater sampling events. Risks minimized through HSP and PPE. No adverse risks to community, due to the Site's remote location. Carbon tetrachloride requires 125 year of MNA to reach cleanup levels.		

Criteria	No Action	Alternative 2 – 45 Years Active Remediation and MNA	Alternative 3 – 35 Years Active Remediation and MNA	Alternative 4 – 25 Years Active Remediation and MNA
Implementability	NA	Moderate. Implemented with standard construction equipment and methods, and use of existing treatment facility capacity. Does not require modification of the treatment facility for additional biological treatment, but will require remedial process optimization to ensure that pumping and treatment throughput rates can be maintained over the 45 year pump-and-treat time frame. Optimization would be more difficult if only existing treatment capability is utilized. MNA for tritium, nitrate, and carbon tetrachloride can be readily implemented. Hydraulic containment for I-129 is similar to flow-path control approach used in 200-ZP-1 Groundwater OU and readily implementable	Good. Readily implemented with standard construction equipment and methods. Requires modification to the treatment facility for additional biological treatment processes. Additional capacity improves operational flexibility to operate under a broader range of flow conditions and contaminant loading. MNA for tritium, nitrate, and carbon tetrachloride can be readily implemented. Hydraulic containment for I-129 is similar to flow-path control approach used in 200-ZP-1 Groundwater OU and readily implementable	Moderate. Readily implemented with standard construction equipment and methods. Requires modification to the treatment facility for additional biological treatment processes. Pumping of the diffuse part of the nitrate plume results in increased amounts of nitrate sent to the treatment facility and requires additional biological treatment. Larger amounts of nitrate sent for treatment could potentially result in periodic overload of the biological system and result in unplanned shut-down periods if not adequately accounted for in design and operation. MNA for tritium and carbon tetrachloride can be readily implemented. Hydraulic containment for I-129 is similar to flow-path control approach used in 200-ZP-1 Groundwater OU and readily implementable.
Present Value	NA	$314 M	$329 M	$352 M
State Acceptance	No	No	Yes	Yes
Community Acceptance	No	No	Yes	Yes

11.0 Principal Threat Waste

The NCP (40 C.F.R. 300.430(a)(1)(iii)(A)) states that EPA expects to use treatment to address the principal threats posed by a site, wherever practicable. Principal threat wastes are source materials that are highly toxic or highly mobile that generally cannot be reliably contained or would pose a significant risk should exposure occur. Contaminated groundwater is generally not considered a principal threat waste because it has been impacted by releases from other sources or reservoirs of contamination that can be principal threat wastes (EPA, 1991, *A Guide to Principal Threat and Low Level Wastes*). Since the 200-UP-1 OU is a groundwater unit impacted by releases from other sources, principal threat wastes were not considered. The NCP expectation for contaminated groundwater is to return useable groundwater to its beneficial use wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site (40 C.F.R. § 300.430(a)(1)(iii)(F)).

12.0 Selected Remedy

This ROD presents the interim remedial action for the 200-UP-1 OU in the Hanford Site, 200 Area, Benton County, Washington, selected 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. The following subsections provide a summary of 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. Existing interim actions for the 200-UP-1 OU are superseded by this selected remedy.

12.1 Summary of the Rationale for the Selected Remedy

As part of the evaluation of alternatives, several key factors influenced selection of the selected remedy including the following:

- The expectation to restore the aquifer to its highest beneficial use as a potential drinking water source.
- The overall time to return the aquifer to beneficial use is the same for Alternatives 2 through 4 based on the time required to achieve the DWS for carbon tetrachloride (125 years). This is consistent with the timeframe identified in the ROD for achieving the DWS for carbon tetrachloride in the adjacent 200-ZP-1 OU.
- More aggressive pumping of contaminated groundwater does not reduce the overall time required to restore the aquifer.
- More aggressive pumping of nitrate contamination adds additional complexity for operations and creates additional solid material handling, dewatering and onsite disposal.

Alternative 3 was identified as the preferred alternative for remediation of the 200-UP-1 OU in the Proposed Plan. The basis for selecting Alternative 3 is that it reduces site risk through the extraction and treatment of contaminated groundwater to levels that support its use as a potential drinking water source and is protective of human health.

Alternative 3 meets the threshold criteria, complies with ARARS (or satisfies criteria for an ARAR waiver for I-129), and provides the best balance of tradeoffs with respect to the balancing and modifying criteria. It is readily implementable. It does not pose the implementation issues of Alternatives 2 and 4 nor the operations and maintenance issues of Alternative 4. While the costs are greater than Alternative 2, the additional cost is less than 5% of its total cost, and the greater groundwater extraction rates for Alternative 3 will result in reductions of uranium and chromium contamination sooner than that achieved under Alternative 2. While Alternative 4 provides for additional extraction and treatment of the diffuse nitrate plume, Alternative 3 provides comparable treatment results for all other constituents at approximately 6% less cost. Alternatives 2, 3 and 4 provide comparable levels of short-term effectiveness and long-term effectiveness and permanence. The community preferences expressed during the public comment period were split, with some expressing support for Alternative 3 and others expressing support for Alternative 4 or some hybrid of Alternatives 3 and 4. The State of Washington Department of Ecology concurs with the selection of Alternative 3. Alternative 3 is cost effective, uses permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and satisfies the preference for treatment as a principal element.

12.2 Detailed Description of the Selected Remedy

A detailed description of the major remedy components for the selected interim remedial action for the 200-UP-1 OU is provided in this section. The selected remedy will be conducted in accordance with a Remedial Design/Remedial Action (RD/RA) Work Plan approved by EPA. DOE will submit the RD/RA Work Plan, including schedule and milestone change package, for review and approval within a 270 day period after the ROD is signed. The RD/RA Work Plan will address development of an O&M Plan and Performance Monitoring Plan.

12.2.1 200-UP-1 OU Groundwater Extraction and Treatment 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 levels of uranium, technetium-99, total and hexavalent chromium, carbon tetrachloride, and nitrate. Extraction wells will be designed, installed, and operated to remove contaminated groundwater from the aquifer and to reduce or prevent further plume migration. Injection wells will be used to inject treated water back into the aquifer and to control groundwater flow.
The placement of injection wells near the plume margins or downgradient of the plume will provide flow path (gradient) control.

The pump-and-treat system will be designed and implemented in combination with monitored natural attenuation to achieve the cleanup levels listed in Table 14 for all COCs in the 200-UP-1 OU, except I-129, within the following time frames: 15 years for Tc-99, 25 years for uranium; 25 years for chromium (total and hexavalent) through pump-and-treat; 35 years for nitrate through pump-and-treat and MNA; and 125 years for carbon tetrachloride through pump-and-treat and MNA; and 25 years for tritium through MNA.

The estimated extraction rate is 430 gpm for parts of the carbon tetrachloride plume, the Tc-99 plumes, the uranium plume, the high concentration nitrate plume, and the chromium (total and hexavalent) plumes. The estimated number of extraction and injection wells and estimated pumping rates are:

- Tc-99 plumes in the WMA S-SX area (15 years) – 3 extraction wells at a total flow rate of 80 gpm. These extraction wells will also remove carbon tetrachloride.
- Uranium plume and high-concentration nitrate plume area (25 years) –2 extraction wells and 2 injection wells operating at a total flow rate of 150 gpm. These extraction wells will also remove carbon tetrachloride.
- Southeast chromium plume (25 years) – 2 extraction wells and 2 injection wells operating at a total flow rate of 200 gpm.

Treatment of contaminated extracted groundwater will be conducted at the 200 West Groundwater Treatment Facility. Modifications to the treatment facility will require addition of a U IX treatment train.

Other modifications to reach effluent requirements may include a third Tc-99 IX treatment train, and a third biological process treatment train. Following extraction, the COCs in groundwater will be treated to achieve the cleanup levels listed in Table 14. 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 Report and RD/RA Work Plan, which are subject to review and approval by EPA.

12.2.2 Monitored Natural Attenuation Component

In addition to the pump-and-treat system, natural attenuation processes will be used to reduce concentrations to below the cleanup levels in Table 14. Natural attenuation processes to be relied on include abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring will be employed in accordance with the approved RD/RA Work Plan to evaluate and confirm the effectiveness of the pump-and-treat system and natural attenuation processes.

MNA will be used to address the diffuse (low-concentration) nitrate plume areas not captured by the extraction wells. MNA will also address that portion of the carbon tetrachloride plume that remains after the active pumping period. The remaining carbon tetrachloride will require the longest MNA time frame estimated to be 125 years, which is consistent with the timeframe for carbon tetrachloride remediation in the ROD for the adjacent 200-ZP-1 OU. 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 in a reasonable time frame, which fate and transport modeling indicate will be 25 years.

12.2.3 I-129 Hydraulic Containment and Treatment Technology Evaluation Component

A technology evaluation to identify viable I-129 treatment technologies will be completed as part of the selected remedy. The evaluation will include a feasibility analysis of potential treatment options. The evaluation will be conducted in accordance with the RD/RA Work Plan approved by EPA. If one or more viable technologies are identified, treatability tests will be conducted. The treatability test planning documents are subject to review and approval by EPA as part of the RD/RA Work Plan.

Hydraulic containment of the I-129 plume will be implemented until a subsequent remedial decision for the I-129 plume is made. Hydraulic containment will be performed using injection wells placed at the leading edge of the I-129 plume. Treated water from the 200 West Groundwater Treatment Facility will be pumped to the injection wells. It is estimated that three injections wells with a flow rate of 50 gpm per well (150 gpm total) will be needed to contain the plume.

12.2.4 Remedy Performance Monitoring Component

Remedy performance monitoring is required to be conducted over the life of the interim remedial action to evaluate its performance and optimize its effectiveness and shall be conducted in accordance with the approved RD/RA Work Plan. For the MNA component, monitoring locations, activities, and specifications to evaluate performance will be described in the RD/RA Work Plan. Performance monitoring will be used to 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 for carbon tetrachloride, tritium and nitrate.

Performance monitoring for the extraction well network will include groundwater sampling and analysis for the COCs. Since cleanup decisions for the soil OUs located above the 200-UP-1 OU have not yet been identified, monitoring will also be conducted for the final COPCs, which include the COCs and the following contaminants: 1,4-dioxane, chloroform, tetrachloroethene, trichloroethene, and strontium-90. Monitoring for these constituents will help to determine if additional contaminants from source units are impacting groundwater at concentrations that may pose an unacceptable risk to human health and the environment.

Performance monitoring will also include monitoring of extraction well flow rates and water level measurements to evaluate groundwater flow path control and changes in water quality and the water table. Requirements for the performance monitoring of the 200 West Groundwater Treatment Facility will be identified in a Performance Monitoring Plan, subject to EPA review and approval.

The overarching requirement is to meet the groundwater cleanup levels identified in this ROD. Monitoring shall be conducted to evaluate the performance of the pump-and-treat system, hydraulic containment, and MNA components of the selected remedy and shall be designed and operated to:

- Demonstrate whether or not the remedial action being taken, including natural attenuation, will achieve cleanup levels for all COCs (except I-129) in the specified time frame,
- Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may impact the pump-and-treat system, natural attenuation processes, and the hydraulic containment actions,
- Verify that the contamination is not expanding downgradient, laterally or vertically subsequent to the period of time over which the pump-and-treat and hydraulic containment components have been functional,
- Detect new releases of final COPCs to the environment that could impact the effectiveness of the remedy,
- Verify attainment of remediation requirements.

12.2.5 Operations and Maintenance (O&M) Component

O&M requirements will be developed and presented in an O&M Plan, which will be subject to review and approval by EPA. The O&M plan will identify the activities necessary to operate and maintain the remedy from completion of construction through decontamination and decommissioning of the remedy. Remedial process optimization will also be addressed in the O&M Plan. Optimization will include the following:

- Optimizing groundwater extraction and injection, well numbers, placement and operations to satisfy remedy requirements through monitoring, observation and modeling, including by, but not limited to:
    - Reducing flow rates at low-concentration wells so that flow rates at higher concentration wells can be increased, and;
    - Cycling extraction well flows to optimize or balance hydraulic and contaminant mass loading rate to the treatment system

12.2.6 Institutional Controls Component

200-UP-1 OU groundwater use will be restricted. 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.

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 200-UP-1 OU Groundwater to prevent unacceptable exposure of humans to contaminants, except as otherwise authorized in lead regulatory agency approved documents.
2. Visitors entering any site areas of the 200-UP-1 OU will be required to be badged and escorted at all times.
3. No intrusive work shall be allowed in the 200-UP-1 OU unless the lead regulatory agency has approved the plan for such work and that plan is followed.
4. The DOE shall prohibit well drilling in the 200-UP-1 OU, except for monitoring, characterization, or remediation wells authorized in EPA approved documents.
5. Groundwater use in the 200-UP-1 OU is prohibited, except for limited research purposes, monitoring, and treatment authorized in EPA approved documents.
6. 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-UP-1 OU.
7. In the event of any unauthorized access (e.g. trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and evaluation of possible prosecution.
8. Activities that would disrupt or lessen the performance of the any component of the remedy are to be prohibited, except as otherwise authorized in lead regulatory agency approved documents.
9. The DOE shall prohibit activities that would damage the remedy components (e.g. extraction wells, piping, treatment plant, and monitoring wells), except as otherwise authorized in lead regulatory agency approved documents.
10. The DOE will prevent the development and use of property above the 200-UP-1 OU for residential housing, elementary and secondary schools, childcare facilities, and playgrounds.
11. The DOE shall report on the effectiveness of ICs for the 200-UP-1 OU interim remedy in an annual report, or on an alternative reporting frequency specified by the lead regulatory agency. Such reporting may be for the 200-UP-1 OU alone or may be part of the Hanford Site wide report.
12. Measures that are necessary to ensure continuation of ICs shall be taken before any lease or transfer of any land above the 200-UP-1 OU. DOE will provide notice to Ecology and EPA at

least 6 months before any transfer or sale of 200-UP-1 OU or any land above the 200-UP-1 OU so that the lead regulatory agency 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 Ecology and EPA at least 6 months before any transfer or sale, DOE will notify Ecology and EPA as soon as possible, but no later than 60 days before the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions, DOE further agrees to provide Ecology and EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to Ecology and EPA.

13. DOE shall notify EPA and Ecology immediately upon discovery of any activity inconsistent with the OU-specific institutional control objectives for the Site.

The ICs specified above will be maintained until 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.

12.2.7 Five-Year Review Component

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 will conduct 5 year reviews in accordance with EPA policy until levels that allow for unlimited use and unrestricted exposure are achieved. Reviews will begin no later than 5 years after initiation of the remedial action to help ensure that the selected remedy is protective of human health and the environment.

12.2.8 Land Use Control Boundary

The land use control boundaries for the 200-UP-1 OU are shown in Figure 11.

12.3 Summary of the Estimated Remedy Costs

Table 11 presents the estimated capital, annual, and other periodic costs for the selected remedy, in non-discounted dollars. The present value cost of the selected remedy is $328 million. Table 12 shows a more detailed breakdown of the capital costs. Table 13 then summarizes the present value analysis for the selected remedy over its full life cycle.

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.

Figure 11. 200-UP-1 Groundwater Operable Unit Land Use Control Boundary

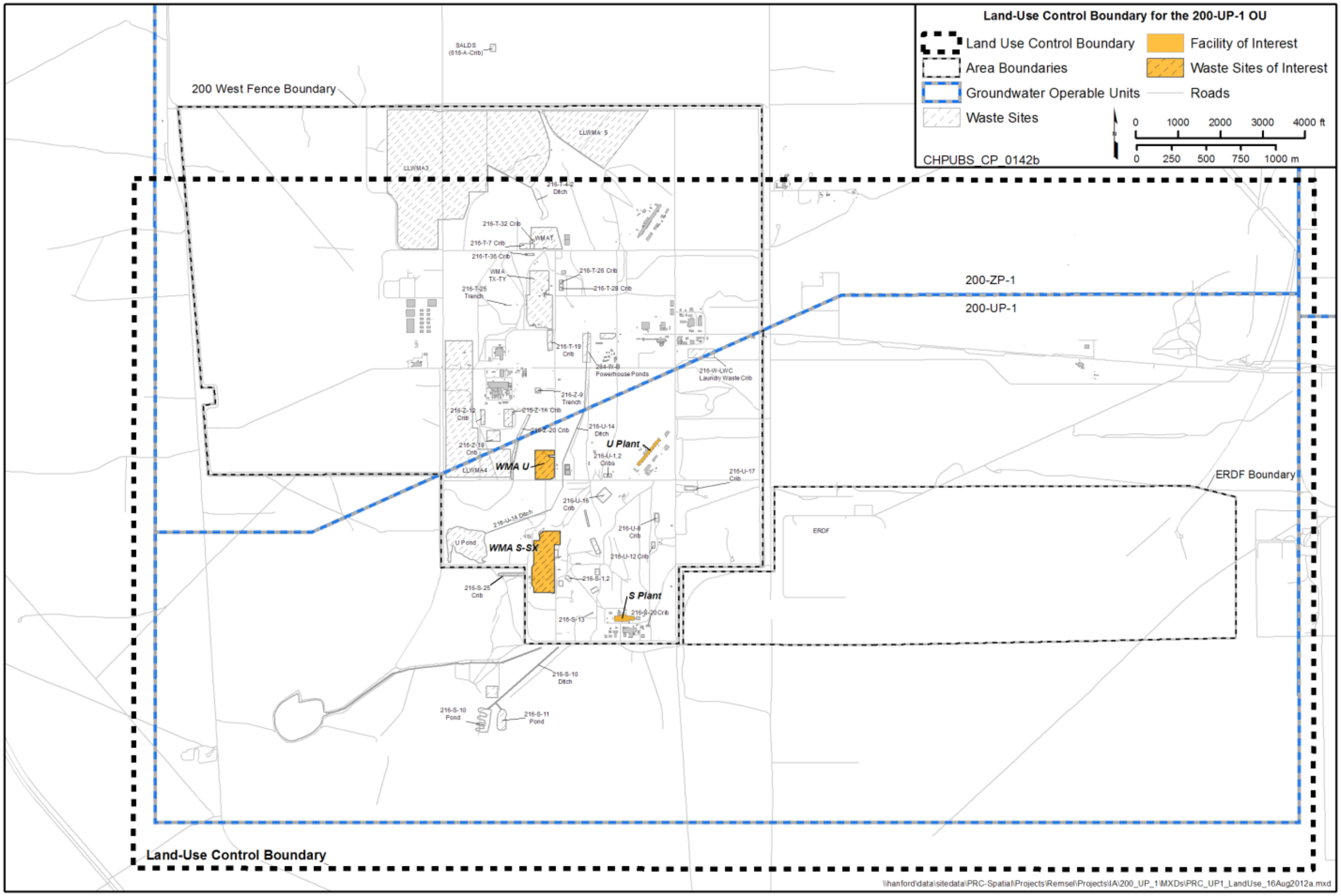


Table 11. Cost Estimate Summary for the Selected Remedy for 200-UP-1 OU

Item Description	Alternative 3
Nominal Extraction Flow Rate	430 gpm
Capital Cost	$131,348,000
Total Annual O&M Cost (non-discounted), summed over the remedy performance period	$205,787,000
Total Periodic Cost (non-discounted), summed over the performance period of 150 years	$87,690,000
Total Non-Discounted Cost	$424,825,000
Total NPV (2.0% Discount Rate)	**$328,940,000**

Table 12. Estimated Capital, Annual and Periodic Costs for the 200-UP-1 OU Remedy

Description	Quantity	Unit	Unit Cost	Cost
Capital Costs				
Extraction, injection, and monitoring wells	39	Wells	$446,410	$17,410,000
Piping	199,185	Linear Foot	$43.46	$8,657,000
Transfer buildings	2	Building	$11,504,000	$23,008,000
200 West Treatment Facility modifications				$41,652,000
Subtotal				$90,727,000
Contingency (33%)				$29,975,000
Project management and support				$10,646,000
Total capital cost				**$131,348,000**
Cumulative Annual Costs				
Pump and Treat (P&T) O&M				$125,763,000
Performance monitoring and evaluation				$53,401,000
Institutional controls *(for 150 year period)*				$26,623,000
Total annual cost				**$205,787,000**
Periodic Costs				
CERCLA reviews and reporting every 5 years				$4,684,500
Well replacement and rehabilitation				$62,138,000
Decommission P&T systems and wells				$20,867,200
Total periodic cost				**$87,690,000**
Total Remedy Cost				**$424,825,000**

All costs are in non-discounted dollars

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980

O&M = operations and maintenance

Table 13. Summary of Present Value Analysis

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost	Annual Discount Rate at 2.0%[a]	Present Value
2015	$131,348,000			$131,348,000	0.9423	$123,770,269
2016		$13,604,572	$2,322,700	$15,927,272	0.9238	$14,714,337
2017		$9,799,172	$3,298,600	$13,097,772	0.9057	$11,863,056
2018		$9,799,172	$2,322,700	$12,121,872	0.8880	$10,763,875
2019		$9,799,172	$3,298,600	$13,097,772	0.8706	$11,402,399
2020		$9,799,172	$3,646,500	$13,445,672	0.8535	$11,475,751
2021		$9,256,472	$3,298,600	$12,555,072	0.8368	$10,505,522
2022		$9,256,472	$2,322,700	$11,579,172	0.8203	$9,498,954
2023		$9,256,472	$3,298,600	$12,555,072	0.8043	$10,097,580
2024		$9,256,472	$2,322,700	$11,579,172	0.7885	$9,130,098
2025		$9,256,472	$9,927,200	$19,183,672	0.7730	$14,829,602
2026		$6,164,072	$1,890,100	$8,054,172	0.7579	$6,104,056
2027		$6,164,072	$1,080,000	$7,244,072	0.7430	$5,382,452
2028		$4,799,872	$604,600	$5,404,472	0.7284	$3,936,865
2029		$4,799,872	$1,580,500	$6,380,372	0.7142	$4,556,623
2030		$4,799,872	$1,697,200	$6,497,072	0.7002	$4,548,986
2031		$4,799,872	$1,580,500	$6,380,372	0.6864	$4,379,684
2032		$4,799,872	$604,600	$5,404,472	0.6730	$3,637,055
2033		$4,799,872	$3,311,500	$8,111,372	0.6598	$5,351,687
2034		$4,799,872	$0	$4,799,872	0.6468	$3,104,744
2035		$4,799,872	$10,531,200	$15,331,072	0.6342	$9,722,290
2036		$4,799,872	$0	$4,799,872	0.6217	$2,984,183
2037		$4,799,872	$975,900	$5,775,772	0.6095	$3,520,511
2038		$4,799,872	$0	$4,799,872	0.5976	$2,868,304
2039		$4,799,872	$975,900	$5,775,772	0.5859	$3,383,806
2040		$4,799,872	$1,092,600	$5,892,472	0.5744	$3,384,486
2041		$865,272	$1,001,000	$1,866,272	0.5631	$1,050,921
2042		$865,272	$1,001,000	$1,866,272	0.5521	$1,030,314
2043		$865,272	$1,001,000	$1,866,272	0.5412	$1,010,112
2044		$865,272	$1,001,000	$1,866,272	0.5306	$990,306
2045		$865,272	$11,223,100	$12,088,372	0.5202	$6,288,718
2046		$865,272	$8,429,400	$9,294,672	0.5100	$4,740,544
2047		$865,272	$0	$865,272	0.5000	$432,660
2048		$865,272	$0	$865,272	0.4902	$424,176
2049		$865,272	$0	$865,272	0.4806	$415,859
2050		$865,272	$672,600	$1,537,872	0.4712	$724,626
2051		$1,407,972	$264,900	$1,672,872	0.4619	$772,780
2052		$1,407,972	$0	$1,407,972	0.4529	$637,657
2053		$1,407,972	$0	$1,407,972	0.4440	$625,154
2054		$1,407,972	$0	$1,407,972	0.4353	$612,896

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost	Annual Discount Rate at 2.0%[a]	Present Value
2055		$1,407,972	$568,500	$1,976,472	0.4268	$843,496
2056		$258,472	$543,800	$802,272	0.4184	$335,671
2057		$258,472	$0	$258,472	0.4102	$106,024
2058		$258,472	$0	$258,472	0.4022	$103,945
2059		$258,472	$0	$258,472	0.3943	$101,907
2060		$258,472	$0	$258,472	0.3865	$99,909
2061		$258,472	$0	$258,472	0.3790	$97,950
2062		$258,472	$0	$258,472	0.3715	$96,030
2063		$258,472	$0	$258,472	0.3642	$94,147
2064		$258,472	$0	$258,472	0.3571	$92,301
2065		$258,472	$0	$258,472	0.3501	$90,491
2066		$258,472	$0	$258,472	0.3432	$88,716
2067		$258,472	$0	$258,472	0.3365	$86,977
2068		$258,472	$0	$258,472	0.3299	$85,271
2069		$258,472	$0	$258,472	0.3234	$83,599
2070		$258,472	$0	$258,472	0.3171	$81,960
2071		$258,472	$0	$258,472	0.3109	$80,353
2072		$129,236	$0	$129,236	0.3048	$39,389
2073		$129,236	$0	$129,236	0.2988	$38,616
2074		$129,236	$0	$129,236	0.2929	$37,859
2075		$129,236	$0	$129,236	0.2872	$37,117
2076		$129,236	$0	$129,236	0.2816	$36,389
2077		$129,236	$0	$129,236	0.2761	$35,676
2078		$129,236	$0	$129,236	0.2706	$34,976
2079		$129,236	$0	$129,236	0.2653	$34,290
2080		$129,236	$0	$129,236	0.2601	$33,618
2081		$129,236	$0	$129,236	0.2550	$32,959
2082		$129,236	$0	$129,236	0.2500	$32,313
2083		$129,236	$0	$129,236	0.2451	$31,679
2084		$129,236	$0	$129,236	0.2403	$31,058
2085		$129,236	$0	$129,236	0.2356	$30,449
2086		$129,236	$0	$129,236	0.2310	$29,852
2087		$129,236	$0	$129,236	0.2265	$29,266
2088		$129,236	$0	$129,236	0.2220	$28,693
2089		$129,236	$0	$129,236	0.2177	$28,130
2090		$129,236	$0	$129,236	0.2134	$27,578
2091		$129,236	$0	$129,236	0.2092	$27,038
2092		$129,236	$0	$129,236	0.2051	$26,508
2093		$129,236	$0	$129,236	0.2011	$25,988
2094		$129,236	$0	$129,236	0.1971	$25,478
2095		$129,236	$0	$129,236	0.1933	$24,979

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost	Annual Discount Rate at 2.0%[a]	Present Value
2096		$129,236	$0	$129,236	0.1895	$24,489
2097		$129,236	$0	$129,236	0.1858	$24,009
2098		$129,236	$0	$129,236	0.1821	$23,538
2099		$129,236	$0	$129,236	0.1786	$23,076
2100		$129,236	$0	$129,236	0.1751	$22,624
2101		$129,236	$0	$129,236	0.1716	$22,180
2102		$129,236	$0	$129,236	0.1683	$21,745
2103		$129,236	$0	$129,236	0.1650	$21,319
2104		$129,236	$0	$129,236	0.1617	$20,901
2105		$129,236	$0	$129,236	0.1586	$20,491
2106		$129,236	$0	$129,236	0.1554	$20,089
2107		$129,236	$0	$129,236	0.1524	$19,695
2108		$129,236	$0	$129,236	0.1494	$19,309
2109		$129,236	$0	$129,236	0.1465	$18,931
2110		$129,236	$0	$129,236	0.1436	$18,560
2111		$129,236	$0	$129,236	0.1408	$18,196
2112		$129,236	$0	$129,236	0.1380	$17,839
2113		$129,236	$0	$129,236	0.1353	$17,489
2114		$129,236	$0	$129,236	0.1327	$17,146
2115		$129,236	$0	$129,236	0.1301	$16,810
2116		$129,236	$0	$129,236	0.1275	$16,480
2117		$129,236	$0	$129,236	0.1250	$16,157
2118		$129,236	$0	$129,236	0.1226	$15,840
2119		$129,236	$0	$129,236	0.1202	$15,530
2120		$129,236	$0	$129,236	0.1178	$15,225
2121		$129,236	$0	$129,236	0.1155	$14,927
2122		$129,236	$0	$129,236	0.1132	$14,634
2123		$129,236	$0	$129,236	0.1110	$14,347
2124		$129,236	$0	$129,236	0.1088	$14,066
2125		$129,236	$0	$129,236	0.1067	$13,790
2126		$129,236	$0	$129,236	0.1046	$13,520
2127		$129,236	$0	$129,236	0.1026	$13,255
2128		$129,236	$0	$129,236	0.1005	$12,995
2129		$129,236	$0	$129,236	0.0986	$12,740
2130		$129,236	$0	$129,236	0.0966	$12,490
2131		$129,236	$0	$129,236	0.0948	$12,245
2132		$129,236	$0	$129,236	0.0929	$12,005
2133		$129,236	$0	$129,236	0.0911	$11,770
2134		$129,236	$0	$129,236	0.0893	$11,539
2135		$129,236	$0	$129,236	0.0875	$11,313
2136		$129,236	$0	$129,236	0.0858	$11,091

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost	Annual Discount Rate at 2.0%[a]	Present Value
2137		$129,236	$0	$129,236	0.0841	$10,873
2138		$129,236	$0	$129,236	0.0825	$10,660
2139		$129,236	$0	$129,236	0.0809	$10,451
2140		$129,236	$0	$129,236	0.0793	$10,246
2141		$129,236	$0	$129,236	0.0777	$10,045
2142		$129,236	$0	$129,236	0.0762	$9,848
2143		$129,236	$0	$129,236	0.0747	$9,655
2144		$129,236	$0	$129,236	0.0732	$9,466
2145		$129,236	$0	$129,236	0.0718	$9,280
2146		$129,236	$0	$129,236	0.0704	$9,098
2147		$129,236	$0	$129,236	0.0690	$8,920
2148		$129,236	$0	$129,236	0.0677	$8,745
2149		$129,236	$0	$129,236	0.0663	$8,574
2150		$129,236	$0	$129,236	0.0650	$8,405
2151		$129,236	$0	$129,236	0.0638	$8,241
2152		$129,236	$0	$129,236	0.0625	$8,079
2153		$129,236	$0	$129,236	0.0613	$7,921
2154		$129,236	$0	$129,236	0.0601	$7,765
2155		$129,236	$0	$129,236	0.0589	$7,613
2156		$129,236	$0	$129,236	0.0578	$7,464
2157		$129,236	$0	$129,236	0.0566	$7,317
2158		$129,236	$0	$129,236	0.0555	$7,174
2159		$129,236	$0	$129,236	0.0544	$7,033
2160		$129,236	$0	$129,236	0.0534	$6,895
2161		$129,236	$0	$129,236	0.0523	$6,760
2162		$129,236	$0	$129,236	0.0513	$6,628
2163		$129,236	$0	$129,236	0.0503	$6,498
2164		$129,236	$0	$129,236	0.0493	$6,370
2165		$129,236	$0	$129,236	0.0483	$6,245
Totals	**$131,348,000**	**$205,787,000**	**$87,690,000**	**$424,825,000**		**$328,940,000**

[a] Discount rate column is a calculated annual multiplier where the year specific discount multiplier = $1/(1+e)^n$, where e = 2.0% and n = year (1 to 150)

12.4 Expected Outcomes of the Selected Remedy

The expected outcome of the selected remedy is the return of the 200-UP-1 OU groundwater to a level that allows its use as a source of drinking water for all COCs, except I-129 and carbon tetrachloride, within 35 years. It will take up to 125 years for carbon tetrachloride contamination to achieve the cleanup level**.** The expected outcome for the I-129 plume is hydraulic containment. An evaluation of potential treatment technologies that can achieve drinking water standards will be conducted for I-129.
The evaluation will include a feasibility analysis of potential treatment options. If one or more viable technologies are identified, treatability tests will be conducted. Hydraulic containment of the I-129 plume will be implemented until a subsequent remedial decision for the I-129 plume is made. Institutional controls will need to be maintained and enforced by DOE to prevent unacceptable exposure to contaminated groundwater.

The cleanup levels for this 200-UP-1 OU groundwater interim remedial action are Federal and state drinking water MCLs and state groundwater cleanup levels (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 14 for the COCs in the 200-UP-1 OU 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]).

Table 14. Selected Cleanup Levels for 200-UP-1 OU

COCs	Units	90th Percentile Groundwater Concentrations	Federal Drinking Water Standard[a]	Model Toxics Control Act Method B Cleanup Levels		Cleanup Level
				Non-Carcinogens at HQ = 1	Carcinogens at 1×10^{-6} Risk Level	
I-129	pCi/L	3.5	1	–	–	1[d]
Tc-99	pCi/L	4,150	900	–	–	900
Tritium	pCi/L	51,150	20,000	–	–	20,000
Uranium	µg/L	206	30	–	–	30
Nitrate[b] (as NO3)	mg/L	133	45	113.6	–	45
Nitrate[b] (as N)	mg/L	30.1	10	25.6	–	10
Total Chromium	µg/L	99	100	24,000	–	100
Hexavalent Chromium	µg/L	52	- [c]	48	–	48
Carbon Tetrachloride	µg/L	189	5	5.6	0.34[e]	3.4[f]

a. Federal DWS from 40 C.F.R. Part 141, "National Primary Drinking Water Regulations," with I-129 and Tc-99 values from **EPA 816-F-00-002, *Implementation Guide for Radionuclides***.

b. Nitrate (NO3) may be expressed as the ion NO3 (NO3- NO_3) or as nitrogen (NO_3-N). The federal DWS for nitrate is 10 mg/L expressed as N and 45 mg/L expressed as NO_3^-. The state cleanup level is 25.6 mg/L, as nitrogen.

c. There is no federal DWS for hexavalent chromium.

d. Currently identified groundwater treatment technology is insufficient to reach the 1 pCi/L DWS.

e. This value is represents estimated risk from an individual contaminant, at 1×10^{-6} risk level.

f. This cleanup level is a risk-based calculation for carbon tetrachloride. This value represents a cumulative 1×10^{-5} risk in accordance with WAC 173-340-720(7)(a).

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, and contaminants as a principal element, and a bias against offsite disposal of untreated wastes.

CERCLA Section 121(c) also requires the use of five-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-UP-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 200 West Groundwater Treatment Facility is part of the OU adjacent to the 200-UP-1 OU and is within the areal extent of contamination and a suitable area in very close proximity to the contamination necessary for implementation of the response action and therefore also considered on-site.

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

13.1 Protection of Human Health and the Environment

The selected interim remedial action for the contaminated groundwater within the 200-UP-1 OU will be protective of human health and the environment. The selected remedy is designed to reduce existing contaminant concentration levels in the groundwater to achieve corresponding health-protective drinking-water MCLs as promulgated under the *Safe Drinking Water Act* (and state standards, where more stringent), with the exception of I-129. The selected remedy requires hydraulic containment of the I-129 plume, an I-129 treatment technology evaluation and treatability tests if viable technologies are identified.

The selected remedy will reduce CERCLA excess lifetime cancer risks to within the acceptable health-protective 10^{-4} to 10^{-6} risk range for the domestic groundwater exposure pathways and will achieve the threshold health-protective CERCLA hazard index of 1 for non-cancer health effects for all COCs, except I-129.

The selected remedy also requires institutional controls to be maintained to prevent access to the contaminated 200-UP-1 OU groundwater. Institutional controls will be required for the 200-UP-1 OU as long as groundwater contamination precludes its use as a potential source of drinking water. There are no short-term threats or cross media impacts associated with implementation of the selected remedy that cannot be readily controlled.

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. The selected remedy includes an interim ARAR waiver under 40 CFR 300.430(f)(l)(ii)(c)(1) of the federal DWS of 1 pCi/L for I-129, as the selected remedy is for an interim remedial action which will only be part of the total remedial action for the 200-UP-1 OU that will attain or otherwise waive the ARAR for I-129 upon completion of remedial action as required by CERCLA Section 121(d)(4), "Cleanup Standards," "Degree of Cleanup." There is currently no identified technologies that can treat the I-129 concentrations present in the 200-UP-1 OU to achieve the DWS. A subsequent ROD will be needed to complete the total remedial action for the 200-UP-1 OU. In the event a viable treatment technology is not available, the use of a technical impracticable waiver under 40 CFR 300.430(f)(l)(ii)(c)(3) may need to be considered as part of the final remedy.

The ARARs are the substantive provisions of any promulgated Federal environmental or more stringent state environmental or facility siting 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 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 (40 C.F.R. § 300.5). 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 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 (40 C.F.R. § 300.5). A definitive list of the ARARS that are to be complied with by the selected remedy is provided in Table 15 and Table 16. Table 15 lists the Federal requirements and Table 16 lists Washington State requirements.

Location-specific ARARs that have been identified include the substantive portions of laws and regulations that protect cultural, historic, and Native American sites and artifacts under the *Native American Graves Protection and Repatriation Act of 1990*, *Archaeological and Historic Preservation Act of 1974*, and *National Historic Preservation Act of 1966* (NHPA), and those that protect listed endangered and threatened species or their critical habitat under the *Endangered Species Act of 1973*. The *Migratory Bird Treaty Act of 1918* has been identified as an ARAR as there is a potential to adversely affect protected bird species.

The *Native American Graves Protection and Repatriation Act of 1990*, *Archaeological and Historic Preservation Act of 1974*, and NHPA apply to remedial actions that have the potential to affect cultural resources and areas of cultural sensitivity. Remediation may have the potential to impact or result in the discovery of such cultural resources. An analysis of potential remediation impacts to cultural resources will be completed prior to any remedial action. This will include an assessment of the cultural resources and areas of cultural sensitivity known to be present and a qualitative comparison to the risk posed by the contaminants present at these locations in accordance with *Hanford Cultural Resources Management Plan* (DOE/RL-98-10). This document identifies cultural resource guidelines and strategies that have been developed based on Hanford's history and cultural resources, and through recurring discussions with the State Historic Preservation Office and the Tribal Nations.

Table 15. Identification of Federal ARARs

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
***Safe Drinking Water Act of 1974* (Public Law 93-523, as amended; 42 USC 300f, et seq.); "National Primary Drinking Water Regulations" (40 CFR 141)**			
"Maximum Contaminant Levels for Organic Contaminants," 40 CFR 141.61	ARAR-chemical	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-UP-1 OU is not currently used for drinking water. However, Central Plateau groundwater is considered a potential drinking water source. Thus, the substantive requirements in 40 CFR 141.62 for organic, inorganic, and radionuclide constituents are relevant and appropriate, except for I-129, which is waived. MCLs will be achieved through groundwater treatment and MNA.
"Maximum Contaminant Levels for Inorganic Contaminants," 40 CFR 141.62	ARAR-chemical	Establishes MCLs for drinking water that are designed to protect human health from the potential adverse effects of inorganic contaminants in drinking water.	
"Maximum Contaminant Levels for Radionuclides," 40 CFR 141.66	ARAR-chemical	Establishes MCLs for drinking water that are designed to protect human health from the potential adverse effects of radionuclides in drinking water.	
Other Federal ARARs			
Archeological and Historic Preservation Act of 1974, 16 USC 469a-1 – 469a-2(d)	ARAR-location	Provides for the preservation of archaeological and 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 Area and may be present in areas where remedial action will be taken pursuant to this ROD; therefore, the substantive requirements of this act are applicable to actions that might result in loss of archaeological or historic data
National Historic Preservation Act of 1966, 16 USC 470, Section 106, et seq. "Protection of Historic Properties" (36 CFR 800)	ARAR-location	Requires federal agencies to consider the impacts of their undertaking on historic properties through identification, evaluation, and avoidance and if impact cannot be avoided through minimization and mitigation	Cultural and historic sites have been identified within the 200 Area and may be present in areas where remedial action will be taken pursuant to this ROD; therefore, the substantive requirements of this act are applicable to actions that might disturb these types of sites.
Native American Graves Protection and Repatriation Act of 1990, 25 USC 3001, et seq. "Native American Graves Protection and Repatriation Regulations" (43 CFR 10)	ARAR-location	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. The Tribal Nations will be consulted if such items are found during remediation.
Endangered Species Act of 1973,	ARAR-location	Prohibits actions by federal agencies that are	Substantive requirements of this act are applicable if

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
Public Law 93-205, as amended; 7 USC Section 136; 16 USC Ch. 1531, et seq. (50 CFR 402, "Interagency Cooperation—Endangered Species Act of 1973, as Amended")		likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of habitat critical to them. Mitigation measures must be applied to actions that occur within critical habitats or surrounding buffer zones of listed species, in order to protect the resource.	threatened or endangered species are identified in areas where RAs will occur or if RAs occur in critical habitats or surrounding buffer zones of listed species.
Migratory Bird Treaty Act of 1918 (16 USC 703-712; Ch. 128; 40 Stat. 755), as amended	ARAR-location	Protects all migratory bird species and prevents "take" of protected migratory birds, their young, or their eggs."	Migratory birds occur in the 200 West Area were 200-UP-1 OU remedial activities will take place.

Note: The state of Washington dangerous waste program has been authorized under the Resource Conservation and Recovery Act (RCRA) and WAC 173-303, "Dangerous Waste Regulations" to operate in lieu of federal RCRA hazardous waste regulations.

Table 16. Identification of State ARARs

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
"Hazardous Waste Cleanup -- Model Toxics Control Act" (RCW 70.105D, as amended); "Model Toxics Control Act—Cleanup" (WAC 173-340)			
"Ground Water Cleanup Standards" (WAC 173-340-720)	ARAR-chemical	These groundwater cleanup requirements are ARARs where they are more stringent than federal MCL ARARs. Method B equations (720-1 and 720-2) will be used to calculate groundwater cleanup levels for noncarcinogens and carcinogens, respectively. Requires an adjustment downward of Method B groundwater cleanup levels based on existing state or Federal cleanup standard so that the total excess cancer risk does not exceed 1 x 10^{-5} and the hazard index does not exceed 1.	The groundwater in the 200-UP-1 OU is not currently used for drinking water. However the 200-UP-1 OU groundwater is considered a potential drinking water source and is considered potable under WAC 173-340-720.
"Public Health and Safety," "Hazardous Waste Management" (RCW 70.105, as amended); "Dangerous Waste Regulations" (WAC 173-303)			
"Identifying Solid Waste" WAC 173-303-016	ARAR-action	Identifies those materials that are and are not solid wastes.	Substantive requirements of these regulations are applicable because they define how to determine which materials generated in conducting the selected remedial action are solid waste subject to the requirements for solid wastes and to dangerous waste designation requirements.
"Recycling Processes Involving Solid Waste" WAC 173-303-017	ARAR-action	Identifies materials that are and are not solid wastes when recycled.	
"Designation of Dangerous Waste" WAC 173-303-070(3)	ARAR-action	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 solid wastes 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 regulations.
"Excluded Categories of Waste" WAC 173-303-071	ARAR-action	Describes those categories of wastes that are excluded from the requirements of WAC 173-303 (excluding WAC 173-303-050).	This exclusion is applicable to waste from remedial actions in the 200-UP-1 OU, should wastes identified in WAC 173-303-071 be generated.
"Conditional Exclusion of Special Wastes"	ARAR-action	Establishes the conditional exclusion and the management requirements of special wastes,	Substantive requirements of this conditional exclusion are applicable to special wastes generated

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
WAC 173-303-073		as defined in WAC 173-303-040.	during the remedial action. .
"Requirements for Universal Waste" WAC 173-303-077	ARAR-action	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**.**
"Recycled, Reclaimed, and Recovered Wastes" WAC 173-303-120 Specific subsections: WAC 173-303-120(3) WAC 173-303-120(5)	ARAR-action	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.
"Land Disposal Restrictions" WAC 173-303-140	ARAR-action	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 ARARs for 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 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 land disposal restriction requirements.
"Requirements for Generators of Dangerous Waste" WAC 173-303-170	ARAR-action	Establishes the requirements for dangerous waste generators.	Substantive requirements of this regulation are applicable to dangerous waste generated during the remedial action. Specifically, the substantive standards for management of dangerous or mixed waste are ARARS to the management of dangerous waste that will be generated during the remedial action.
"Closure and post-closure" WAC 173-303-610	ARAR-action	Establishes requirements for clean closure of a TSD	The substantive requirements of this regulation are applicable to the 200 West Groundwater Treatment Facility since it treats groundwater that contains dangerous waste and is subject to closure

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
			requirements of a dangerous waste treatment unit.
"Use and Management of Containers" WAC 173-303-630	ARAR-action	Establishes requirements for dangerous waste facilities that store containers of dangerous waste	The substantive requirements of this regulation are applicable to the 200 West Groundwater Treatment Facility since it the treatment process will result in use of containers that store dangerous waste while awaiting disposal.
"Solid Waste Management—Reduction and Recycling" (RCW 70.95, as amended); "Solid Waste Handling Standards" (WAC 173-350)			
"On-Site Storage, Collection and Transportation Standards," WAC 173-350-300	ARAR-action	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-UP-1 OU remediation activities.
"Water Well Construction" (RCW 18.104, as amended); "Minimum Standards for Construction and Maintenance of Wells" (WAC 173-160)			
"How Shall Each Water Well Be Planned and Constructed?" (WAC 173-160-161)	ARAR-action	Identifies well planning and construction requirements.	The substantive requirements of these regulations are ARARs to actions that include construction and maintenance of wells used for groundwater extraction, monitoring, or injection of treated groundwater. 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 ARARs to groundwater well construction, monitoring, or injection of treated groundwater or wastes in the 200-UP-1 OU.
"What Are the Requirements for the Location of the Well Site and Access to the Well?" (WAC 173-160-171)	ARAR-action	Identifies the requirements for locating a well.	
"What Are the Requirements for Preserving the Natural Barriers to Ground Water Movement Between Aquifers?" (WAC 173-160-181)	ARAR-action	Identifies the requirements for preserving natural barriers to groundwater movement between aquifers.	
"What Are the Minimum Standards for Resource Protection Wells and Geotechnical Soil Borings?" (WAC 173-160-400)	ARAR-action	Identifies the minimum standards for resource protection wells and geotechnical soil borings.	
"What Are the General Construction Requirements for Resource Protection Wells?" (WAC 173-160-420)	ARAR-action	Identifies the general construction requirements for resource protection wells.	
"What Are the Equipment Cleaning Standards?"	ARAR-action	Identifies the minimum casing standards.	

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
(WAC 173-160-430)			
“What Are the Minimum Casing Standards?” (WAC 173-160-440)	ARAR-action	Identifies the equipment cleaning standards.	
“What Are the Well Sealing Requirements?” (WAC 173-160-450)	ARAR-action	Identifies the well sealing requirements.	
“What Is the Decommissioning Process for Resource Protection Wells?” (WAC 173-160-460)	ARAR-action	Identifies the decommissioning process for resource protection wells.	
“Underground Injection Control” WAC 173-218			
“UIC Well Classification Including Allowed and Prohibited Wells” (WAC 173-218-040)	ARAR-action	Identifies what an injection well is and types of prohibited wells.	The substantive requirements of these regulations are ARARs 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.
“Decommissioning of UIC Well” (WAC 173-218-120)	ARAR-action	Identifies requirements for decommissioning of UIC wells.	The substantive requirements of these regulations are ARARs to actions that deal with decommissioning UIC wells.
“Washington Clean Air Act” (RCW 70.94, as amended); “General Regulations for Air Pollution Sources” (WAC 173-400)			
“General Regulations for Air Pollution Sources” (WAC 173-400)	ARAR-action	Defines methods of control to be employed to minimize the release of air contaminants associated with fugitive emissions resulting from materials handling, construction, demolition, or other operations. Emissions are to be minimized through application of best available control technology.	Groundwater remedial actions implemented in the 200 Area pursuant to this ROD provide the potential for emissions subject to these standards because hazardous contaminants detected in 200-UP-1 OU groundwater include covered hazardous air pollutants.

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
“General Standards for Maximum Emissions” (WAC 173-400-040) “Emission Standards for Sources Emitting Hazardous Air Pollutants” (WAC 173-400-075)	ARAR-action	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. Establishes national emission standards for hazardous air pollutants. Adopts, by reference, 40 CFR 61, “National Emission Standards for Hazardous Air Pollutants,” and appendices.	Substantive requirements of these standards are ARARs to this remedial action when visible, particulate, fugitive, and hazardous air emissions and odors resulting from remedial activities will require assessment and reporting. This requirement is action-specific.
“Washington Clean Air Act” (RCW 70.94, as amended); “Controls for New Sources of Toxic Air Pollutants” (WAC 173-460)			
“Purpose” (WAC 173-460-010) “Applicability” (WAC 173-460-030) “Control Technology Requirements” (WAC 173-460-060) “Ambient Impact Requirement” (WAC 173-460-070) “First Tier Review” (WAC 173-460-080) “Table of ASIL, SQER and de Minimis Emission Values” (WAC 173-460-150) “Second Tier Review” (WAC 173-460-090)	ARAR-action	Requires that new sources of air emissions meet emission requirements identified in this regulation.	Substantive requirements of these standards are ARARs to this remedial action because of the potential for toxic air pollutants to become airborne as a result of remedial activities.
“Washington Clean Air Act” (RCW 70.94, as amended); “Ambient Air Quality Standards and Emission Limits for Radionuclides” (WAC 173-480)			
“General Standards for Maximum Permissible Emissions” (WAC 173-480-050(1))	ARAR-action	All radionuclide emission units are required to meet emission standards. At a minimum all emission units shall meet chapter 246-247 or 246-248 WAC (as applicable) requiring every reasonable effort to maintain radioactive materials in effluents to unrestricted areas, as low as reasonably achievable (ALARA).	Substantive requirements are ARARs when fugitive and diffuse emissions resulting from excavation occur, and related activities will require assessment and reporting. This requirement is action-specific.

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
"Emission Monitoring and Compliance Procedures" (WAC 173-480-070(2))	ARAR-action	Requires that radionuclide emissions 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 ARARs 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.
"Emission Standards for New and Modified Emission Units" (WAC 173-480-060)	ARAR-action	Requires that construction, installation, or establishment of new air emission control units use best available radionuclide control technology.	Hazardous contaminants detected in 200-UP-1 groundwater include radionuclides that could be emitted from air emission control units during remedial actions.
"Nuclear Energy and Radiation" (RCW 70.98, as amended); "Radiation Protection—Air Emissions" (WAC 246-247)			
"National Standards Adopted by Reference for Sources of Radionuclide Emissions" (WAC 246-247-035) (WAC 246-247-035(1)(a)(i) [adopts by reference 40 CFR 61.12, "Compliance with Standards and Maintenance Requirements"])	ARAR-action	Requires the owner or operator of each stationary source of hazardous air pollutants subject to a national emission standard for a hazardous air pollutant to determine compliance with numerical emission limits in accordance with emission tests established in "Emission Tests and Waiver of Emission Tests" (40 CFR 61.13) or as otherwise specified in an individual subpart. Compliance with design, equipment, work practice, or operational standards shall be determined as specified in the individual subpart. Also, maintain and operate the source, including associated equipment for air pollution control, in a manner consistent with good air pollution control practice for minimizing emissions.	Substantive requirements of this standard are ARARs because this remedial action may provide airborne emissions of radioactive particulates. As a result, requirements limiting emissions apply.

ARAR Citation	Relevancy and Category	Requirement	Rationale for Use
"National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities" (WAC 246-247-035 (1)(a)(ii) [adopts by reference 40 CFR 61.93, "Emission Monitoring and Test Procedures"])	ARAR-action	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 greater than 10 mrem/yr effective dose equivalent. This state regulation is as (or more) stringent that the equivalent Federal program requirement.	Substantive requirements of this standard are ARARs because this remedial action may provide airborne emissions of radioactive particulates. As a result, requirements limiting emissions apply. This is a risk-based standard for the purposes of protecting human health and the environment.
"General Standards" WAC 246-247-040(3) WAC 246-247-040(4)	ARAR-action	Requires that emissions be controlled to ensure ALARA-based and best available control standards are not exceeded.	Substantive requirements of this standard are ARARs 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.
"Monitoring, Testing and Quality Assurance" WAC 246-247-075	ARAR-action	Establishes the monitoring, testing, and quality assurance requirements for radioactive air emissions. Emissions from nonpoint and fugitive sources of airborne radioactive material will be measured. Measurement techniques may include but are not limited to sampling, calculation, smears, or other reasonable method for identifying emissions.	Substantive requirements of this standard are ARARs when fugitive and nonpoint source emissions of radionuclides to the ambient air may result from activities, such as operation of exhauster and vacuums, performed during the 200-UP-1 OU remedial action. This standard exists to ensure compliance with emission standards.

13.3 Cost Effectiveness

In the DOE and EPA's judgment, the Selected Remedy is cost-effective. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP § 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs.

The estimated total present value of the Selected Remedy is $328,940,000. Although Alternative 2 is less expensive at a total present value of $313,901,000, this alternative involves extracting contaminated groundwater at lower rates over a longer period of time than under Alternatives 3. Alternative 4 involves sending higher amounts of nitrate contamination to the treatment facility and adds additional complexity for operations and creates additional requirements for solid material handling, dewatering and onsite disposal, which in turn increases costs. Alternative 3 presents fewer operations, maintenance and residuals handling challenges than Alternative 4 due to the lower amounts of nitrate contaminated groundwater that would require biological treatment. Alternative 3 is readily implementable, in part due to a high level of construction, operation and optimization experience in a similar remedy being implemented in the adjacent 200-ZP-1 OU and the existing 200 West Groundwater Treatment Facility. Alternative 3 is cost effective relative to other alternatives.

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-UP-1 OU. 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 and 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 satisfies the criteria for long-term effectiveness by removing and treating groundwater contamination in combination with MNA to reduce contaminant levels to below drinking water standards for all COCs except I-129. A technology evaluation will be conducted to try and identify treatment technologies that can be employed to reduce I-129 to below drinking water standards. 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, except that the selected alternative is more readily implementable than the other alternatives. The services and materials required to implement this remedy are readily available. The State has concurred on the selection of Alternative 3. Based on public comment, some members of the public have expressed support for Alternative 3 while other have expressed support for Alternative 4 or some hybrid of Alternatives 3 and 4 that would involve more aggressive pumping rates.

13.5 Preference for Treatment as a Principal Element

Under CERCLA Section 121(b), remedial actions in which treatment which permanently and significantly reduces the volume, toxicity or mobility of hazardous substances, pollutants and contaminants as a principal element are to be preferred over remedial actions not involving such treatment. 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 or where treatment is impracticable."

There are no known contaminant source materials such as dense aqueous-phase liquids in the 200-UP-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-UP-1 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 contamination from portions of the affected aquifer which in combination with MNA will achieve cleanup levels for the COCs, except I-129. The extracted groundwater that is collected from the extraction well network will be treated to achieve the cleanup levels identified in Table 14 for uranium, technetium-99, total and hexavalent chromium, carbon tetrachloride, and nitrate prior to injection back into the aquifer. By using groundwater treatment as a significant portion of the remedy to reduce the volume and toxicity of hazardous substances, pollutants and contaminants, 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 CERCLA Section 121(c) and 40 CFR 300.430[f][4][ii] is required no less often than every five years after the initiation of remedial action 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. Because the selected remedy will not achieve levels that allow for unlimited use and unrestricted exposure, five year reviews will be conducted in accordance with CERCLA Section 121(c) and 40 CFR 300.430(f)(4)(ii) Reviews will begin five 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

No significant changes were made to the remedy.

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, criticisms and any new relevant information received during the public comment period on the Proposed Plan for interim remedial action of the 200-UP-1 OU on the Hanford Site.

2.0 Community Involvement

A formal public comment period on the Proposed Plan was held from July 17 through August 16, 2012. Individuals sent written comments through mail or electronically. The public comment period was publicized in the *Tri-City Herald* on July 17, 2012. A fact sheet on the Proposed Plan was mailed to the Hanford mailing list on July 16, 2012 and sent electronically on the Hanford Listserv on July 17, 2012. The newspaper ad, fact sheet, and listserv message stated that a public meeting on the Proposed Plan was not scheduled, but a meeting could be requested by contacting the listed EPA representative by phone, email, or mail. Two inquiries were made about potential public meetings, but no requests were made to have a public meeting on the Proposed Plan, so no public meetings were held.

3.0 Comments and Responses

Comments were received from 8 individuals and groups covering a range of topics. The following is a summary of the significant comments received:

- General Support for an Interim Remedy and Alternative 3
- Support for More Aggressive Pumping Rates (Alternative 4 or some combination of Alternatives 3 and 4)
- Need to Address Sources of Groundwater Contamination
- Concerns over Contamination Reaching the Columbia River and Adequacy of Risk Assessment
- Concerns over Exposure Point Concentration Values in Conducting Human Health Risk Assessment
- Need to Develop a Treatment Technology for Iodine-129 and Concerns Over Ability to Hydraulically Contain Iodine-129 Groundwater Contamination
- Concerns over Groundwater Plume Characterization and Treatment of Chromium Contamination
- Concerns with Cost Estimate Ranges
- Concerns over Comingling of US Ecology Contamination
- Concerns over Natural Disasters and Offsite Waste

Appendix A provides all the public comments received on the Proposed Plan, in their entirety. Agency responses to significant concerns, criticisms and any new relevant information received during the public comment period are provided below in the *italicized* text. No significant changes were made to the selected remedy based on public comment.

GENERAL SUPPORT FOR AN INTERIM REMEDY AND ALTERNATIVE 3
Response: The agencies agree and have selected Alternative 3 as the selected remedy for the interim remedial action for the 200-UP-1 OU.

SUPPORT FOR MORE AGGRESIVE PUMPING RATES (Alternative 4 or some combination of Alternatives 3 and 4)
Response: The agencies acknowledge that stopping plume migration of contaminated groundwater at Hanford is important and have identified groundwater remediation as a priority. DOE and EPA have selected Alternative 3 for implementation. Two key factors that influenced selection of Alternative 3 were: (1) although more aggressive pumping of contaminated groundwater reduces the time to reach cleanup levels for some contaminants, it does not reduce the overall time required to restore the aquifer to below cleanup levels; and, (2) the overall time to return the aquifer to beneficial use is the same for Alternatives 2 through 4 based on the time required to achieve the drinking water standard for carbon tetrachloride (125 years). This is consistent with the timeframe identified in the ROD for achieving the cleanup level for carbon tetrachloride in the adjacent 200-ZP-1 OU. Additionally, Alternative 3 presents fewer operations, maintenance and residuals handling challenges than Alternative 4 due to the lower amounts of nitrate-contaminated groundwater that would require biological treatment. Higher amounts of nitrate contamination sent to the treatment facility add additional complexity for operations and creates additional solid material handling, dewatering and onsite disposal. Alternative 3 will address the distal portions (edges) of the carbon tetrachloride and nitrate plumes through monitored natural attenuation (MNA) and will require DOE to reduce or prevent further plume migration.

NEED TO ADDRESS SOURCES OF GROUNDWATER CONTAMINATION
Response: DOE and EPA agree that it is important to stop contamination impacting Hanford's groundwater. Characterization and control of sources of groundwater contamination in the Hanford Central Plateau is or will be addressed through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process and Hanford Site Permit activities for the land overlying groundwater in this area. The agencies identified a need to begin groundwater remediation in the 200-UP-1 OU in order to stop further migration of groundwater contamination at levels that pose an unacceptable risk. This is why this interim cleanup decision is being made before decisions are in place for potential sources of continuing release from the vadose zone. Alternative 3 will require DOE to reduce or prevent further plume migration.

CONCERNS OVER CONTAMINATION REACHING THE COLUMBIA RIVER AND ADEQUACY OF RISK ASSESSMENT
Response: The agencies would like to clarify that based on fate and transport modeling conducted as part of the RI/FS, contamination originating from the 200-UP-1 OU will not migrate beyond the boundaries of the OU at levels that pose an unacceptable risk to people or the environment, even if no remedial action is taken. Since contaminated groundwater is not expected to migrate off the 200-UP-1 OU at levels that pose an unacceptable risk, it is not expected to impact the 300 Area or the Columbia River.

Draft versions of the 200-UP-1 Remedial Investigation/Feasibility Study (RI/FS) document had a third remedial action objective (RAO) identified to protect the Columbia River. Since the contamination from the 200-UP-1 OU is not expected to reach the Columbia River at levels that pose an unacceptable risk, this RAO was not included in the final RI/FS document.

There were no exposure of ecological receptors to 200-UP-1 OU contamination at levels that could pose unacceptable risk identified during the risk assessment. Due to this lack of direct or indirect exposure by ecological receptors to groundwater contamination from the 200-UP-1 OU at concentrations that pose unacceptable risk now or in the future, no baseline quantitative ecological risk evaluation was conducted.

Native American scenarios developed by the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) were evaluated in Appendix E of the RI/FS (DOE/RL-2009-122). The assessment of human health risk for this interim remedial action was based on reasonable maximum exposure associated with use of groundwater for drinking and other domestic purposes identified in the baseline risk assessment

CONCERNS OVER EXPOSURE POINT CONCENTRATION VALUES IN CONDUCTING THE HUMAN HEALTH RISK ASSESSMENT

Response: EPA and DOE recognize there are concerns over using the 90th percentile value instead of the 95 percent upper confidence limit (95% UCL) for estimating exposure point concentrations (EPCs). EPA Superfund guidance (OSWER 9285.6-10, Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites) recommends using the 95% UCL on the mean concentration for estimating EPCs. However, experience at the Hanford Site indicates that averages and UCLs can sometimes be unreliable for groundwater datasets. This is in part due to Hanford groundwater data being usually collected from areas with known contamination, which results in data sets containing higher contaminant concentrations and frequencies of detection. Additionally, the groundwater at 200-UP-1 OU exhibits an aquifer setting where multiple contaminants are present in overlapping plumes and the highest concentrations have different locations within the plumes.

The 90th percentile, which represents a value that is greater than 90% of the values in a data set, was identified as a potential value to use for EPCs. The 95% UCL on the mean represents a value that when calculated for a random data set equals or exceeds the true mean 95% of the time. The 90% UCL and the 90th percentile values were calculated for the 200-UP-1 OU data set. In comparing these two values, the 90th percentile (with few exceptions) is a higher concentration than the 95% UCL. The comparison shows that the 90th percentile concentration values are more conservative than the 95% UCL values. For those few instances where the 90th percentile value was lower than the 95% UCL, both values were used to determine potential risks and it was determined that these contaminants would have been eliminated during the COPC selection process, regardless of which value was used. Since the 90th percentile values are more conservative than the 95% UCL values, the 90th percentile was used to determine EPCs for the 200-UP-1 OU risk assessment. The method used to calculate EPCs was conservative and identified the appropriate COCs.

NEED TO DEVELOP A TREATMENT TECHNOLOGY FOR IODINE-129 AND CONCERNS OVER ABILITY TO HYDRAULICALLY CONTAIN IODINE-129 GROUNDWATER CONTAMINATION

Response: DOE and EPA recognize that evaluating technologies to address I-129 is an important part of the process of restoring the aquifer. While some commercial I-129 treatment technologies exist, these technologies are not effective in treating the high concentrations of I-129 present in the 200-UP-1 OU. The selected remedy includes a requirement for a technology evaluation to identify viable I-129 treatment technologies. The evaluation will include a feasibility analysis of potential treatment options. If one or more viable technologies are identified, treatability tests will be conducted. The costs for this evaluation are included in the costs of the selected remedy.

The agencies would like to clarify that the selected interim remedy will not re-inject groundwater contaminated with I-129 above the drinking water standard of 1 pCi/L. The selected interim remedy for I-129 is a technology evaluation, treatability tests for any viable technologies, and hydraulic containment. Groundwater extraction and treatment is not part of the interim remedy for the I-129 contamination. The I-129 plume will be contained by injecting treated groundwater at the leading edge of the I-129 plume.

CONCERNS OVER GROUNDWATER PLUME CHARACTERIZATION AND TREATMENT OF CHROMIUM CONTAMINATION

Response: The 200 West Groundwater Treatment Facility was designed and constructed to treat total and hexavalent chromium contamination. The system is designed to use bioreactor reduction to cause metals such as hexavalent chromium to coagulate and fall out of solution, meaning the chromium becomes a solid and can be filtered from the groundwater. The treatment system does not depend on a chromium ion exchange resin. The use of bioreactor reduction for contaminants such as hexavalent chromium is a proven technology. The influent groundwater currently going into the 200 West Groundwater Treatment Facility contains hexavalent chromium levels similar to the concentrations present in the 200-UP-1 OU and it is effectively removed by the fluidized bed reactor (i.e. there is no hexavalent chromium in the water once it goes through the treatment system). Treated groundwater leaving the 200 West treatment system must be below contaminant cleanup levels identified in the 200-ZP-1 and 200-UP-1 records of decision. DOE and EPA are confident that the levels of total and hexavalent chromium in the 200-UP-1 OU groundwater can be effectively treated through the 200 West Groundwater Treatment Facility's bio reduction system.

DOE and EPA acknowledge that more information is required to fully identify the size of the southeast chromium plume in the 200-UP-1 OU. The selected remedy was based on the "worst case scenario" for this plume and conservatively estimates the size and concentration of this plume based on a small amount of data. This was done to ensure that, even in the worst case, the selected remedy will address the fullest possible extent of contamination in the OU. The remedial design of the selected remedy will consist of collecting additional information to accurately design the groundwater extraction and treatment portion of the remedy to achieve the 48 µg/L cleanup level within 25 years for chromium (total and hexavalent).

DOE and EPA are confident that sufficient data was used to characterize the extent of nitrate contamination. This information is available in Chapter 4 for the 200-UP-1 OU RI/FS document.

CONCERNS WITH COST ESTIMATE RANGES

Response: The cost estimates presented in the Proposed Plan are based on cost estimates developed during the feasibility study and were created in accordance with EPA guidance (OSWER 9355.0-75, A Guide to Developing and Documenting Cost Estimates During the Feasibility Study). At the feasibility study stage, the design for the remedial action project is still conceptual and the cost estimate is considered to be an "order-of-magnitude" estimate. Assumptions about the detailed design are made in order to prepare the initial cost estimate, which is why a -30%/+50% range is given. After the selected remedy is identified, the remedial design can be developed in detail. At that point, the range of accuracy is reduced to a -10%/+15% range. The cost estimates in the Proposed Plan are intended to help readers compare the relative costs of each alternative to each other and, due to the uncertainties in the design, are not a final price tag of the alternative.

CONCERNS OVER COMINGLING OF US ECOLOGY CONTAMINATION

Response: US Ecology leases land on the Hanford Site and its operations are subject to regulation by the Washington State Department of Ecology and Washington State Department of Health. The agencies have had preliminary discussions on identifying how cleanup activities on the Hanford Site may impact contamination originating from the US Ecology site. Based on the current understanding of groundwater flow from the upgradient area of the 200-UP-1 OU towards the downgradient area where US Ecology is located, it is not believed that US Ecology is impacting the 200-UP-1 OU groundwater. At this time, US Ecology is not considered a source of the contamination present in the 200-UP-1 OU. The agencies plan to work collaboratively on this topic in the future to determine if US Ecology contamination is impacting the 200-UP-1 OU.

CONCERNS OVER NATURAL DISASTERS AND OFFSITE WASTE

Response: The potential for massive disasters such as flooding and earthquakes has been studied extensively at the Hanford Site. The potential effects of floods or earthquakes would be minimal for the 200-UP-1 OU. Seismic activity at Hanford is monitored through the Hanford Seismic Assessment Program (HASP). The 200 West Groundwater Treatment Facility has been constructed to withstand seismic and wind activity that may reasonably be expected to occur at Hanford and there are no expected impacts to the 200-UP-1 selected remedy.

The agencies would like to clarify that the selected remedy addresses groundwater contamination in the 200-UP-1 OU and does not address receipt of offsite radioactive waste at the Hanford Site. The receipt and management of offsite radioactive waste is subject to requirements and regulations applicable to such wastes.

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APPENDIX A

COMMENTER #1: Jose M Cardial, Oregon
This plan looks very good. Best proposal yet. I am very happy with the plan.

COMMENTER #2: Susan Leckband, Hanford Advisory Board
Dear Messrs. McCormick and Faulk,

The Hanford Advisory Board (Board) would like to thank the Tri-Party Agreement (TPA) agencies for the 200-UP-1 Remedial Investigation/Feasibility Study (RI/FS), Proposed Plan, and Interim Record of Decision (Interim ROD) presentation provided to the Board's River and Plateau Committee meeting on July 11, 2012. The Board compliments a collaborative TPA effort that moves remediation forward with this well-founded project through a well-considered process. Additionally, the Board further appreciates the thoughtful, built-in, additional capacity of the new 200-West Groundwater Treatment Facility that will optimize treatment expansion to include 200-UP-1 groundwater remediation.

The Board fully supports the use of the Interim ROD process for 200-UP-1, since time is of the essence to reduce the impact of the expanding groundwater contaminant plumes. The use of an Interim ROD provides an opportunity to address the need for more detailed characterization of the lesser defined plumes (e.g. chromium plume), and provides more time to identify potential Iodine-129 groundwater remediation technologies.

The Board concurs with the choice of Alternative Three in the Proposed Plan, Rev. 0 and commends the TPA Agencies for a well-written plan.

Sincerely,

Susan Leckband
Hanford Advisory Board Chair

COMMENTER #3: Gordon C. Smith, Seattle, WA
Dear Ms. Nguyen –
I am writing in regard to the cleanup strategies for the contaminated groundwater in the central area. Minimizing and stopping the plume spread of groundwater contaminants at Hanford is of primary importance – A problem that must be solved in our generation.
I urge you to pursue alternative #4 and sponsor research on more permanent and effective solutions
Thank you –
Gordon C. Smith
8029 Meridian N
Seattle 98103

P.S. please tell Emerald I support a meeting in Seattle

COMMENTER #4: Jan Castle, Lake Oswego, OR
Dear Ms. Nguyen,
Thank you for the opportunity to comment on the proposed plan to clean up contaminated groundwater in the 200-UP-1 Groundwater OU at Hanford. I am pleased to see this plan and am hopeful that experience with this project will lead to clean-up of the larger plumes which are already making their way to the

Columbia River. This is an important step in fulfilling our moral obligation to return this land to the tribes from whom we have borrowed it, and I commend USDOE for their thoughtful planning.
I sought interpretation of this report from Ken Niles of the Oregon Department of Energy, who shared his letter to you with me. Based on what I have read, I would agree that a combination of Alternatives 3 and 4 would be most desirable, with pumping as aggressive as you can make it considering the depth of the aquifer, in order to best treat the edges of the carbon tetrachloride and nitrate plumes.
The Proposed Plan appears to be a very important piece of a larger puzzle which needs to be fully assembled before work should begin. The other pieces of the puzzle that should be addressed concurrently with pumping and treating are:

- Identify and eliminate the contaminant source in the vadose zone. It seems that it would be far more expensive to treat a continuous supply of contamination indefinitely than to eliminate the source.

- Develop a way to treat the Iodine 129 contamination in the groundwater. The risk of spreading Iodine 129 by injecting treated water must be eliminated. The whole plan is pointless if the Iodine is not removed.

- Add a chromium ion exchange train (as has been developed and well proven along the River Corridor) to deal directly with the 200-UP-1 chromium plume.

- Address the potential co-mingling of groundwater plumes from Hanford operations and contaminants originating from the US Ecology site.

Again, I commend USDOE for developing this plan and look forward to more progress on the daunting challenge of cleaning up the Hanford site.

Jan Castle
16181 Parelius Circle
Lake Oswego, OR 97034-4673

COMMENTER #5: Paul Bulkley
Ladies/Gentlemen:
Public response deemed a key element in the decision making process has been requested for the proposed cleanup program. Three cleanup Alternative programs #2, #3, and #4 have been identified, and already Alternative #3 has been declared the approved choice by the U.S.Department of Energy (DOE), U.S.Environmental Protection Agency (EPA), and Washington State Department of Ecology.
The proposed cleanup Alternative programs as per 200-UP-1 are given in detail. Alternative programs #5 and #6 have been already excluded from further consideration. The treatment process and resolution of the contaminated groundwater in all three Alternate programs appear similar. The claimed costs of all three Alternates fairly similar ($304 million to $342 million).
It is clear there are many advantages in adopting Alternate #4:
1. The cleanup process is undertaken in 25 years - 20 years faster (Alternate #2) and 10 years faster (Alternate #3). The real risk of serious contamination of the Columbia River minimized to the shortest period.
2. Unexpected economic shocks and excessive inflation is limited to the shortest period.

3. The real risk of the polluted site suffering a massive disaster such as earthquakes and other real physical climatic disasters subjecting 5 to 10 million individuals to grave physical, ecological, and economic danger (Washington, Oregon, and Idaho) limited to the shortest period.
Although the cost of all three Alternative programs are fairly similar, the risks of Alternative #4 is considerably less, and appears an obvious choice. Bluntly I am puzzled why Federal and State Departments have chosen Alternative 3# and have ignored the obvious risks. Why is there no explanation? Now a subject of considerable concern - COST.
I am appalled that you expect a meaningful public response based on your projected project costs that range incredibly from plus 50% and minus 30%. What kind of estimate prognosis is that? Taking into consideration the enormous amount of site data, site conditions, and scientific research, any qualified cost opinion should be in the range of plus and minus 5% with the understanding that the cost planning process is of a high professional standard not subject to vested interests, and with sound rigid no nonsense cost control throughout the planning/design/construction phases.
This expectation is not unreasonable. With correct skilled cost planning procedures, construction projects however complex and irregardless of magnitude should have a cost prognosis within 1%-2% of averaged bids, and with sound cost control not subject to vested interest interference throughout the design and construction phases a final construction cost similar to the budget cost prognosis.
How can you be serious inviting the public to make meaningful opinions of the three Alternative programs when your cost prognosis for the identical solution range from $213 million to $513 million?

Alternate #2	$304 million	$213 million (-30% range)	$456 million (+50% range)
#3	$319 million	$223 million	$479 million
#4	$342 million	$240 million	$513 million

Sincerely Yours,

Paul Bulkley

COMMENTER #6: Jeanne Raymond, Corvallis, Oregon
Comments to Tifany Nguyen, U.S. Department of Energy, Richland Operations Office
Proposed cleanup plan of 200-UP-1
1. The clean-up plan does not address the first priority, which in my opinion, is to reject any new source of radioactive waste to the site.
2. The alternatives to cleanup in the "proposed cleanup plan" seem to be a misnomer, if they do not clean up the site.
3. Admission to the reality that there is no technical solution at this time to I-129, should be presented to public officials, news sources, and public agencies.
4. Are we to presume that since all alternative actions require a minimum of 25 years clean-up (alternative 4), 35 years for your preferred plan (alternative 3) 45 years (alternative 2), and indefinitely (alternative 1), that meanwhile toxic radioactive waste will continue to contaminate the ground water? Does this contaminated groundwater continue to threaten the waters of the Columbia River? This contaminated groundwater poses an unacceptable risk to the health of those who would drink or bathe in those contaminated waters.
5. If the above is true, how can this be acceptable to the DOE or to the people of Washington and Oregon?
6. If the FS determines that the considered alternatives are the only and best feasible plans, then that which would take the shortest time to remedy, would be the preferred. I suggest seeking additional alternatives.

Jeanne Raymond
Corvallis, Oregon

COMMENTER #7: Ken Niles, Oregon Department of Energy
August 14, 2012
Dear Ms. Nguyen:
Oregon appreciates the opportunity to review and comment on important clean-up decisions, such as the *Remedial Investigation/Feasibility Study and Proposed Plan for the 200-UP-1 Groundwater Operable Unit*, (DOE/RL-2009-122, Revision 0).
Oregon commends the U.S. Department of Energy (DOE) for a well thought-out planning approach, especially for the forethought of building extra capacity into the 200-West groundwater treatment facility to allow expansion for 200-UP-1 groundwater remediation.
We appreciate and support the decision to proceed with remediation of the 200-UP-1 groundwater unit, based on an interim Proposed Plan approach which delays the final Record of Decision until some groundwater plumes (such as chromium and nitrates) have been better defined, and which provides more time to identify iodine 129 groundwater remediation technologies.
While Oregon is generally supportive of Alternative 3, the higher rate of pumping that is proposed in Alternative 4 seems that it would better address the edges of the carbon tetrachloride and nitrate plumes. The faster, more complete remedy achieved by implementation of Alternative 4 would also minimize DOE's potential liabilities under the Natural Resource Damage Assessment provisions of CERCLA. We do note that the depth of groundwater in the Central Plateau aquifer may not allow the aggressive pumping that Alternative 4 proposes, so a remedy intermediate between those of Alternatives 3 and 4 might be more appropriate.
While we support the general approach described in the Proposed Plan, Oregon continues to have concerns about some aspects of the 200-UP-1 proposed groundwater remediation approach.

- We are particularly concerned that groundwater treatment is proceeding even though the source(s) for much of the groundwater contamination has not been identified nor dealt with in the vadose zone. This cart-before-the horse approach basically deals with contamination that is in the groundwater now, but not with that which is yet to be released from the vadose zone source(s). While it is important and laudable to begin remediation of existing plumes without delay, it is equally important to identify and characterize source areas. The EPA Remedy Review Board recommendations for the 100-K, 200-UP-1 and 300 Areas of the Hanford Superfund Site said, "The Board notes that the (200-UP-1) remediation time frames for all alternatives assume that the contaminant source is eliminated. However, vadose zone contamination still exists." Failure to identify and clean-up source areas creates a high potential that pump-and-treat systems will need to operate on a long, open-ended time frame to remediate continuing contaminant releases into groundwater.

- We would like to see DOE take a more aggressive approach to address the iodine 129 groundwater contamination. Iodine has been identified as one of the largest risk contaminants of concern at Hanford (most recently by the Hanford Natural Resource Trustee Council Vadose Zone Integration Expert Panel). To date, little attention has been given to this important contaminant in Hanford aquifers, based on the presumed lack of an appropriate remediation technology. There are, however, iodine remediation technologies currently on the market which potentially could be used or adapted to address the problems at Hanford. Because the current treatment facility is not designed to specifically remove iodine, re-injecting treated groundwater into the aquifer may actually serve to spread the iodine contamination. That problem could be alleviated if DOE were able to identify an iodine treatment technology.

- We are also concerned that there is no chromium treatment train (like the ion-exchange resin found in the 100-Area pump-and-treat systems) in the 200-West groundwater treatment facility. Rather it has been assumed that the reducing environment of the bio-reactors (meant to digest nitrate) will cause the chromium^6 to convert to chromium^3, causing it to flocculate. There has been no treatment test of this phenomena's success or rate of occurrence, and bio-reactions are often temperamental and cyclic. Oregon urges DOE to consider adding a chromium ion exchange train (as has been developed and well proven along the River Corridor) to deal directly with the 200-UP-1 chromium plume.

- Only two wells define the 200-UP-1 chromium plume. There is a need for a considerable amount of additional characterization to determine the lateral extent and depth of the contamination in the aquifer.

- Finally, there is no mention of the potential co-mingling of groundwater plumes from Hanford operations and contaminants originating from the US Ecology site. It is unclear to us how remediation of these groundwater plumes will be managed and it appears that steps have not yet been taken to answer these questions. The likely mixing of contaminants from Hanford sites and US Ecology provides an interesting opportunity for a collaborative solution.

If you have any questions or comments about our recommendations, please contact Dale Engstrom of my staff at 503-378-5584 (or dale.engstrom@odoe.state.or.us).
Sincerely,
Ken Niles,
Administrator, Nuclear Safety Division

Commenter #8: Russell Jim, Confederated Tribes and Bands of the Yakama Nation ERWM

August 16, 2012

Dear Mr. Faulk:

The U.S. Environmental Protection Agency (EPA) anticipates issuing the Record of Decision (ROD) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for the 200-UP-1 Groundwater Operable Unit (OU) this year. The Confederated Tribes and Bands of the Yakama Nation appreciate the opportunity to review and provide comments on this document.

While we applaud EPA's decision to issue the remedy for the 200-UP-1 OU as an Interim ROD, our concerns, for the most part, remain outstanding. The attached comments summarize our significant concerns. We have also attached copies of supporting documents on these same topics. We look forward to discussing our concerns regarding current cleanup plans for Hanford with you further.

Sincerely,

Russell Jim
Yakama Nation ERWM Program Manager

Attachment 1: Yakama Nation Comments on: DOE/RL-2010-05 Revision *0, Proposed Plan* for Remediation of the 200-UP-I Groundwater Operable Unit, July 2012

General:
The Preferred Alternative - Alternative 3 - relies heavily on several assumptions, hydraulic containment and monitored natural attenuation (MNA) being foremost. Somewhat simplistic statements are made to reassure the public that through the reinjection of *treated* water near the margins or down-gradient of the plume, a hydraulic condition will occur to prevent further

outward spread of I-129 contamination. What is not acknowledged is that reinjection will be of water containing the very contamination (I-129) you are trying to prevent and that the geological stratigraphy underlying the plumes is varied. Not discussed is the issue of just how and when there is to be an evaluation of I-129 treatment technologies and from where the funding dollars for research will be procured. There is an implied future use of *a request for technical wavier* without further remedial actions.

While there is some acknowledgement of and the need for additional characterization (particularly with regards to the chromium plumes in the 200 Areas and the influence from inputs from U.S. Ecology to the east) and new well placements, there is little information within the Proposed Plan as to how these additional, yet essential to the performance of the remedy, requirements will be achieved. There is an over-reliance on the ability of the 200-ZP-l OU systems to capture and treat the contaminants of concern for the 200-UP-1. The design of the 200-ZP-l facility is not robust enough to guarantee the treatment of chromium (total or hexavalent). Far-field well area contamination (chromium to the south and nitrate to the north) will not have a complete remedy. How will the remedy for groundwater meet the goal without addressing future impacts from sources in the vadose zone? Relying solely on a system (anaerobic and aerobic biodegradation) that has not been demonstrated to be a proven technology for the removal of a non-organic contaminant does not meet the CERCLA remedy requirements to remediate all contaminant concerns. Instead of reliance on unknown future technologies, we suggest utilization of the successful ion-exchange resin that has been developed and evolved into the treatment used now on the River Corridor for capture of chromium and strong base resins like Dowex 1 and Purolite A909 as ion exchange media for removing 1-129.

We remain very concerned that there has not been an ecological risk assessment performed when risk from the Central Plateau groundwater plumes is clearly identified in the 300 Area ROD documents. It is unclear why Remedial Action Objective (RAO) #3 of the Draft Proposed Plan, where DOE acknowledges the need to protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants migrating from 200-UP-1, has been removed from the Final Proposed Plan. Protecting the Columbia River is a critical goal for the cleanup of Hanford and should be included. Furthermore, we do not support use of the 90^{th} percentile concentration values in determining Exposure Point Concentration values. The approach used to calculate Exposure Point Concentrations (EPCs) is a deviation from CERCLA risk assessment guidance and will be precedent setting. The way the EPCs have been calculated has also resulted in elimination of COCs.[1] We also request DOE revise risk values dependent upon the YN Exposure Scenario.

We are concerned that while Ecology has concluded that the *proposed approach for treatment* and monitoring complies with the Applicable or Relevant and Appropriate Requirements *(ARARs) of MTCA (WAG 173-340),* the active phase of treatment extends for only a short period of time with reliance on use of institutional controls (ICs) and monitored natural attenuation (MNA) for nearly a hundred years. We remain very concerned that our Treaty Rights will be infringed upon with the needed extensive remediation of the groundwater as there will be continued effects and potential new contaminants of concern (COCs) from the Tank Farms not considered in this Proposed Plan. We are concerned that any remedy reviews will not include actual sampling actions or technological systems review to confirm performance.

[1] OSWER 9285.6-10, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites,* states that, "an exposure point concentration (EPC) is a conservative estimate of the average chemical concentration in an exposure medium." OSWER Publication 9285.7-081, *Supplemental Guidance to RAGS: Calculating the Concentration Term,* states that, "because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable."